Air Chief Marshal (later Marshal of the Royal Air Force) Sir Arthur Harris
C.-in-C. Bomber Command 1942-1945

Photograph courtesy of Imperial War Museum, London.
PRESS ON REGARDLESS

A HISTORY OF THE ORIGINS AND ACHIEVEMENTS
OF THE R.A.F.'S PATHFINDER FORCE 1916 - 1945

A Thesis

Submitted in partial fulfillment
of the requirements for the Degree
of

Master of Arts in History

in the

University of Canterbury

by

Rex F. Cording

University of Canterbury 1992
GROUP HEADQUARTERS
ROYAL AIR FORCE
WE GUIDE TO STRIKE

College of Arms,
November, 1954.

Chester Herald
and Inspector of Royal
Air Force Badges.
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PREFACE

The object proposed in this study is to consider both the activities and the importance of the Pathfinder Force, Royal Air Force, in the Second World War.

Their story has a much earlier beginning than 15 August 1942 when the founder squadrons gathered on various R.A.F. stations in the vicinity of the cathedral city of Ely in Cambridgeshire. Some form of target finding and marking force became inevitable from the moment it was acknowledged that the preparations that had been made for war during the 1930s were less than adequate. The arguments that ensued prior to August 1942 were much less concerned with the need, than with the form, such a force should take. Unfortunately, while the administrative in-fighting surged back and forth, R.A.F. aircrews went to war not only insufficiently trained but also poorly equipped. Necessity and duty drove these men to attempt to combat weather conditions and enemy defensive measures in aircraft, that all too frequently, were unfitted for the roles they were expected to fulfil. To their credit they pressed on despite the hazards of weather, the fury of enemy defences and the deficiencies of their aircraft and equipment. Regardless of the forces of nature and man ranged against them, the crews of Bomber Command and the Pathfinder Force pressed on.

It is therefore fitting that 'Press on Regardless' became the unofficial motto of the Pathfinder Force. It would also provide a singularly apt epitaph for the 3,727 men of the Pathfinder Force who were killed on operations.

This work has been written in tribute to all who served in the Pathfinder Force but particularly to those who failed to return.

R.F. CORDING
DECEMBER 1992
ACKNOWLEDGEMENTS

Firstly, I must express my gratitude to all those ex-pathfinders who have both assisted and encouraged me in the production of this work. In this respect two names stand out - Allan J. Vial in Queensland and George Sanders in New Zealand. Special thanks also go to the numerous other ex-pathfinders who have taken the trouble to write to me, to respond to questions, or who have provided me with copies of their books. In this respect two names in particular come to mind - Hamish Mahaddie in England, and Bob Nielsen, who was living in the United States but may now be home in Australia.

Thank you also to Therese Angelo, Research Officer at the R.N.Z.A.F. Museum at Wigram, Staff at the Library of the Ministry of Defence in Wellington and the Staff at the Library of the University of Canterbury. Your efforts on my behalf are all much appreciated.

Thank you also to Vincent Orange, my tutor at the University of Canterbury, for your guidance and encouragement.

The final thank you goes to my daughter Susan Wardrop for the sacrifices entailed in doing my typing. Without your expertise my work would never have been completed.

In conclusion, my apologies to Tom Scotland in Western Australia - the story of the Pathfinders operating from Italy in 205 Group, 614 Squadron, has yet to be told.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>A.B.C.</td>
<td>Airborne Cigar. Jamming of German V.H.F. transmissions used to control night fighters.</td>
</tr>
<tr>
<td>A.E.A.F.</td>
<td>Allied Expeditionary Air Force</td>
</tr>
<tr>
<td>A.I.</td>
<td>Airborne Interception (Aircraft Radar)</td>
</tr>
<tr>
<td>A.M.P.</td>
<td>Air Member for Personnel</td>
</tr>
<tr>
<td>A.O.C.</td>
<td>Air Officer Commanding</td>
</tr>
<tr>
<td>A.O.S.</td>
<td>Air Observers' School</td>
</tr>
<tr>
<td>A.P.I.</td>
<td>Air Position Indicator (Automatic air plot)</td>
</tr>
<tr>
<td>A.S.V.</td>
<td>Air to Surface Vessel (Radar Device)</td>
</tr>
<tr>
<td>B.B.S.U.</td>
<td>British Bombing Survey Unit</td>
</tr>
<tr>
<td>B.D.U.</td>
<td>Bomber Development Unit</td>
</tr>
<tr>
<td>B.H.P.</td>
<td>Beardmore - Halford - Pullinger (Aero engine)</td>
</tr>
<tr>
<td>B.I.B.</td>
<td>Baby Incendiary Bomb</td>
</tr>
<tr>
<td>C</td>
<td>Compass Heading (Allowing for Variation and Deviation)</td>
</tr>
<tr>
<td>C.A.S.</td>
<td>Chief of the Air Staff</td>
</tr>
<tr>
<td>C.I.D.</td>
<td>Committee of Imperial Defence</td>
</tr>
<tr>
<td>C.-IN-C.</td>
<td>Commander-in-Chief</td>
</tr>
<tr>
<td>C.I.G.S.</td>
<td>Chief of the Imperial General Staff</td>
</tr>
<tr>
<td>C.R.T.</td>
<td>Cathode Ray Tube</td>
</tr>
<tr>
<td>C.S.B.S.</td>
<td>Course Setting Bomb Sight</td>
</tr>
<tr>
<td>C.W.R.</td>
<td>Charge/Weight Ratio (Of bombs)</td>
</tr>
<tr>
<td>D.B.Ops.</td>
<td>Director (or Directorate of) Bomber Operations (Air Ministry)</td>
</tr>
<tr>
<td>D.C.A.S.</td>
<td>Deputy Chief of the Air Staff Deviation (Of a Compass Needle)</td>
</tr>
<tr>
<td>D.D.B.Ops.</td>
<td>Deputy Director of Bomber Operations (Air Ministry)</td>
</tr>
<tr>
<td>D.D. Plans.</td>
<td>Deputy Director of Plans (Air Ministry)</td>
</tr>
<tr>
<td>D/F</td>
<td>Direction Finding</td>
</tr>
<tr>
<td>D.F.C.</td>
<td>Distinguished Flying Cross</td>
</tr>
<tr>
<td>D.F.O.</td>
<td>Director of Flying Operations</td>
</tr>
<tr>
<td>D. of T.</td>
<td>Director (or Directorate) of Training</td>
</tr>
<tr>
<td>D.R.</td>
<td>Dead Reckoning (Navigation)</td>
</tr>
<tr>
<td>D.R.C.</td>
<td>Distant Reading Compass</td>
</tr>
<tr>
<td>D.S.O.</td>
<td>Distinguished Service Order</td>
</tr>
</tbody>
</table>
E.H. .......... Electra House
E.T.A. .......... Estimated time of arrival

Flak .......... Fliegerabwehrkanone
(Anti-aircraft gun)
F.R.A. .......... First Run Attack
F.T.S. .......... Flying Training School

G.C.I. .......... Ground Controlled Interception
G.L. .......... Gun Laying (Radar)
G.P. .......... General Purpose
(Bomb)
G.P.I. .......... Ground Position Indicator
G.R. .......... General Reconnaissance
Grand Slam .......... 22,000 H.E. Bomb
G/S .......... Ground Speed

H.C. .......... High Capacity
(Bomb)
H.C.U. .......... Heavy Conversion Unit
Hdg. .......... Heading
H.E. .......... High Explosive

I.B. .......... Incendiary Bomb

J.I.C. .......... Joint Intelligence Committee
Service Institution or
Journal of the Royal United
Services Institute for
Defence Studies.

kts. .......... knots
(Nautical miles per hour)

L.N.S.F. .......... Light Night Striking Force
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>M</td>
<td>Magnetic Heading (Allowing for Variation)</td>
</tr>
<tr>
<td>M.C.</td>
<td>Medium Capacity (Bomb)</td>
</tr>
<tr>
<td>m.p.h.</td>
<td>Miles per hour</td>
</tr>
<tr>
<td>M.P.I.</td>
<td>Mean point of impact (Of bombs)</td>
</tr>
<tr>
<td>N.B.S.</td>
<td>Navigation and Bombing System</td>
</tr>
<tr>
<td>N.F.T.</td>
<td>Night Flying Test</td>
</tr>
<tr>
<td>O.R.S.</td>
<td>Operational Research Section</td>
</tr>
<tr>
<td>O.T.U.</td>
<td>Operational Training Unit</td>
</tr>
<tr>
<td>P.F.F.</td>
<td>Pathfinder Force</td>
</tr>
<tr>
<td>P/L</td>
<td>Position Line</td>
</tr>
<tr>
<td>P.R.</td>
<td>Photographic Reconnaissance</td>
</tr>
<tr>
<td>P.R.U.</td>
<td>Photographic Reconnaissance Unit</td>
</tr>
<tr>
<td>P.W.E.</td>
<td>Political Warfare Executive (Leaflets)</td>
</tr>
<tr>
<td>R.A.A.F.</td>
<td>Royal Australian Air Force</td>
</tr>
<tr>
<td>R.A.E.</td>
<td>Royal Aircraft Establishment</td>
</tr>
<tr>
<td>R.A.F.</td>
<td>Royal Air Force</td>
</tr>
<tr>
<td>R.D.F.</td>
<td>Radio Direction Finding (Radar)</td>
</tr>
<tr>
<td>R.F.C.</td>
<td>Royal Flying Corps</td>
</tr>
<tr>
<td>R.N.A.S.</td>
<td>Royal Naval Air Service</td>
</tr>
<tr>
<td>R.N.Z.A.F.</td>
<td>Royal New Zealand Air Force</td>
</tr>
<tr>
<td>R.S.H.A.</td>
<td>German National Central Security Office</td>
</tr>
<tr>
<td>R/T</td>
<td>Radio Telephony. Communications using voice.</td>
</tr>
<tr>
<td>S.A.S.O.</td>
<td>Senior Air Staff Officer</td>
</tr>
<tr>
<td>s.n.</td>
<td>Staff navigator</td>
</tr>
</tbody>
</table>
T ........ True Heading
TAS ........ True Air Speed
T.F.F. ........ Target Finding Force
T.I. .......... Target Indicator
T.M.G. ....... Track made Good
T.N.T. ....... Trinitrotoluene
(Explosive)
T.O.T. ....... Time on Target
Tr .......... Track
T.R.E. ....... Telecommunications Research Establishment
T.V. .......... Terminal Velocity
(Of a bomb)

U.S.A.A.F. ........ United States Army Air Force
U.S.S.A.F.E. ...... United States Strategic Air Force Europe
u-sec ........ Microsecond
(One millionth of a second)
U.X.B. ........ Unexploded Bomb

Var. .......... Variation
V.C. .......... Victoria Cross
V.H.F. ........ Very High Frequency
(Radio)

W.A. Plan ........ Western Air Plan
W/T ........... Wireless Telegraphy
W/V ........... Wind Velocity
Communications using morse
<table>
<thead>
<tr>
<th>Code Name</th>
<th>Description</th>
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<tr>
<td>Abigail-Rachel</td>
<td>Attack on Mannheim 16/17 December 1940</td>
</tr>
<tr>
<td>Arcadia</td>
<td>Washington Conference (Dec. 1941-Jan. 1942)</td>
</tr>
<tr>
<td>Argument</td>
<td>Combined attacks by Eighth and Fifteenth American Air Forces against strategic targets in the German aircraft industry</td>
</tr>
<tr>
<td>Berlin Method</td>
<td>Use of both ground and skymarkers irrespective of cloud conditions</td>
</tr>
<tr>
<td>Big City</td>
<td>Berlin</td>
</tr>
<tr>
<td>Big Week</td>
<td>20-25 February 1944 attempt to destroy Luftwaffe fighter force</td>
</tr>
<tr>
<td>Blind Bombing</td>
<td>Bombing without visual identification of the target</td>
</tr>
<tr>
<td>Boozer</td>
<td>Passive warning device for allied bomber crews that their aircraft was being tracked by ground or airborne radar</td>
</tr>
<tr>
<td>Butt Report</td>
<td>Report on accuracy of British bombing on 18 August 1941</td>
</tr>
<tr>
<td>Cigar</td>
<td>British jamming of German V.H.F. traffic</td>
</tr>
<tr>
<td>Controlled Bombing</td>
<td>British bombing with Master Bomber in charge</td>
</tr>
<tr>
<td>Attack</td>
<td></td>
</tr>
<tr>
<td>Controlled Oboe</td>
<td>Oboe Marking, bombing controlled by Master Bomber</td>
</tr>
<tr>
<td>Corkscrew</td>
<td>Dive, climb and turn manoeuvres by British bombers to evade German fighters</td>
</tr>
<tr>
<td>Corona</td>
<td>Spurious orders to German night fighters by British authorities</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Creep-back</td>
<td>Bombing area moving inadvertently from Aiming Point back along direction of approach of the bomber stream</td>
</tr>
<tr>
<td>Crossbow</td>
<td>Attack on V-weapon launch sites</td>
</tr>
<tr>
<td>Düppel</td>
<td>German name for window</td>
</tr>
<tr>
<td>FIDO</td>
<td>Fog investigation and dispersal operation or, Fog, Intensive Dispersal of</td>
</tr>
<tr>
<td>Freya</td>
<td>German early warning radar</td>
</tr>
<tr>
<td>Gardening</td>
<td>Minelaying in German waterways</td>
</tr>
<tr>
<td>Gee</td>
<td>Radar navigation aid using a Master and one or two Slave ground stations</td>
</tr>
<tr>
<td>Gee-H or GH</td>
<td>Radar navigational aid and blind-bombing device</td>
</tr>
<tr>
<td>Gomorrah</td>
<td>Attacks on Hamburg from 24/25 July to 2/3 August 1943</td>
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<td>Goodwood</td>
<td>Maximum effort</td>
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<tr>
<td>Happy Valley</td>
<td>The Ruhr</td>
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<tr>
<td>H₂S</td>
<td>Navigation and Bombing aid</td>
</tr>
<tr>
<td>Himmelbett</td>
<td>German controlled night fighting</td>
</tr>
<tr>
<td>Hurricane I</td>
<td>Maximum effort area attack in Ruhr</td>
</tr>
<tr>
<td>Hurricane II</td>
<td>Maximum effort on precision targets (especially oil) in Germany</td>
</tr>
<tr>
<td>Hydra</td>
<td>Peenemünde raid on 17/18 August 1943</td>
</tr>
<tr>
<td>Jostle</td>
<td>Airborne device to jam German Flak radar</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Kammhuber Line</td>
<td>German searchlight and radar belt from the Baltic to the Swiss border</td>
</tr>
<tr>
<td>Knickebein</td>
<td>German navigation and bombing aid</td>
</tr>
<tr>
<td>Main Force</td>
<td>Bomber Command squadrons with no specialist role</td>
</tr>
<tr>
<td>Mandrel</td>
<td>Radio swamping of German early warning radar</td>
</tr>
<tr>
<td>Master Bomber</td>
<td>Officer controlling a particular bombing attack in order to maintain accuracy</td>
</tr>
<tr>
<td>Millenium</td>
<td>First 1,000 bomber raid on Cologne 30/31 May 1942</td>
</tr>
<tr>
<td>Monica</td>
<td>Tail warning device in British bombers</td>
</tr>
<tr>
<td>Musical</td>
<td>Prefix applied to P.F.F. marking techniques when Oboe-equipped Mosquitoes did the primary marking</td>
</tr>
<tr>
<td>Naxos</td>
<td>German radar device enabling fighters to home onto British bombers using H2S</td>
</tr>
<tr>
<td>Neptune</td>
<td>Amphibious operations within 'Overlord' 5/6 June 1944</td>
</tr>
<tr>
<td>Newhaven</td>
<td>P.F.F. ground marking carried out visually using Mk XIV bomb-sight and flares at night</td>
</tr>
<tr>
<td>Nickel</td>
<td>Leaflet</td>
</tr>
<tr>
<td>Oboe</td>
<td>Blind bombing device</td>
</tr>
<tr>
<td>Overlord</td>
<td>Allied invasion of Europe 6 June 1944</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pampas</td>
<td>Mosquito operations gathering weather data</td>
</tr>
<tr>
<td>Parramatta</td>
<td>Blind groundmarking using H(_2)S</td>
</tr>
<tr>
<td>Pointblank</td>
<td>Directive June 1943 for the Combined Bomber Offensive</td>
</tr>
<tr>
<td>Random Error</td>
<td>The M.P.I. of all bombs aimed at a target</td>
</tr>
<tr>
<td>Red Spot Fire</td>
<td>Marking device which ignited in the air then burned on the ground</td>
</tr>
<tr>
<td>Sampson</td>
<td>Blind Bombing using Gee</td>
</tr>
<tr>
<td>Schräße Musik</td>
<td>German upward firing guns in defensive fighters</td>
</tr>
<tr>
<td>Sea Lion</td>
<td>German plan for the invasion of Britain</td>
</tr>
<tr>
<td>Shaker</td>
<td>Target illumination and marking using Gee</td>
</tr>
<tr>
<td>Spoof</td>
<td>Diversionary raid to attempt to draw German fighters away from the Main Force</td>
</tr>
<tr>
<td>Systematic Error</td>
<td>Bombing error caused by aiming at centre of Target Indicators rather than the Aiming Point itself</td>
</tr>
<tr>
<td>Tame Boar ('Zahme Sau')</td>
<td>Ground controlled German nightfighter</td>
</tr>
<tr>
<td>Tinsel</td>
<td>Jamming of R/T communication between German ground controllers and nightfighters by using engine noise</td>
</tr>
</tbody>
</table>
Tour ... Number of operational sorties expected from crews before being rested. Usually 30 sorties for Main Force crews; 45 for P.F.F. crews.

Wanganui ... Blind skymarking by P.F.F.

Wild Boar ('Wilde Sau') ... Freelance German night-fighter

'W' Mines ... Small mines dropped in shallow fresh water

Window ... Tinfoil strips dropped by British bombers to disrupt German ground radar

Würzburg ... German ground to air radar for controlling search-lights, anti-aircraft guns and night fighter aircraft

x-Gerät ... German bombing aid

y-Gerät ... German bombing aid

Zephyrs ... Averaged winds found by selected crews and then broadcast for use by the Main Force.
Martin Middlebrook and Chris Everitt,
The Bomber Command War Diaries
PART ONE

PREPARATIONS FOR WAR
1. Introduction

The bomber offensive against Germany launched by the Royal Air Force in September 1939 with such high hopes had, by July 1941, reached a critical stage. Very early in the war it was learned that day bombing provided only minimal returns while the force employed suffered heavy losses in both crews and aircraft. That tactic was therefore virtually abandoned until either fighters were available for escort duties or a greater measure of air superiority could be obtained. On the other hand night operations for either leaflet dropping or bombing, at least until July 1941, had produced few losses directly attributable to either enemy ground or air actions. But by July 1941 many were questioning the cost-effectiveness of a bomber offensive. Were the returns from the night operations commensurate with the expenditure? Was either German production or morale being lowered by Bomber Command's operations? Would the Germans be deprived 'of the means or the will to continue the war' by ill-directed, spasmodic, pin pricks? Could the expansion of Bomber Command, which appeared to demand a major portion of Britain's productive capacity, be justified?

During the 1930s the thoughts of many had dwelt on the possibility of air forces delivering a 'knock-out' blow. Phalanxes of bombers, it was believed, would lay waste to cities destroying both industry and the populace. The expansion plans of the R.A.F. were based on the need to counter this threat and provide one of their own. Fear of the 'knock-out' blow from bomber forces had permeated through to the highest levels. This fear, however, was based on the lessons of the First World War which had either been improperly learned or else forgotten. The efficacy of bomber forces had become grossly exaggerated. Both the accuracy which could be attained and the destruction that could be wrought were figments of human imagination. But by 1939 the populace at large clung to the hope that the declared intention of the R.A.F. in war, to attack only strictly military targets, would be reflected in the actions of the Luftwaffe, the German Air Force.

Air Chief Marshal Sir Edgar Ludlow-Hewitt, head of Bomber Command from September 1937 until April 1940, soon became aware of the weaknesses of the force he commanded. Bomber Command was short of aircraft and many of those in service were, if not already obsolete, certainly obsolescent. Aircrew training, he appreciated, had not prepared his crews for a European War. His force lacked navigators both in quantity and quality because recruiting had been delayed and slow and the training inadequate. In the years between the wars the growing need for trained, full-time navigators, was only reluctantly and belatedly acknowledged. Unfortunately, those responsible for navigation in the Air Staff were either unwilling, or unable, to implement initiatives that could have

improved the situation. It was a neglect which created difficult problems for the bomber offensive. As far as air gunners were concerned, wrote Ludlow-Hewitt in July 1939, they 'have no real confidence in their ability to use this equipment [i.e. their guns] efficiently in war, and Captains and crews have, I fear, little confidence in the ability of the gunners to defend them against destruction by enemy aircraft.'

This letter, addressed to the Air Ministry, would have aroused sobering thoughts among the aircrews of Bomber Command had they been aware of its existence. They were part of a force which lacked both armour plating for the crews and self-sealing petrol tanks in the wings of their aircraft. Their defences were based on formations allegedly capable of defending themselves by the combination of precise flying and competent gunners. Fortunately, the letter was not written for aircrew eyes.

Pre-war planning for the operational tasks of Bomber Command was based on the theory that offensive action provided the best means of defence. Under this guideline, Western Air Plans numbered from one to sixteen had been drawn up listing specific German and Italian targets. They ranged from an attack on the German Air Striking Force and its maintenance organisation, including the aircraft industry (W.A.1), to mine laying in inland waterways (W.A.16). All except W.A.12, which were plans for attacking the German fleet or a section thereof at sea, entailed some risks to either German or Italian civilians.

However, political considerations consequent upon the Munich Agreement in 1938 showed the need for restraint before any strategic bombing offensive was initiated. Prudence demanded that the Royal Air Force was not seen as the initiator of a bombing offensive in which civilians were killed. German military action in Eastern Europe was not seen, necessarily, as requiring the launching of a strategic bombing offensive in the West. Offending potential allies, or putting them at increased risk, were additional reasons for caution before beginning any bombing programme. Franklin D. Roosevelt, President of the United States, issued an appeal on 1 September 1939 to 'every government, which may be engaged in hostilities, publicly to affirm its determination that its armed forces shall in no event ... undertake bombardment from the air of civilian populations and unfortified cities upon the understanding that the same rules ... will be ... observed by all their opponents'.

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2 Webster & Frankland, _op. cit._, p.116
4 _Ibid._, Appendix A.1
The British Government in a reply dated the same day declared that this was already their intended policy. A further, joint reply, by the British and French Governments on 3 September 1939, confirmed the decision to restrict all bombing and bombardment to 'strictly military objectives in the narrowest sense of the word'. They reserved their rights, however, in the event that an enemy did not observe the same restrictions.

The pre-war plans that the R.A.F. had prepared were therefore somewhat nullified when war was declared on 3 September 1939. Bombing raids which put civilians at risk could not be undertaken because that action would invite retaliation and condemnation. There was also the need to consider the question of the relative strengths of the R.A.F. and the Luftwaffe. The parity which the R.A.F. was seeking had not been achieved when war broke out so numerical inferiority was a further determinant of actions. Also, the leaders of the R.A.F. well-appreciated the necessity for conservation of limited resources. The French authorities, aware of their vulnerability, urged that no actions be undertaken which could invite retaliation.

Thus, at the outbreak of war, Bomber Command's policy was to conduct a restricted bombing campaign aimed at targets of an undeniably military nature. Bombing was limited to attacks on German naval units at anchor in harbour or at sea. The risks to German civilians and the difficulties of definition, and of hitting land targets, were barriers to a more wide-ranging offensive. The major activity for some units of the bomber force was the distribution of propaganda leaflets over German cities. And yet bombing policy, despite appearances, was not in fact dictated by humanitarian considerations. The prime motivation was expediency.

Pre-war, Bomber Command had been trained and equipped to carry the war to the enemy in daylight using the defensive qualities offered by close formation flying. This tactic was shown to be severely flawed early in the war. From thirty sorties flown by Wellingsons and Blenheim on 4 September 1939, seven aircraft were lost. Significantly, foreshadowing other problems to arise, bombs fell on neutral Denmark 110 miles away from the briefed target.

5 Panter, op.cit., Appendix A.3
In addition to the doubts which were growing with regard to the defensive qualities of close formations, there were other factors which, ultimately, would have to be taken into account. The R.A.F. had wanted a fast bomber capable of surprising an enemy and avoiding both fighters and anti-aircraft fire. It did not exist in 1939 and nor was one available even by 1945. Perhaps the nearest approach was the Mosquito, but they were still able to be shot down by either anti-aircraft fire or German fighters.

When war broke out in September 1939, and for a considerable period afterwards, the R.A.F. lacked fighters with sufficient range to enable them to act as bomber escorts. Ludlow-Hewitt, in August 1938, had tentatively suggested that the lessons of war in China and Spain had shown the need for bombers to have fighter escorts. But he admitted that history, and even his own inclination, were against the proposal. The Air Ministry, as far back as 1923, had decided that the provision of long-range fighter escorts was not a viable option. They re-affirmed their position by ignoring Ludlow-Hewitt’s letter. Their rejection of the suggestion was based on the lack of resources to build such an aircraft plus their belief that it would be ineffective against short-range opposition. Sir Charles Portal, Chief of the Air Staff (C.A.S.), agreed. On 27 May 1941 he advised Prime Minister Churchill that 'The long range fighter, whether built specifically as such, or whether given increased range by fitting extra tanks, will be at a disadvantage compared with the short range high performance fighter'.

Lack of armour protection for crews was another on-going problem. In late 1941 a Halifax pilot was somewhat inconvenienced by shrapnel entering his lower anatomy after penetrating the under-side of his seat. The pilot approached Handley-Page’s field representative and shortly afterwards crew members went to their aircraft provided with their own personal protection. Matters were brought to a head one night, however, when a commanding officer intercepted an over-loaded navigator proceeding to his aircraft. The revelation that the canvas navigation bag contained armour plating brought a swift word to the Handley-Page representative that the practice had to cease or 'the bloody aircraft could be so heavy that they would never get airborne'. Armour plating meant an increase in all-up-weight and required either a reduction in the weight of bombs carried or a reduced fuel load. Neither was acceptable.

7 Webster & Frankland, op.cit., Vol.1, p.95
8 Ibid., Vol.1, pp.116-7
9 Ibid., Vol.1, p.239,
Losses were also incurred because the British authorities were not fully aware of the developments that had taken place in German radar detection equipment. Supporters of the bomber offensive encouraged the belief that German anti-aircraft fire, rather than Luftwaffe fighters, was responsible for the British losses. Generally the early raids had been at comparatively low level which exposed the bombers to German ground defensive fire. The belief was that bombing attacks carried out from higher levels would incur fewer losses.

On 14 December 1939 a formation of twelve Wellingtons took off from bases in England for an armed reconnaissance of German controlled waters. Half the formation was destroyed.\textsuperscript{11} On 18 December 1939 twenty two Wellingtons were attacked in the Wilhelmshaven area and twelve were shot down while another three had to make forced landings in England.\textsuperscript{12} Losses were heavier than Bomber Command could continue to sustain either in crews or aircraft. The confidence previously held in the efficacy of both self-protecting bomber formations and daylight bombing had, by now, been severely eroded. The plans for daylight attacks against German industrial and oil targets in the Ruhr, Rhineland and the Saar, were further deferred.

Postponement was not simply a consequence of the heavy losses experienced in raids which had required only minimal penetration of enemy held territory. From the first night of the war Whitley bombers had flown through German airspace to spread propaganda leaflets. Their losses from German defences, either guns or aircraft, were minimal. If leaflets could be dropped in safety, why not bombs? The head of 4 Group engaged on leaflet raids ('nickels') was Air Vice-Marshal A. Coningham. Although he and his staff were aware of the navigational problems, the severe and often unforecast weather conditions and the many deficiencies of their aircraft, darkness appeared to offer protection to the raiders. Between 10 November 1939 and 16 March 1940 losses due to enemy action had been nil.\textsuperscript{13}

On 9 December 1939, Coningham advised Ludlow-Hewitt that 'Our views have undergone considerable change since the war started. The absence of enemy fighters' opposition at night, the comparative ineffectiveness of their anti-aircraft fire even at middle heights, their doubtful searchlight efficiency ... [were all factors combining] ... to lower in a surprising degree our opinion of the opposition we expected to meet'.\textsuperscript{14}

\textsuperscript{11} Webster & Frankland, \textit{op.cit.}, Vol.1, p.194

\textsuperscript{12} John Terraine, \textit{The Right of the Line} (London: Hodder & Stoughton, 1985) Appendix G, pp.703-4

\textsuperscript{13} Webster & Frankland, \textit{op.cit.}, Vol.1, p.202

\textsuperscript{14} \textit{Ibid.}, Vol.1, pp.201-2
Navigation, target illumination, location and identification, all remained problems, but the prospect of reduced casualties caused Ludlow-Hewitt to turn to night operations with enthusiasm. The decision had been reached, however, without due consideration being accorded to European weather conditions. Accurate navigation at this stage of the war demanded that crews be able to see the ground at frequent intervals and positively identify exactly where they were. In Western Europe, except on rare occasions, this is simply not possible. Even by low flying, which introduced other hazards, cloud and reduced visibility made map reading virtually impossible on most nights. Ludlow-Hewitt's hope was that training and improved equipment would enable Bomber Command crews to overcome the problems and carry out, successfully, a precision night bombing offensive.15

The German attack on France, Belgium and Holland in May 1940 provided vastly expanded opportunities for the employment of Bomber Command. The targets, however, remained of a strictly military nature. The German Blitzkrieg required that the R.A.F. bombers were used in a tactical support role for the hard-pressed allied ground forces. It was a return to a 1914-1918 situation with the R.A.F. called upon to attack road and rail communications, bridges and aerodromes, in the attempt to slow down the German advance. The rapidly changing military situation on the ground provided little opportunity for either considered policy making or its implementation.

On 15 May 1940, with Holland having already capitulated and German forces well advanced in Belgium, approval was belatedly given by the British War Cabinet for R.A.F. bombers to attempt to wrest the initiative from the enemy. That same night 99 British aircraft attacked 16 different strategic targets - oil, rail and industrial - east of the Rhine. It was the start of a long and increasingly bitter campaign. But at this stage bombing was still restricted. The intentional bombing of enemy civilians was banned, targets had to be identified and Red Cross conventions were to be observed.16

Until October 1940 Bomber Command's activities were essentially defensive. France's defeat had exposed Britain's vulnerability. Longer term strategic objectives were no longer the priority - the first requirement was survival. The urgent need was to attempt to reduce the potential for air attacks on Great Britain. In an effort to increase the security of British people and their factories, the German aircraft industry became the prime target for Bomber Command.

15 Webster & Frankland, op.cit., Vol.1, p.208

16 Panter, op.cit., p.84
As the weight and nature of the German bombing of Great Britain increased and changed, political and public opinion increasingly demanded effective retaliation. But R.A.F. planners had learned one lesson from the Battle of Britain. They believed that the Luftwaffe's lack of concentration, the failure to maintain the aim, had perhaps, cost it the battle. Fighter Command and its airfields survived, British industry had been surprisingly little disrupted and civilian morale had not collapsed. Bomber Command had experienced, already, many diversions from its primary strategic aim. The battle of France, the air and invasion threats to Great Britain, the hazards posed to British supply routes by the actions of surface raiders and U-boats - all had required attention. Now it was time to conserve and expand. With increased strength, and concentration on the aims of the bomber offensive, greater harm could be done to Germany than by further diversions in attempting reprisals.

On 3 September 1940 Prime Minister Winston Churchill addressed a memorandum to the War Cabinet. 'The Navy can lose us the war, but only the Air Force can win it. Therefore our supreme effort must be to gain overwhelming mastery in the air. The Fighters are our salvation, but the Bombers alone provide the means of victory. We must therefore develop the power to carry an ever-increasing volume of explosives to Germany ... In no other way at present visible can we hope to overcome the immense military power of Germany ... The Air Force ... must ... claim the first place over the Navy or the Army.'

The quotation provided by Gilbert from the same memorandum is somewhat abbreviated. Although it alluded to the fact that 'bombers alone' provided the way to victory it failed to bring out the priority that Churchill considered should be given to the Air Force over both the Army and the Royal Navy in order to gain 'overwhelming mastery'.

Due to shortcomings in tactics, aircraft, training and equipment, Bomber Command early in the war, had been forced into a night role. Some in authority, however, remained sceptical of the ability of the force to carry out its task. Air Marshal Sir Richard Peirse, newly appointed as head of Bomber Command in October 1940, was one such doubter. On 25 October 1940 he received a draft directive from the Air Staff listing the bombing priorities for his Command. Admittedly they were wide ranging. Priority he was told, was to be given to oil targets but large cities, Berlin included, were

\[17\] Winston S. Churchill, Their Finest Hour
(London: Reprint Society, 1954), P.368

\[18\] Martin Gilbert, Finest Hour
(London: Heinemann, 1983), Vol.6, pp.769-70
to be attacked for the damage that could be caused to German industry and civilian morale. In addition, raids were to continue on targets in Northern Italy and railway marshalling yards in Germany. Bomber Command was also expected to conduct mining operations and carry out attacks on the possible invasion ports in the Low Countries and France. Finally, limited bombing efforts were to be made against German bomber airfields which were being used by the Luftwaffe for the night offensive against Britain. 19

Peirse objected to the draft on the grounds that the targets listed were too numerous for his small force. At the same time he hoped that he would not be accused of being pessimistic for, he added, 'with twice the force, I would gallop away with your directive'. 20 It would appear, however, that size was not the only reason for his misgivings. He doubted the efficiency of the force he commanded. Already he had reached the conclusion that only one aircraft in three attacked the primary target on short range attacks, and that the proportion sank to only one in five on longer flights. 21

The doubts expressed by Peirse concerning the capabilities of Bomber Command crews were further confirmed on 15 November 1940. Wing Commander L.K. Barnes, Chairman of a Group Navigation Officers' Conference at Bomber Command Headquarters, in his summation of the meeting, concluded that only 35 per cent of all bombers sent on raids actually reached their primary targets. Perhaps indicative of the malaise he suspected, Barnes also criticised the Conference's brief agenda and the fact that less than half of the Bomber Command Groups had sent representatives to the meeting. 22

Peirse's dilemma should, however, evoke some measure of sympathy. Theoretically Bomber Command had doubled its strength since the outbreak of war. In October 1940 the daily returns of aircraft on squadron strength totalled 532. But there is a different picture when the aircraft are broken down into particular types. There were 217 Blenheims now unfitted for operations, 85 Battles about to be declared obsolete, 100 Wellingtons, 71 Hampdens and 59 Whitleys. Bomber Command's strength was thus vested in an effective total of 230 aircraft, 130 of which, the Hampdens and Whitleys, were also due for replacement. 23

Webster & Frankland, op.cit., Vol.4, pp.128-131

Ibid., Vol.1, p.157

Ibid., p.156

Ibid., p.205

Middlebrook & Everitt, op.cit., p.93
first line strength can be better gauged, however, when it is appreciated that Peirse's effective strength for night operations rarely exceeded 150 aircraft. Servicing requirements and repairs of battle damage significantly reduced the base-line of 230 aircraft. Even when 150 aircraft were available their effectiveness was lowered by the fact that many were, perforce, manned by inexperienced crews.

But reduced operational efficiency was not due solely to crew inexperience. Bomber Command, in the winter months of 1940/41, also suffered from a critical lack of aircrew. Partly, the shortage was due to the necessity to provide experienced instructors for the Operational Training Units (O.T.U.s.) then being established to cope with the planned, bomber expansion programmes. There were other factors. Bomber reinforcements were also required in the Middle East and they could only be provided from the front line squadrons in England. A total of 96 Wellingshams and Blenheim, complete with crews and reserves, were despatched between 31 August 1940 and 1 March 1941. There was also the partial collapse of the ferry pilot organisation. This meant that operational crews had to collect their own replacement aircraft from the widely dispersed maintenance units. Finally, crew shortages also resulted from leave requirements and sickness. The low point was reached on 1 December 1940. The establishment strength of the five Groups of Bomber Command on this date was 820 crews. In fact only 431 crews (53 per cent) were operationally fit and available. It should have occasioned no surprise that Peirse entertained such reservations about the capabilities of his Command. Perhaps he was simply being realistic.

In the summer of 1940 the Joint Planning Staff made an assessment of the future military strategies required to ensure Germany's defeat. The Air Force role was to bring increasing economic pressures to bear on Germany by attacking oil, industrial and communications targets. At the same time, expansion of Bomber Command was to continue. New aircraft were being produced and it was expected that by 1942 the R.A.F. would have at least 1,600 heavy and 400 medium bombers in the first line. Until the end of October 1940, however, Bomber Command continued with precision attacks on widely dispersed targets in the effort to achieve the aim. The Bombing Directive of 30 October 1940 marked a significant turning point in the bomber war. Area bombing was about to replace rarely successful precision attacks.

24 Panter, op.cit., pp.146-7
25 Ibid., p.143
Area bombing, the attack on a major industrial centre without defining a specific target, was code named 'Abigail'. German cities at this time had all been given female names and Mannheim's nom-de-guerre was 'Rachel'. The first area bombing attack, called Operation 'Abigail-Rachel', took place on 16 December 1940. The aim was 'to cause the maximum possible destruction in a selected German town'. Churchill, tacitly, had agreed to the R.A.F. determining the methods to be used to create industrial, physical and moral distress in Germany. Air Marshal Portal, appointed CAS in October 1940, became a prime initiator of the area bombing technique.

It was the method that would continue for much of the war although in these early days it remained largely ineffective. The plan was that the first attackers would drop incendiary bombs which would start fires providing aiming points for the following bombers loaded with a mixture of high explosives and more incendiaries. By concentrating the bombing in time the view was that the German civil defence organisations would be overcome. The aim was to destroy selected industrial targets in German cities. At the same time it was appreciated that such raids would have important secondary effects. Destruction of housing, water mains, transport and cinemas would all affect civilian morale. But, at this stage of the war, bombing was still inaccurate. If the first fires started were not in the target area then subsequent bomb loads were put in the wrong place. Nevertheless, as will be seen later in discussing the methods used by the Pathfinder Force (P.F.F.), it was a foretaste of greater suffering still to be endured by German cities and their peoples.

It is important that the differences between precision and area bombing are understood. Equally important are the nuances involved. It is generally accepted that the first principle of war is the selection and maintenance of the aim. For the R.A.F. this required the defining of targets and the occasion or occasions when they were to be attacked. A bombing raid is essentially an offensive action but it can be either strategically or tactically offensive. In the first case the aim is long term. To destroy an enemy's capacity to build bombers to wage war requires a strategic offensive. The bombing of an enemy airfield to prevent enemy fighter operations is a tactically offensive action. Tactically offensive actions are essentially a response to short term and immediate requirements.

One early determination required from the planning staff in Bomber Command was the nature of the strategic bombing offensive. Was it to be a selective or a general offensive? Should it be directed against a group of interconnected...
targets in, for example, the aircraft industry, or oil, or transport? Or was it to be a general offensive aimed at a variety of targets not necessarily related? These options do not provide a differentiation between precision and area attacks. Both the selective and general offensives could be executed using either precision or area bombing tactics. The final determinants were the nature and location of the targets and the capabilities of the bombing force. An isolated target where near misses caused no damage, ideally, required a precision attack. But when the requirement was to destroy civilian morale then area bombing became the means. Area bombing meant aiming at a city or one of its suburbs and not simply at the home of Herr Schmidt and his family in a particular street. Near misses in area bombing were direct hits on neighbours and had as great an effect on morale.

In war, each arm of the services attempts to appear to be making the greatest possible contribution to final victory. But in the harsh reality of conflict there is a considerable degree of inter-service dependency. While the Air Staff saw Bomber Command's role as strategic, the Royal Navy and Army commanders principally looked to it for tactical support. The independence of Bomber Command and its offensive was frequently eroded by the immediate needs of the Army or Navy. The Battle of the Atlantic and reinforcements for the Middle East are but two examples of the diversions experienced. But they were not problems that could be solved unilaterally. The War Cabinet or Chiefs of Staff had, of necessity, to be the final arbiters.

Bomber Command had been forced to abandon day bombing because of heavy losses. In the night role, precision attacks on specific targets failed because the targets could not be located. By July 1941 area bombing by night was also the subject of critical assessment. Portal had often expressed his doubts regarding precision bombing. He said that 'since almost all the primary first priority targets are isolated and in sparsely inhabited districts, the very high percentage of bombers which inevitably miss the actual target will hit nothing else important and do no damage'. 28 Portal, however, was hopeful that area attacks aimed at industrial complexes in large cities could provide the solution. The relatively few bombs that hit the briefed target would be of value, but perhaps of greater impact would be the fact that those that missed the target would fall on the homes, shops and entertainment areas of the workers on whom German industry depended. Here was a reconfirmation of the Trenchard dictum of the value of the moral effect of bombing over the material.

In July 1941 Portal refused to agree to the continuation of precision night bombing attacks against German oil targets. The suspicions of many that night bombing was ineffective,

were confirmed. Portal argued that, although on economic grounds a particular enemy target system may appear attractive, it 'is not worth pursuing if it is not tactically attainable'.\textsuperscript{29} The hope that key industrial targets in Germany could be destroyed by precision night bombing was tacitly admitted to be a chimera.

By July 1941 Coningham had also changed his mind about what could be achieved at night over Germany. Weather and darkness, he now appreciated more clearly, were formidable foes.\textsuperscript{30} His changed perceptions combined with Ludlow-Hewitt's scepticism and Peirse's doubts were all confirmed by an Air Ministry summation that 'it was useless to attempt the destruction of specific targets on dark nights'.\textsuperscript{31}

The Air Ministry Directive of 9 July 1941 addressed to Bomber Command was even more explicit. In Appendix A Air Vice-Marshall N.H. Bottomley, Deputy Chief of the Air Staff (D.C.A.S.), stated that, 'It is accepted as a principle of this plan that the successful attack of a specific target at night can only be undertaken in clear moonlight. It follows therefore, that for approximately \textsuperscript{32} of each month it is only possible to obtain satisfactory results by heavy, concentrated and continuous area attacks of large working class and industrial areas in carefully selected towns ... it is a matter of the greatest difficulty to find selected towns on moonless nights unless they lie on or near water, and failure to deliver the maximum weight of attack results in dispersion of effort and loss of the desired moral effect'.\textsuperscript{32}

The Butt Report of 18 August 1941 confirmed for many the doubts that had been rising of the accuracy and effectiveness of the night bombing of Germany. At the instigation of Lord Cherwell, (formerly Prof. F.A. Lindemann, Scientific Adviser to the British Prime Minister Winston Churchill), Mr. D.M.B. Butt of the War Cabinet Secretariat had been requested to carry out a statistical investigation of the usefulness or otherwise of R.A.F. night bombing. His report was devastating to supporters of the bombing offensive. After examining approximately 600 photographs taken by Bomber Command crews in June and July 1941 and considering other documentary evidence, Butt decided that only one third of the aircraft which had claimed to have attacked their briefed target were even within five miles.

\textsuperscript{29} Webster & Frankland, \textit{op.cit.}, Vol.1, p.168

\textsuperscript{30} Vincent Orange, \textit{Coningham} (London: Methuen, 1990), pp.63-4

\textsuperscript{31} Webster & Frankland, \textit{op.cit.}, Vol.1, p.244

\textsuperscript{32} \textit{Ibid.}, Vol.4, p.137
Bombing accuracy had many variables. The position of the target - on the coast or inland, the weather conditions and German defences - all influenced bombing accuracy. For attacks aimed at French ports two out of three aircraft claiming to have attacked were within five miles. When the raid was against a target in the Ruhr industrial area only one aircraft in five was within the five mile radius. In full moon periods two aircraft in five were within the ten mile wide circle but on moonless nights the number fell to only one aircraft in fifteen.\textsuperscript{33} It must be remarked that a circle of radius five miles defines an area of approximately 78 square miles. If Butt's contention was correct much of Bomber Command's effort - crews, bombs and aircraft - were being wasted. Although the report was not claimed to be infallible, by and large it was accepted by those in authority and great concern was exhibited.

With day bombing being impossible due to the German defences and night precision bombing grossly inaccurate a vastly expanded Bomber Command was required to carry out area bombing with the aim not only of reducing German production but also of lowering the morale of the population. The Air Staff had been seeking an expansion of Bomber Command on a vast scale. They called for a force of 4,000 heavy bombers but there was considerable resistance in several quarters against the allocation of such an apparently vast proportion of national resources to an imprecise vehicle. Churchill awaited Portal's 'proposals for action' over Lord Cherwell's version of the Butt Report with interest and concern because he viewed the report as 'a very serious paper'.\textsuperscript{34}

Acceptance of the Butt Report by the Air Staff showed that they admitted Bomber Command's shortcomings and were well aware of the necessity for improving bombing accuracy. Above all, the report had shown that the success of night operations was largely dependent on navigation. If a bomber could not be directed to the actual target then whether or not the bomb aimer could place his bombs within 300 or 3,000 yards was immaterial. Recognition of the fact that the success of bombing missions was almost totally reliant upon accurate navigation meant that the first step had been taken toward solving a long-standing problem. The Butt Report also confirmed that area bombing by an expanded force with the parallel aims of reducing both enemy production and morale was the only feasible option if the continuation of strategic operations was still contemplated. That strategy, in December 1941, was still a matter of considerable doubt.

\textsuperscript{33} Webster & Frankland, \textit{op.cit.}, Vol.1, p.178

\textsuperscript{34} Winston S. Churchill, \textit{The Hinge of Fate} (London: Reprint Society, 1954), p.236
The first positive reaction to the Butt Report was made on 18 September 1941. On this date the Operational Research Section (O.R.S.) for Bomber Command was established. Its functions were to determine what happened to British bombers over enemy territory, what enemy defensive measures were they encountering, how accurate was the bombing and what improvements could be effected. Uncoordinated researches had begun, in 1940 initially, into the study of bomber losses and, gradually, the work had expanded. Now it had been regularised. The formal brief for the O.R.S. was to analyse 'bombing operations with a view to determining weak points in the enemy defence system, to ascertain the cause of casualties so that steps can be taken to reduce them and to assess the effectiveness of bombing attacks'. The section was also charged with investigating particular radio problems experienced in Bomber Command. The formation of the O.R.S. was germane to the immediate needs and as the war progressed its work expanded. By 1944 the O.R.S. was divided into six sections and the work of at least some of these elements will be met later. In the Command structure, the O.R.S. was responsible to the Senior Air Staff Officer (S.A.S.O.), but direct access to the Air Officer Commanding (A.O.C.) was available at all times.

The Butt Report of 18 August 1941 marked a significant turning point in the history of Bomber Command in the Second World War. It also posed one major question to the War Cabinet. It was not simply a matter of whether Bomber Command would employ precision or area attacks methods. The question was should Bomber Command continue as a viable option for war?

Churchill made the determination. Germany could only be attacked from the air and therefore the bombing must continue. It was the one avenue where the potential existed for Germany to be hurt. With the German forces now committed in Russia, perhaps ways could be found to make bombing more effective. It was clear that time was required. Churchill directed the C.A.S. that during the winter of 1941/1942 Bomber Command was to be conserved, expanded, and better equipped and trained, for a renewed onslaught in the Spring.

Excessive R.A.F. losses had long been his concern. In repeated minutes addressed to Sir Archibald Sinclair, Secretary of State for Air, and Portal the C.A.S., Churchill criticised the apparent stagnation of the bomber force and what he regarded as unacceptable loss rates. His concern at the loss rates was further confirmation that Bomber Command

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Gilbert, op.cit., pp.1178-9
was not causing significant damage to German industry, the German forces or the German people. Had the bombing provided better returns then losses no doubt could have been borne. The minute Churchill sent on 15 November 1940 was a typical example. 'We cannot afford to have losses of this kind in view of your very slow replacements. If you go on like this you will break the bomber force down to below a minimum for grave emergencies. No results have been achieved which would in any way justify or compensate for these losses. I consider the loss of eleven aircraft out of one hundred and thirty nine, i.e. about 8 per cent - a very grievous disaster at this stage of our bomber development.'\(^27\)

Churchill did not let up. One year later, on 11 November 1941, he sent yet another minute to Sinclair and Portal. On the night of 7/8 November 1941, 392 bombers attacked Berlin, Cologne and Mannheim and 37 had been lost. It was believed that severe weather conditions had contributed to the high losses. Gilbert considered that Churchill was 'angered' by the losses. Churchill's minute called the losses 'grievous'. It continued 'We cannot afford losses on that scale in view of the short-fall of the American bomber programme. Losses which are acceptable in a battle or for some decisive military objective ought not be incurred merely as a matter of routine. There is no need to fight the weather and the enemy at the same time ... [Bomber Command had to] ... re-gather their strength for the spring'.\(^28\)

Admittedly Churchill, throughout the war and despite his workload, continued to involve himself in the minutiae of administration. His call for the possible use of Lysander pilots in 'simpler' bombing missions to the Ruhr, and seeing this target complex as an easy target at close range and able to be attacked in safe conditions, displayed his lack of appreciation of the difficulties under which Bomber Command crews operated.\(^29\)

This study is an attempt to define the problems faced by Bomber Command crews in the strategic bomber offensive in the Second World War. The failure to properly assimilate, or have forgotten, the lessons of the First World War and the reasons why particular problems arose and how they were countered, will all be considered with particular reference to the role of the Pathfinder Force. The first section of the work up to September 1939 will cover the activities of the Independent

\(^27\) Churchill, Their Finest Hour, pp.541-2

\(^28\) Gilbert, op.cit., pp.1231-2

\(^29\) Churchill, Their Finest Hour, p.535
Force in the First World War; economic considerations in rearmament; aircraft and the aircraft industry; bombs, bomb sights and bomb aiming; bombing photography; aircrew training between the wars; a detailed examination of the navigational problem and pre-war target planning. No excuse is proffered for the attention that will be given to the problems and attempted solutions encountered in navigation because accuracy in that area was crucial to the success of Bomber Command's operations.

The second section of the work will be the study of Bomber Command at war. It will consider operations prior to the establishment of the Pathfinder Force and then the arguments that were advanced against such a force and the reasons for its formation. The Pathfinder Force in action will constitute the next area to be reviewed. The selection of crews, conditions of service, tactics employed and their successes and failures, will all be discussed.

Finally, an attempt will be made to assess the worth of the Pathfinder Force in Bomber Command's battles over Germany. Was the heightened efficiency of Bomber Command due solely to the efforts of the Pathfinder Force? Or were other factors relevant? Were the accolades accorded the force and its members during the war, merited? Was there any particular significance to be attached to the fact that neither the leader of the Pathfinder Force, Air Vice-Marshal D.C.T. Bennett, nor Air Chief Marshal Sir Arthur Harris, head of Bomber Command, received any immediate, post-war award? In Bennett's case there were many who considered his rapid wartime promotions a more than ample reward for a colonial. He had left the R.A.F. in August 1935 as a Flying Officer, rejoined in September 1941 as an acting Wing Commander (having rejected appointment as a Squadron Leader) and was appointed an Acting Group Captain in July 1942. In January 1943 Bennett was promoted to Air Commodore and only a few months later, prior to his thirty third birthday and on Harris's insistence, confirmed as an Air Vice-Marshal. In the case of Harris perhaps political (or religious?) overtones were more relevant. With the war now won, the methods employed to bring about victory were being more closely scrutinised.

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2. An Earlier Strategic Bombing Offensive

The problems that Bomber Command experienced between 1939 and 1942 which required new equipment, tactics, training and a pathfinder Force, were all identified during the First World War. They remained unresolved in the 1920s and 1930s and even required reidentification during the first three years of the Second World War. For this reason it is necessary to examine the planning for and activities of, the Independent Force of the R.A.F. during 1918. Bomber Command was the heir of the Independent Force but the worth of its inheritance for too long had been unrecognized. The costly learning experience was going to have to be repeated.

The history of the strategic bombing offensive carried out by the Independent Force in the First World War is, in essence, the story of an inadequate, non-expanding force, suffering heavy casualties, incapable of pursuing the vaguely defined strategic aim, and achieving only minimum results.

When the strategic offensive opened in June 1918 the force was equipped with three day and two night squadrons. In August four additional Squadrons joined the Independent Force. But this was a far cry from the force that had been envisaged either in numbers or striking power. It was also less than the fourteen squadrons that General Trenchard had been promised.¹ Nor did it augur well for the planned expansion to 37 squadrons by October 1918.² The anticipated 'Surplus Air Fleet' was a myth. When the war ended there were still only nine long-distance bomber squadrons in the Independent Force. Aircraft production estimates for Spring 1918 had been grossly exaggerated but there was also a more specific reason for the dramatic shortfall. The non-availability of reliable aero engines was a major stumbling block.

Engines were ordered into mass production that were unproven and only at the experimental stage. The Sunbeam Arab engine - 200 horse power, water cooled, eight cylinders - is a good example. Orders for 4,400 units of this engine were placed for the 1917-18 production programme. It was hoped that 1,800 would become available before the end of 1917 but in fact only 61 were delivered.³ The Beardmore-Halford-Pullinger (BHP) engine to be used in the day bombers was another failure.⁴ Also, the Rolls-Royce Company, producers

⁴ Ibid., p.164
of some of the more successful engines in the First World War, was continually frustrated in its efforts not only to improve their products but also increase production. So bad was the aero-engine problem in 1918 that only the delivery of the French Hispano-Suiza engines, ordered by the Admiralty in 1916—contrary to the wishes of Lord Curzon, President of the Air Board—averted what could have been a critical situation. According to one authority the estimated production of aero-engines would total 15,914 with an anticipated surplus of 3,302 units. In fact, actual deliveries only totalled 8,571 leaving a total shortfall on requirements of 4,041.

The Independent Force was also weakened by the fact that the aircraft produced as the standard day bomber, the DH.9, was incapable of achieving an adequate operational performance. Trenchard wrote that it appears that the DH.9 'will not be able to fly in formation at 15,000 feet carrying a full load of bombs, and that they only carry enough petrol to reach the nearest German towns, and then only at a lower height than is attained in the case of De Havilland 4's'.

Another contributory factor in dashing any hopes of either an early, or vast, expansion of the bomber force was the increased losses of aircraft and crews following the stepping-up of air operations on the Western Front in 1918.

The daylight Gotha raids on London in June and July 1917 were the catalysts for the creation of the Independent Force and the initiation of a strategic bombing offensive to be directed against German towns involved in the production of war materials. The Smuts' Report of 1917, produced under pressure and based on inaccurate forecasts of aircraft availability, envisaged a force capable not only of independent action but also perhaps, of becoming the primary

Jones, The War in the Air, Vol.6, pp.45-51


H.T. Trenchard, Long Distance Bombing AIP 1/725/97/1, 26 November 1917, p.6

agent in war. But operational planning for the bomber force was both inadequate and imprecise. The establishment of a bomber force was a political response to a military problem. It was a panacea for the people. British civilians had been killed in the Gotha raids and this solution provided the opportunities for retribution. Unfortunately, in planning the offensive, the primary objective remained undefined. Was it to be the enemy industrial capacity or was it to be directed against the morale of the German people or were both to be attacked?

The original plan for the employment of the Independent Force had been to destroy sections of the German chemical and iron industries and thus reduce munitions production. Additional targets were to be railway centres, enemy transport and aerodromes. In the event, a disproportionate amount of the bombing effort was expended on railways and aerodromes. The target planners in the Air Ministry were over-ridden by the needs of Trenchard the field commander. His concern was force conservation. Bomber losses from intensive German fighter activity caused him to concentrate many of his attacks on enemy aerodromes. In August 1917 while the German chemical industry received eight per cent of the raids and the steel industry seven per cent, aerodromes received 49.5 per cent.¹⁰

The other target that received considerable attention from the Independent Force was the German controlled railway system. In August 1918 31 per cent of the raids were against railway marshalling yards and important rail junctions at short distances behind the enemy lines.¹¹ These attacks, in contravention of Air Ministry wishes, were another example of how Trenchard viewed his role. A major concern for him remained the need to provide direct support for the armies in the field. In September 1918 the Independent Force dropped 178.75 tons of bombs of which the railway station and marshalling yards at Metz received 32 tons. A total of 83.3 per cent of the raids in September were directed either at enemy aerodromes or German controlled railways.¹² Trenchard's belief in the value of, and the need for, tactical bombing, had persisted. Tactical bombing assistance was Trenchard's response to a direct request from Foch for aid in his St. Mihllef offensive. Nearly half of the total bomber force was involved in purely tactical support operations.¹³

¹⁰ Cooper, op.cit., p.57
¹¹ Ibid., p.57
¹² Ibid., p.57
¹³ Boyle, op.cit., p.300
Director of Flying Operations (DFO) viewed these distractions 'as a violation of the policy of the Independent Force'.

Had the experiences of both the day and night bombing squadrons of the Independent Force been more closely scrutinised the fear of the bomber, widespread in the 1930s, might have been considerably reduced. Another potential lesson ignored was the vulnerability of the R.A.F. day bombers to attacks from defending German fighters. Tight defensive formations did not provide security. Nor did darkness always provide sufficient protection for the bomber forces. German night defences - aircraft, anti-aircraft guns and balloons - all took their toll. The vagaries of the weather - with fragile aircraft attempting to contend with conditions for which their pilots had been neither equipped nor trained - provided another hazard. On the night of 16/17 September 1918 seven bombers from a force totalling only 21 aircraft were lost. It must also be noted that on night raids aircraft operated singly, at considerable intervals, because of a perceived risk of collision.

Statistics of R.A.F. bomber losses fail to give an adequate picture. According to Jones losses of the Independent Force amounted to only 3.9 per cent of the bombers employed. What must also be considered when assessing the success or otherwise of the campaign is, how many bombers turned back without dropping their bombs, and how many others were forced to attack alternative targets? Again, with reference to Jones, 24 per cent were thwarted by mechanical failures, weather, or enemy action, and returned with their bomb loads intact. A further 20.5 per cent were forced to drop their bombs on secondary targets. Whether or not the strategic bombing offensive was successful can be measured by considering the example of the Badische Anilin und Soda Fabrik at Mannheim - the most heavily attacked target in the German chemical industry during the First World War. The survey carried out immediately post-war by a British team investigating bombing effectiveness reported that the factory was 'never forced to stop work owing to the damage done by air raids'. The management of the same firm simply described the war-time bombing as 'annoying'.

14 Cooper, op.cit., p.57
15 Ibid., p.57
16 H.A. Jones, op.cit., Vol.6, p.163
18 H.A. Jones, op.cit., Vol. 6, p.155
These results observed at Mannheim confirmed another truism that was for too long ignored during the early years of the strategic bombing offensive in the Second World War. Large factory complexes were comparatively easy to hit from the air but difficult to destroy. Conversely, small factories, although difficult to hit, were comparatively easy to destroy. Both types of targets, therefore, required large scale attacks if destruction was to be achieved.

Furthermore, an argument could be sustained that the effects of the bombing offensive on German morale were minimal. Raids were not only widespread but also sporadic and most frequently on targets near to the front line where war was already a reality. The few major German cities within reach of the bombers were attacked only infrequently and casualty numbers were small. There is no evidence that any German Government action was required to quell civilian unrest or disquiet caused by any fall in morale. Yet German morale was again to become a prime target in the Second World War and its susceptibility to bombing to be grossly exaggerated to the detriment of both bombing equipment and operational tactics. But that is a topic to which we will return later.

The relevance of this section on the Independent Force in the First World War to the role of the FFF in the Second World War is that had lessons learned in 1917 and 1918 been properly absorbed then many of the deficiencies rediscovered between 1939 and 1942 would not have existed. The problems in Bomber Command were simply repetitions of the difficulties and shortcomings previously identified in the establishment and operations of the Independent Force. Lord Tiverton in a searching analysis written on 3 September 1917 defined most of Bomber Command's problems from 1939 until 1942. The tragedy is that for 22 years his work was allowed to remain mouldering in archives.

Lord Tiverton served as the Armament Officer with No. 3 Wing at Luxeuil in 1916 where his responsibilities were bombs, bomb release gear and bombsights. A barrister by profession but perhaps a mathematician or scientist by inclination, and a qualified pilot, he made a close and detailed study of the requirements necessary for the establishment and operations of an offensive bomber force. His findings were not the consequences of either estimation or unsubstantiated opinion. They were securely based on adequate testing, experimentation and mathematical probabilities.

Thus it was that as early as 1917 the bombing problem was identified as being directly correlated with the accuracy or otherwise of the aircraft's navigation. He also specified the

17 Neville Jones, The Origins of Strategic Bombing, pp.143-7
need to have a proficient meteorological service to provide accurate and up-to-date weather forecasts, the difficulties of target location and identification, and the inaccuracies inherent in bombing from aircraft. These were all problems that would reappear, for Bomber Command, from 1939 onwards. But Lord Tiverton went further. He pre-empted the Operational Research Section of Bomber Command. The O.R.S. was not finally established until 13 September 1941 'for the purpose of analysing bombing operations with a view to determining weak points in the enemy defence system, to ascertain the cause of casualties so that steps can be taken to reduce them and to assess the effectiveness of bombing attacks'.

Lord Tiverton had already defined the problems and, more, had offered solutions as early as 1917 and 1918. He was one of the first to stress the importance of the bomb over that of its carrier, the aeroplane. For him the bomber needed to be designed simply for the carriage of a specific weapon to where it could be placed to create the maximum damage. Unfortunately for the R.A.F. during the between war years aircraft were too often built without regard to their function in war. Numbers to maintain parity with a potential enemy, or the need to provide continued employment in the aircraft industry, were all too frequently the dominant considerations when orders were placed.

With regard to bombs Lord Tiverton related them to his study of potential enemy targets. His considerations had included not only the essential nature of particular German industries but also the damage that their destruction would cause to the German war effort. His work was aimed at determining the type of bomb necessary for the obliteration of a particular factory, or building within the factory complex, and the number of such bombs required after allowing for bombing inaccuracies. Yet when war broke out again in 1939 only three types of bombs were available to Bomber Command. They were the 500lb General Purpose (GP) high explosive (HE), the 250lb GP HE, and a 40lb GP. Although the 40lb GP was mainly an anti-personnel weapon all were dependent on penetration and subsequent fragmentation to create damage.

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20 Air Ministry, The Origins and Development of Operational Research in the Royal Air Force, p.44

21 Neville Jones, The Beginnings of Strategic Air Power, p.19

As well as stressing the navigational problems of a strategic bombing offensive, the difficulties of target location and identification and the infinite variables in bomb aiming, Lord Tiverton also defined the need for and the value of concentration in bombing attacks. For maximum damage in both material and morale senses, and as a means of overwhelming defences on the ground and in the air, concentration was essential. Confirmation of the correctness of Lord Tiverton's assessment came in the Second World War on the night of 30/31 May 1942.

On this night, under the code name Operation Millennium, the German cathedral city of Cologne was the briefed target to be attacked by 1,047 R.A.F. bombers. The Daily Mail of 1 June 1942, naturally euphoric, printed headlines of '2,000 Tons of Bombs in 90 Minutes'. In fact the raid lasted from 0038 hours until 0310 hours on 31 May; 898 aircraft claimed to have bombed the target and 540 tons of HE and 915 tons of incendiaries were dropped. Initial British estimates of the number killed varied between 1,000 and 6,000. Official German police records however only listed 474 deaths and stated that Cologne 'was functioning normally again within two weeks of the raid'. Bomber Command leaders were provided with confirmation of Lord Tiverton's thesis. The concentration of a bombing attack in both time and space meant increased damage to the enemy and increased safety for the bombing force. Thus concentration again became the tactical aim. Aircraft losses for the R.A.F. in the raid on Cologne had been 4.8 per cent in the first wave, 4.1 per cent in the second wave and only 1.9 per cent in the final wave.

Even then Lord Tiverton's writings at the end of First World War, but still pertinent to the conflict from 1939 to 1945, were not ended. On the 22 May 1918 he wrote to the CAS expressing his concern at the failure to prepare a blue-print for the 1918 bombing offensive. The Air Council however had taken the view that time was on the Allies' side. They

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23 Daily Mail, June 1, 1942, p.1
26 Middlebrook & Everitt, op.cit., p.273
believed that the war would continue into at least the summer of 1919. Perhaps they were waiting for the fulfilment of the promised, enormous expansion of the bomber force. Sir William Weir, Secretary of State, expressed the optimistic hope that expansion of the bomber force could 'contribute towards bringing about a definite demand for peace'. Lord Tiverton was less concerned with possible expansion than with the need for a bombing plan. He saw the formation of a plan as the first essential in securing both French co-operation and participation in the bombing offensive. Co-operation with French and American authorities was as relevant and necessary in the First World War as the joint English and American unity and agreement was in the Second. Differences there may have been but consensus was essential and fortunately it was secured.

Finally, Lord Tiverton was concerned over the training inadequacies. On 22 April 1918 the Strategic Council, formed to consider the most appropriate ways of implementing the Air Council's policies, held its first meeting. It had four permanent members, the CAS, DCAS, the Director of Flying Operations (DFO) and the Controller of the Technical Department. It also had the authority to co-opt other officers with specialist knowledge. Any potential for division between the Air Council and the Strategic Council was obviated by having the CAS and the DCAS on both bodies. At their first meeting there were ten topics for consideration. The three accorded the highest priority in 1918 were still highly relevant to Bomber Command's problems from 1939 to 1942. Firstly, there were the problems of long range air navigation and the need for both training and equipment to overcome them. Secondly, there was the need to provide improved bomb sights to increase bombing effectiveness. Finally, what could be done to improve meteorological forecasting, particularly in the provision of upper air winds, for the R.A.F.? It was Lord Tiverton who was delegated the task of preparing the response.

Lord Tiverton's concern over the navigation problem is evident certainly as early as 1915. Accurate navigation he appreciated was dependent on the provision of maps and charts for the crew, suitable instrumentation, adequate training and continual practice. He was also aware that increased navigational difficulties would be experienced if a long range night bombing offensive was initiated. For this reason, among others, he tended to reject the night option. However,

27 Neville Jones, The Origins of Strategic Bombing, p.179
28 Ibid., pp.173-4
29 Ibid., p.175
it was in the consideration of the essential training for air navigators that Lord Tiverton was palpably ahead of his time. He saw that accurate navigation was the prerequisite for accurate bombing. His summation was that 'It cannot be recognised too early, that the problem of bombing over distances which vary between 150 and 200 miles necessitates a training in the knowledge of the country among the pilots which is far beyond anything which they are now given. It is not a question so much of theoretic navigation as of knowing - the maps of the country over which they are going to fly so well that they have no difficulty in recognizing any possible outstanding mark that they may come across. This means months of training'.

The navigation problem, identified in the First World War but largely unsolved, was virtually ignored in the R.A.F. between 1918 and 1939. Thus when Bomber Command was forced into the night role early in 1940 because of unsustainable losses the minimal training that had been received for the day role was insufficient to ensure target location and identification at night.

The majority of the problems of Bomber Command between 1939 and 1942 were recognised in the First World War. The tragedy was that their solution had not been an on-going consideration by the Air Staff. The R.A.F. became a shop window service providing tremendous spectator appeal at the annual Hendon displays but remaining unprepared and ill-equipped for war. Although deficiencies were frequently exposed in the regular air exercises the problems were allowed to persist.

The Royal Jubilee Review of the R.A.F. at Mildenhall and Duxford in 1935 is a classic of its kind. Consider the navigational deficiencies that were displayed. During the rehearsals 'several squadrons got out of position and even failed to find Duxford at all'. Another correspondent signing himself 'C.G.G.' (presumably C.G. Grey the editor, and a noted aviation writer), in the same issue of the Aeroplane, was even more scathing of the navigational abilities of R.A.F. pilots, but in a restrained manner. He regarded the inability of a R.A.F. squadron to find its way from Mildenhall to Duxford via Bury St. Edmunds 'across twenty or thirty miles of Eastern England ... [as a]... sad story'. It must be noted that this is virtually local flying, in day, with no distractions in the shape of enemy defences. Certainly weather conditions played a role but they were and are the

30 Jones, The Origins of Strategic Bombing, p.146
31 Aeroplane, July 10, 1935, p.46
32 Ibid., p.52
norm for flying operations in England and Europe. Even smudge fires on the ground were used to provide navigational assistance and 'C.G.G.' observed, no doubt with tongue in cheek, that there was 'no truth in the rumour that one squadron followed the smoke signals and landed at Manchester'. The same writer's summation of the Royal Review Flight at Duxford is a lament for an air force that might and should have been. He believed that if the Review had been presented as 'an exhibition of the nakedness of this land and the inadequacy of our Air Power, staged to make the British Taxpayer more malleable in the hands of the Tax Collector when called upon to pay for the expansion of the Air Force,' then perhaps the exercise had been worthwhile. It may also have been worth acting out the writer considered, if 'the exhibition was staged as a bluff for foreign powers'. The writer's summary was that 'if the Review Flight was intended to be demonstration of British Air Power, then it was simply pathetic, - a fizzle, a wash-out'.

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Aeroplane, July 10, 1935, p.52
Ibid., p.51
Ibid., p. 51
Ibid., p. 51
3. **Deficiencies in the R.A.F. Before 1939**

**Economic Considerations**

In September 1939 R.A.F. Bomber Command was unprepared for war. Many general reasons can be advanced to explain this situation. Often the blame has been attached to the appeasement policies so avidly pursued in the 1930s. But surely such policies were inevitable when the enormous external demands for the defence needs of the British Empire were balanced against the realities of a delicate internal economy? Some previous supporters of appeasement now view the policy as the gradual surrender of both power and influence but yet, surely at the time, it offered hope? The alternatives were bleak - adequate defences and bankruptcy, or strategic vulnerability and solvency.¹ Appeasement did not necessarily fail because it was wrong but rather because it was attempted with an intransigent politician. Herr Hitler operated from a position of strength while Britain was incapable of countering the triple threat posed by Germany, Italy and Japan. Government policies and economic considerations both played their parts in the failure to prepare for war in the 1930s but there was also another relevant factor. The ruling elite, anxious not only to preserve the political and social status quo, but also at the same time fearful of the impact of apparently unaffordable defence spending and increased taxation on a fragile economy, pre-empted rearmament considerations. Perhaps, in the final analysis, it was moral commitment that drove the British people to accept war in 1939 - it was assuredly not military preparedness. In 1939 for Bomber Command and the R.A.F. as a whole, as also for both the Royal Navy and the Army, deficiencies were manifold. Twenty one years without a major war had made many military leaders complacent. Their background was the Great War and it restricted their thinking and bound them to traditions and tactics which they failed to appreciate had become out-moded. Too many in high places for too long failed to see that a powerful enemy was arising and that a highly technological war was fast approaching. People clung for too long to the vain hope that the Great War had been the war to end all wars. Too many professionals in the Services at the end of the Great War looked forward in peace to rebuilding their elitist family groupings. They sought a return to the times when advancement was gained by who, rather than what, you knew. The R.A.F. in the 1930s became for many simply the finest private flying club in the world.

But all these elements, pertinent as they may be, are broad generalisations and are not relevant to this particular study. The aim is to consider specific reasons for Bomber Command's deficiencies on the outbreak of war. Inadequate

preparation for war led, inevitably, to poor performance. Sadly, up to late 1942, that is the summation of Bomber Command's efforts in the first three years of war. The realisation that the strategic bombing offensive was failing and that Bomber Command's independence was at risk were prime reasons for the formation of the Pathfinder Force in August 1942.

What were the specific deficiencies in R.A.F. Bomber Command in September 1939? There were many: realistic training had been neglected, the aircraft generally were obsolescent, totally inadequate consideration had been given to the problems of navigation, target location and bomb aiming, there was a shortage of fully trained navigators and tactics had not been updated. Perhaps however, underpinning most of the problems for all three Services in the 1920s and early 1930s were the economic realities and this is the first area to be examined.

With the benefit of hindsight it is easy now to criticise Britain's political and military leadership between the wars for its failure to maintain the armed forces either in sufficient numbers, or well trained, or even adequately equipped. But in the 1920s one specific consideration dominated. The shadows cast by the Great War were very persistent and the horrors of the Somme and Passchendaele too recent to permit politicians to entertain policies even remotely suggestive of the possibility of another war. The League of Nations was the straw to which politicians and the public alike clung grimly. War had to be unthinkable. In the 1930s with the memories of the Great War still largely undimmed another and perhaps more cogent reason for avoiding war became evident. Fear of the bomber and the casualties it could create became an obsession.

The emergence of air power meant that the security previously offered to Great Britain by her island isolation and the Royal Navy had been lost. Her cities and people, and London in particular, the hub of empire, appeared vulnerable. The Air Ministry in 1932 calculated that an air attack on the United Kingdom by an Air Force able to deliver 400 tons of bombs in a week would cause 6,375 civilian deaths and leave 12,376 wounded. By 1937 with the increased bomb tonnages that it was estimated the German Air Force could deliver, civilian casualties were estimated at 58,900 dead and 116,000 injured every day. These were not simply the ravings of a lunatic fringe. The assessment had been completed by a Home Defence Sub-committee of the Committee of Imperial Defence (C.I.D.). Even in June 1940 when bombing effects had been reassessed it was still calculated that up to 18,000 deaths a day could result from a bombing assault on London.2

Bertrand Russell, greatly disturbed at the threats posed by aerial bombing, offered perhaps his most spine-chilling prediction when, in 1936, he wrote that 'London for several days will be one vast raving bedlam, the hospitals will be stormed, traffic will cease, the homeless will shriek for help, the city will be a pandemonium. What of the Government at Westminster, it will be swept away by an avalanche of terror. Then will the enemy dictate its terms'.

The threat had already been clearly defined by the Lord president of the Council, Stanley Baldwin, in the House of Commons on 10 November 1932 when he averred that 'I think it is well also for the man in the street to realise that there is no power on earth that can protect him from being bombed. Whatever people may tell him, the bomber will always get through. The only defence is in offence, which means that you have to kill more women and children more quickly than the enemy if you want to save yourselves'.

Baldwin's words had already been shown to be true. In the Air Exercises of 1930 the bombers had got through. 'By the end of the third night ... The Red capital had ceased to exist as a capital, the population was in open rebellion, and the High Commissioner had been forced to remove himself to a neighbouring village'. They were reconfirmed in the Air Defence of Great Britain Command Exercise for 1933 when from 47 individual aircraft raids in daylight only 18 were intercepted prior to reaching their targets. From 79 night raids it was perhaps optimistically claimed that 35 had been intercepted before reaching their targets. Gradually in the 1930s as appeasement hopes faded war became less and less unthinkable. Increasing attention was focused on the prevention of war by deterrence. As a natural corollary rearmament became a necessity.

Great Britain's suffering in the First World War had not been limited solely to enormous human casualties. There was also the economic burden and that did not end even with the signing of a peace at Versailles in 1919. The retention of

'Blue Force Staff Officer', 'Some Lessons of the Air Exercises 1930' in Royal Air Force Quarterly, Vol. 2, No.1, Jan 1931, p.64
Britain's armed forces, even though on a massively reduced scale, considerably added to that burden. World economic conditions further eroded the British economy dependent as it was on expanding world trade. Economic considerations dominated political thought. During the 1920s and even in the early 1930s Treasury officials and most politicians were agreed that economic problems posed a greater threat than any foreseeable military confrontation.7

In this harsh economic climate many were relieved to accept the insubstantial shelter offered by the Ten Year Rule. Although the Great War had ended in November 1918 with the signing of the Armistice this did not mean that British military commitments totally disappeared. The army was still heavily involved in the Middle East and India, there were expeditionary forces to be maintained in Russian Siberia and a garrison was required in Ireland. At the same time the Royal Navy was at full strength in the Eastern Mediterranean while still continuing to maintain the blockade of German ports. Military expenditure remained high.

As early as November 1918 the Government in Britain was fully conscious of the significant imbalance between national expenditure and the gross national product. Expenditure exceeded income. Almost immediately the Services were advised that their annual votes would be reduced. With their free-spending days ended the Services now required a stable platform on which to base their annual estimates. This the Government supplied with their first version of the Ten year Rule. On 15 October 1919 - although the exact implementation date is in doubt8 - the British Cabinet decided that 'It should be assumed, for framing the revised estimates, that the British Empire will not be engaged in any great war during the next ten years, and that no expeditionary force is required for this purpose'.9 Upper limits of expenditure for 1920-21 were then announced for the three services.

The cost of maintaining the armed services in peacetime was not the only financial concern of the British Government after 1918 - there was also the war debt owed to the United States. This debt was less than half what Britain herself was owed but unfortunately the debts to Britain had to be

regarded as uncollectable. War time loans to allies were not the solid assets it was assumed they would be once peace was declared. In June 1921 Austen Chamberlain, Chancellor of the Exchequer, reported that 49 per cent of the total revenue for 1921–22 was required solely for servicing the war debt. At the same time he admitted that expenditure exceeded income by 24 per cent. Military budgets continued to be pared.

The Ten Year Rule did not remain in its original form for long. After the Conservative Government assumed office in November 1924 Winston Churchill, as a pragmatic Chancellor of the Exchequer, called for its review in light of increasing demands from the Admiralty. Naval officials sought to base their building and construction programmes on their projections of increasing Japanese naval activity in the Pacific. As advisors to the Cabinet, the Committee of Imperial Defence concluded, in 1925, that the Japanese offered no significant threat to the British Empire within the next ten years. The parameters of the Ten Year Rule had undergone a subtle change – whereas previously it would have expired in 1929 now, at least in the case of Japan and the Royal Navy, it had been extended to 1935.

In June 1928 Churchill, still dissatisfied with the Naval estimates, called for a further examination of the Ten Year Rule. He suggested that all Service estimates should be based on a moving time frame. His proposal was 'That it should now be laid down as a standing assumption that at any given date there will be no major war for 10 years from that date'.

The C.I.D. accepted Churchill's proposals with the proviso that they 'should be reviewed annually by the C.I.D.' and as such they were approved by Cabinet and reaffirmed by the incoming Labour Government in 1929.

Acceptance of the moving time factor meant that every day a major war was still ten years away. Under those conditions preparations did not have to be rushed and monies did not have to be squandered. During the 1920s with successive Governments promoting disarmament (or at least a very low level of armaments), the Ten Year Rule had become a comfortable cushion for the Treasury. During the early 1930s the threat of the Japanese navy in the Pacific and the rise of Hitler made the Ten Year Rule a dangerous delusion. Whether the Ten Year Rule was cancelled in 1932 or 1933 is still the subject of semantic argument. If it is accepted that an expression of 'no dissent' by Cabinet does not equate with 'positive approval' then the Ten Year Rule, rather than being cancelled in March 1932, remained in existence until 15 November 1933.

10 Roskill, op.cit., p.69
11 Ibid., p.69
12 Ibid., p.70
Financial restraints did not end with the cancellation of the Ten Year Rule. Rather the contrary, because immediately following the cancellation Neville Chamberlain, then Chancellor of the Exchequer, introduced the lowest figures for estimated expenditure on armaments since the end of the Great War.\(^\text{13}\) As late as 1938 Neville Chamberlain, by then Prime Minister, still insisted that Treasury had a dominant role in the rearmament debate. As a consequence, preparations for war in Britain in 1938 consumed barely eight per cent of the gross national product - half that of her already recognisable enemy, Hitler's Germany.\(^\text{14}\) Military critics of Temple influence on rearmament considerations in the late 1930s saw it as applying the brake on preparations for an inevitable war while at the same time preparing to meet the indemnity consequences arising from defeat.\(^\text{15}\)

Treasury arguments over the affordability or not of defence spending were many faceted. Did Britain have the man-power available both to dramatically increase the size of her armed forces and provide their necessary war equipment? Potential allies and guaranteed sources of supply for essential materials were not always immediately obvious. An increase in war production meant a reduction in exports and a widening trade imbalance. It was also argued in the late 1930s that with prices rising and costs likely to increase because of wage demands, there was a danger of the economy overheating. The bitter economic memories of the 1931 depression were all too easily recalled.\(^\text{16}\)

Of the three Services the R.A.F. was the only one able to increase its expenditure in the decade 1922 to 1932 although its share of the defence budget was markedly lower than that of either the Royal Navy or the Army. In 1922 the Royal Navy vote was 64.9 million pounds; the Army received 62.3 million and the R.A.F. 10.9 million. Both the Royal Navy and Army estimates then fell regularly (apart from a rise for the Royal Navy in 1929) so that in 1932 the Royal Navy vote was for 50.5 million and the Army 36.5 million. Over the same period the


\(^{15}\) Dunbabin, *op.cit.*, p.598

\(^{16}\) *Ibid.*, p. 598
Air Force vote rose gradually and steadily (apart from a decrease in 1927) to reach 17.4 million in 1932.\(^\text{17}\)

This is not to say however that the modest goals set by Air Force planners were always attained by the expected date. The scheme to enlarge the home defence element of the R.A.F. to 52 squadrons, launched in June 1923, provides a good example of the delays that could occur. Until 1923 it had been difficult for Britain to discern a potential European enemy. In that year however, relations with France had deteriorated over German reparation payments and the subsequent French occupation of the Ruhr. The R.A.F. expansion was designed to counter a perceived French air threat. The British Prime Minister Stanley Baldwin said the expansion was to ensure that the home defence element of the R.A.F. would be 'of sufficient strength adequately to protect us against air attacks by the strongest air force within striking distance of this country'.\(^\text{18}\) Completion date was only loosely defined but it was hoped that it 'could be accomplished in the next three or four years'.\(^\text{19}\) In 1925 however the target completion date was moved forward to 1935. A further delay to the 52 squadron plan came in 1929 when, perhaps not unexpectedly because it fitted conveniently with the revised Ten Year Rule, completion was deferred until 1938. Despite all the pressures, but perhaps because the British Government still hoped that war could be averted, no new squadrons were formed between November 1931 and March 1933.\(^\text{20}\) The Cabinet was determined to accord the Disarmament Conference every chance of success and had accepted an armaments truce during this period.

Severe economic restraint for the Services until the mid-1930s had, for the bomber force, both short and long term effects. The failure to implement the planned expansion meant that it remained very small. This had the effect of helping to make exercises unrealistic and the detection of possible operating problems difficult. Firm economic control meant that the Hendon Display was not simply a show of the potential of the R.A.F. It was in fact virtually the sum total of its capacity. Economic control meant that reserves for the first line were inadequate if not non-existent, research and development for the bomber force was deferred and

\(^{17}\) H. Montgomery Hyde, *British Air Policy between the Wars 1918-1939* (London: Heinemann, 1976), Appendix VI, p. 516

\(^{18}\) Neville Jones, *The Beginnings of Strategic Air Power*, p.28


\(^{20}\) *Ibid.*, p.34
its advanced training negligible. The need to show that the Air Force vote was being well spent required, because personnel numbers were kept low, that specialisation of both aircraft and aircrew was discouraged. Bomber aircraft in the early 1930s were simply adaptations of the two-seater fighters and both aircraft and pilots were too often expected to be capable of fulfilling both a day and a night role. ²¹ There are important differences to be noted between the situation in Britain and that in either Germany or the United States with regard to aircraft design, or the materials with which they were constructed, but that discussion can be more fully pursued in the section on Aircraft and the Aircraft Industry.

Economic stringencies also introduced a strange dichotomy between the accepted concept that the bomber would always get through and the limitations implied by the application of the Ten Year Rule. The theoretical aim of the Air Staff was, for most of the 1930s, to create a bomber deterrent force. In that regard it would be expected that both all energies and the air vote would have been directed toward research and development to create a bomber force fully trained and equipped and capable of fulfilling its planned role. Any imminence of war should have encouraged the process. On the other hand the Ten Year Rule provided a breathing space to develop and introduce technology capable of reversing the perceived bomber invincibility. Unfortunately the necessary finances were not available to support research and development into both offensive and defensive equipment, training, or tactics. Fortuitously perhaps, and despite the lip-service paid to the superiority of the offensive over the defensive, scientific and technical research was principally directed into defensive measures. Inadequate funding was one reason that Bomber Command went to war in September 1939 ill-trained and inadequately equipped. ²²

Perhaps it was true that many decisions made by the British Cabinet on rearmament owed more to economic and political expediency rather than the acknowledged recognition of military necessity. But the Government was always faced with a dilemma. To encourage or allow overspending entailed the risk of a depression. Contrariwise, to restrict expenditure on the Services increased the likelihood of military unpreparedness. Treasury, as the Government's economic adviser, gave equal priority to the maintenance of economic stability and the requirements of the armed services. Indeed, Treasury regarded economic stability 'as a fourth arm of defence'. ²³

²¹ Wernham & Frankland, op. cit., p.35
²² Ibid., p.35
It must not be assumed that either the Services in general or the Royal Air Force in particular were always hampered in their planning by Treasury economies. When Treasury relaxed the economic brake in 1933/34 they did so while still remaining cognisant of two important factors. Britain had need not only to prepare for war but also to be economically capable of continuing any struggle once it had begun. In 1934, far from discouraging spending, Treasury went as far as offering criticism to the R.A.F. for having submitted what Treasury considered was too low an estimate of forecast spending. Perhaps some may claim that Treasury restrictions pressed heavily on the Services but in 1934, 1935 and 1936 the Air Vote for aeroplanes and spares was marginally underspent.24

Several hypotheses can be advanced to explain this apparent neglect. Firstly, that the planners in Air Ministry, too long influenced by Treasury restraints, were unable to appreciate the loosening of the economic reins. They had become accustomed to delays and procrastination and failed to perceive the urgency that politicians, in 1934 and subsequently, were according the topic of rearmament. Even the fifty-two Squadron expansion scheme formulated by the Air Ministry and approved by Cabinet in 1923, still remained unfulfilled in 1934. Why now that rush to re-arm? It is also apparent that the Air Staff equated rushed expansion with reduced efficiency. This they were justifiably loath to accept. Perhaps also they under-estimated the preparations then being made in Germany's rearmament. Air Chief Marshal Sir Edward Ellington (C.A.S.), in a memorandum on Air Defence Requirements in May 1934, wrote that he believed 'that the completion of the 52 squadron scheme, or an extension of it, was not only all that could be done but all that needed to be done'.25

Another reason for minor under-spending of the Air Force vote is that in 1934 the British aircraft industry was in no condition to undertake either new projects or massively increased production. The major problem was a shortage of skilled labour that could only be overcome by manpower direction. This drastic measure was considered unthinkable.26 Although the planners in Air Ministry were

24 Peden, op.cit., p.206
becoming aware that numerical parity was becoming less critical than operational efficiency, aircraft factories continued to produce the same bi-planes which, if not already so, were rapidly approaching obsolescence. Unfortunately the aircraft industry was not able, certainly in the early years of rearmament, to meet the requirements that the R.A.F. sought. For their part, the R.A.F. was becoming reluctant to continue to receive aircraft which although fine for Hendon pageants were unfitted for war.

By 1936 the demands being made by the Armed Services on the economy forced Treasury to attempt to gain a measure of control over the rearmament programme. The Royal Air Force requirements were accorded priority. Although the R.A.F. budget was set lower than the other two Services it was acknowledged that the most pressing need for Britain's defence was the creation of a deterrent bomber force. Air force expansion required increased recruitment and training, purchase of land for and the construction of aerodromes, and an extensive building programme to provide accommodation for both men and machines. Treasury saw no requirement to put a ceiling on recruitment because they saw a manpower rather than an aircraft shortage as providing the greater concern.

Industrial and manpower resources in Great Britain were however finite. A Cabinet ruling in February 1936 (not revoked until March 1938) that 'rearmament was not to interfere with normal trade and industry' created problems for aircraft orders. In 1936 the emphasis for R.A.F. expansion was concentrated on the building of a deterrent bomber force. It was a sop to public opinion and was also accepted by Treasury and the Government as a cost-effective means of defence. The appreciation changed in 1937 when it was realised that the structure of British industry and particular Government policies prevented the planned expansion of the bomber force. Technical and industrial problems thwarted Air Ministry efforts to spend the monies provided by a willing Treasury. There was also the very considerable time lag between the recognition of a particular need in aircraft design and when the finished products could enter operational squadrons. However, the complex nature of the problem meant that although the time may be reduced it was always going to have to be measured in years and success could never be guaranteed. Aircraft deliveries in general and bombers in particular fell further and further behind production schedules.

By 1937 the Air Ministry were becoming increasingly concerned because parity was not being achieved either in the numbers of bombers or in the tonnage of bombs capable of being carried. They were also becoming more aware of the vital

Peden, op.cit., p.153
importance of quality, as compared with mere numbers, in the aircraft with which the front-line squadrons were being equipped. Perhaps it was due to industrial incapacity, perhaps it was a question of economics but a front line bomber force without reserves was a sham, a dangerous illusion of safety. Fighter aircraft were also needed - they were needed quickly and in large numbers. In 1935 the C.A.S. Edward Ellington had said that 'even fighter squadrons had no place in measuring the relative strength of air forces'.\textsuperscript{28} But now in 1937 relativity was no longer the major concern. The bomber deterrent theory was collapsing and fighters were seen, certainly by Sir Thomas Inskip the Minister for the Coordination of Defence, as the only possible salvation. Economies had to be made and although the Air Staff was not in general agreement the Cabinet, in 1938, accepted Inskip's recommendation that bomber production be considerably reduced and that the fighter force, including reserves, be made as strong as possible. Inskip's appreciation was a refutation of Air Staff doctrine on which policy had been based and plans detailed and emphasised defence at the expense of attack. Fortunately, the plan to ultimately equip Bomber Command with heavy bombers, although now subjected to further delays, was retained. Perhaps it was another example of military needs being redefined by economic realities but at least it eased the burden on the aircraft industry caused by the previous demand for bombers.\textsuperscript{29} The policy of providing defence by offensive bombers was about to be superseded by a build-up of defensive fighters. The transfer of Treasury support from deterrent bombers to defensive fighters was in accord with their tenet that the cloth of military policy must be cut according to economic and industrial means. Fighter aircraft as the protection against a German knock-out blow were now seen as the urgent requirement.

In the last resort it would appear that it was not necessarily the size of the Air Force vote that determined how well prepared Bomber Command was for war. Generally the monies requested had been provided. Unfortunately they were not always totally spent nor, would it appear, were they always wisely invested. The expansion of the R.A.F. may have been both inadequate and unbalanced however, to a larger

\textsuperscript{28} Peden, op.cit., p.118

\textsuperscript{29} Malcolm Smith, 'Planning and Building the British Bomber Force, 1934-1939' in Business History Review, Vol.LIV, No.1, Spring 1980, p.37
extent than either the Army or the Royal Navy, the Air Force had freed itself from financial shackles. The Services annual expenditure for the years 1933 to 1939 shows the increasing R.A.F. domination of Treasury resources. Amounts are in million of pounds sterling.\footnote{N.H. Gibbs, \textit{Grand Strategy} (London: H.M.S.O., 1976), Vol.1. Pt.3, p.532}

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4. Deficiencies in the R.A.F. Before 1939:
Aircraft and the Aircraft Industry

At the end of the First World War the R.A.F. was the most powerful air force in the world. There were over 350 squadrons available in Europe, the Mediterranean, Mesopotamia and India. In the United Kingdom alone there were 400 fighter aircraft and 330 pilots in the front line with another 227 aircraft and 165 pilots in reserve. These to defend the British Isles and the people against not more than forty German bombers. Yet by mid-1920 the R.A.F. had shrunk to twenty squadrons with only two based in England. As a fighting force it had ceased to exist. Fortunately, there was no immediate risk of a major war. The consequences of such a run-down, however, were severe and long-felt. The R.A.F. in fact had to struggle for survival against Treasury economies and the demands of the Army and the Royal Navy.

The Army and the Royal Navy saw aircraft as ancillary to their own particular needs and invaluable in the support they could provide in either land or sea operations. But they did not agree that there was necessarily any requirement for a separate, autonomous Air Force. This inter-service rivalry linked as it was with public and political demands for disarmament plus the economic crises of the 1920s and 1930s, meant that an almost crippling burden was placed on the R.A.F. Trenchard's concept of an Air Force with an adequate platform for expansion when required, was almost still-born in the gestation period. Levels of training, manpower, aircraft and equipment almost sank below the minimum from which expansion could take place. With the problems faced by the Royal Air Force during the 1920s its survival depended almost entirely on finding a cheap role overseas. It may appear churlish to criticise the preparations made by the R.A.F. for war knowing now the considerable contribution it made to victory in 1945, but this work is concerned with one major question - why was a Pathfinder Force required? It is necessary therefore to examine in greater detail why the bomber aircraft provided for R.A.F. aircrew in 1939 were not only too few in number but also incapable of meeting the requirements of modern war.

For the aircraft industry to survive at the end of the First World War it was clear that government assistance would be essential. The government had to become involved in the development of civil aviation and perhaps even provide direct financial subsidisation. With the reduced military demands and vast quantities of surplus aircraft and components it was obvious that the industry would experience difficult

1 Hilary St. George Saunders, Per Ardua (London: Oxford University Press, 1944), p.311
conditions. Until 1920 aircraft manufacturers even had to pay an excess profits duty to the extent of 80 per cent above a certain datum line of profit.\(^2\) Certainly it was not going to be military purchasing that would save the aircraft industry. The Air Estimates for the whole of 1920 were for an amount equal to a fortnight's expenditure in 1918.\(^3\)

The 52 squadron expansion scheme announced in 1923 provided a glimmer of hope. Although initially there were differences of opinion as to the composition of the expansion - bombers or fighters - at least the R.A.F. was going to be provided with additional aircraft although on a very extended time-frame. Transport aircraft were not considered at this stage nor was great interest displayed in providing extra machines for training purposes. As an additional economy measure it was decided that some squadrons would do all their own flying training from initial instruction on Avro trainers to operation of their own particular aircraft type. This saved the cost of establishing additional Flying Training Schools. This meant a minimum of at least two years before any particular squadron employing this system could be considered to possess even a nucleus of operational pilots.\(^4\) Trenchard, of course, in accordance with his theory of the supremacy of the offensive over the defensive saw the greater need as being for bombers. He saw the French, in the face of a bombing assault, 'squealing' before the British. He called for thirty nine bomber and twenty fighter squadrons with Staff College theorists falling between those extremes.\(^5\) The final ruling in July 1923 was for thirty five bomber squadrons and seventeen fighter.

But were these additional bomber squadrons to have a day, night, or dual role? The lessons of the Great War had shown that day bombers reached the target areas but that enemy defences of aircraft, guns and balloons had forced them up to an altitude that made accurate bombnig difficult. Night bombers, on the other hand, by flying low on short penetration raids, usually on clear nights, also reached their targets. Their bombing accuracy, however, was not significantly better than the high flying day attackers. Perhaps it was a question of which force hurt the Germans the most. The heavier night bombers, under cover of darkness and by sacrificing speed and performance for increased range and bomb load, appeared to offer the better prospects. The arguments went in circles. The day bombers were less handicapped by adverse weather and their navigation was a less daunting task. Also, by bombing

\(^2\) Aeroplane, November 24, 1937, p.616
\(^3\) Saunders, op.cit., p.310
\(^4\) Wernham & Frankland, op.cit., p.26
\(^5\) Ibid., p.26
in daylight the workers would be caught at their machines. Considering the morale effects of bombing, the fact that families were separated and lack of knowledge acts as a spur to worry, day bombing had its supporters. Another factor in favour of day bombing was that large formations would be employed, against the single night raiders, so although individually, lighter loads were carried in daylight raids, in total they would drop comparable bomb tonnages.

It was agreed however that in bombing saturation of the target should be the ideal. Therefore it was desirable that any bombing force created should possess both a day and a night capability. Air Commodore Brooke-Popham at Staff College in 1923 suggested that a force capable of striking at full strength by day and by night was required. He wanted the force equipped with a standard bomber with the crews trained for both day and night operations.

The decision reached by the Air Council on 31 July 1923 was that the first 24 squadrons would be split equally into twelve day and twelve night. Ultimately the aim was to have six specialist day squadrons, three specialist night squadrons and 26 with a dual, day/night capability. But decisions do not necessarily imply implementation. Other factors were involved and Treasury, which saw economic dangers as potentially greater than military, had a role to play. The growth of the R.A.F. bomber force was to be protracted and, ultimately, barely sufficient to meet the challenges offered.

The period from 1923 to 1933 was one of great uncertainty and discouragement for servicemen, civilians and the British aircraft industry. The original planned completion date for the 52 squadron expansion scheme was 1928 but this was very early deferred until 1930. In 1925 completion was again delayed until 1935 or 1936. In 1929 it was announced that the programme would not be completed until 1938. There were many reasons; the Ten Year Rule, economic conditions, the desire to avoid war and the hopes placed with the Geneva Disarmament Conference, all played a part.

European thought in 1932 was dominated by the psychology of fear - fear of a 'knock-out' blow by bombing aircraft against which there was apparently no effective defence. At the same time there was continued revulsion at the misery and deaths caused by the First World War which greatly encouraged a growing belief in the necessity for disarmament. The League of Nations flew a flag of hope for the future. The Geneva Disarmament Conference which opened on 2 February 1932 was a symbol of this hope. As such it was the logical extension of the Pact of Paris signed on 27 August 1928. The Kellog Pact (as it became known), agreed to by fifteen states - including Great Britain, France, the United States,
Germany, Italy and Japan - not only condemned any recourse to war but also rejected war as a policy instrument for international relations. This agreement, to which 45 other states later confirmed their support, provided a firm foundation for the Geneva talks which aimed firstly at the reduction of arms and then their total elimination.

When it early became clear to delegates at Geneva that an acceptable formula for arms limitations would not be found, the aim of the talks was shifted. Abolition of offensive weapons - particularly the bomber aircraft - became the primary objective. Britain, naturally, because of the perceived vulnerability of London to aerial attack, took a prominent role in all the discussions. Had the talks been successful the British Government would then have had to disband her defensive bomber force which was being established as a weapon of deterrence. Unfortunately, Britain, in 1932, operated not from a position of strength but rather from weakness - a fact of which the other major states were well aware. On 17 September 1932 Air Staff estimates of the first-line strengths of the Great Powers put Great Britain in a lowly fifth place. France was believed to possess 1,613 front-line aircraft, Russia 1,174, U.S.A. 1,105, Italy 1,012, Great Britain 748 and Japan 440.\footnote{J.M. Spaight, The Expansion of the Royal Air Force 1934-1939, London: Air Ministry, no date, p.18} It was made clear to everyone that Britain was weaker in her air element than several other states which were not only less vulnerable but also had fewer global responsibilities.

Parity for Britain was achievable in two ways - Britain could either increase her numbers of operational aircraft or the other Powers would have to be induced to reduce theirs. In 1932 reduction by international agreement offered the better prospects for Britain because the effects of the depression, which had begun in 1929, were still very apparent. Practically, reduction would also have meant that Germany's demands to be allowed, legally, to build an air force would have been deflected.\footnote{Ibid., p.20}

The major problem that arose in the Geneva talks was that delegates were continually diverted onto side-tracks that turned out to be blind alleys. The first aim had been the limitation and reduction of armaments which then led to the hope that perhaps bombing could, if not banned entirely, at
least be restricted within reasonable limits. Others sought the total disbandment of all national air forces. This idea, however, required that civil aviation would have either to be rigidly controlled or even internationised because it is not difficult to convert civil aircraft to military uses. C.G. Grey, an influential writer on aviation matters in the 1930s, likened the plethora of formula presented by delegates at Geneva to the small Jewish boy going up and down the street changing a dollar bill. 'First, the Jew boy changed his dollar into quarters in one shop; then the quarters into dimes in another shop; then the dimes into nickels at the next shop; then the nickels into pennies at a last shop; and then he would change his pennies back into a dollar bill and go through the whole process all over again. Finally, asked by a merchant who had helped him make this change several times, why he was putting himself and everyone else to so much trouble, the little Jew replied, - "Sometime somebody is going to make a mistake and it won't be me".'

During 1932 and early 1933 the Geneva Disarmament Conference stumbled, unevenly, on its way. Then on 16 March 1933, in an effort to salvage something from the discussions, the British delegation offered a Draft Convention. Presented by J. Ramsay MacDonald the British Prime Minister and afterwards called the MacDonald Plan, it replaced vague theorising with concrete numbers. However, one section provoked a storm of criticism in Britain not only in the House of Commons but also in the press. Bombing from the Air was to be prohibited except that Britain wanted to retain bombing rights 'for police purposes in certain outlying regions'. In other words, although Britain was prepared to forgo any right to bomb future enemies, bombing was legitimate when directed against her own peoples. Other sections of the MacDonald Plan suggested the establishment of a Permanent Disarmament Commission leading to the abolition of military and naval aircraft and with the authority to ensure that civil aviation was not misused for military purposes. If adequate supervision of civil aircraft was not possible then minimum numbers were to be permitted to various countries depending on the size of their air forces. Under those terms Great Britain, France, Italy, Japan, Russia and the United States

9 Spaight, op.cit., p.21


11 Hyde, op.cit., p.291

12 Ibid., p.292
would be allowed to have 500 machines each capable of being converted to war uses, reducing to 25 machines in the cases of Finland and Portugal. Germany was not mentioned.

One writer provided a musical simile in his description of the MacDonald Plan. He described the attempts to outlaw air offensives as Gilbertian and 'that the total abolition of war aircraft became the major fugue running through the unfinished symphony of the Disarmament Conferences of 1933, with the British Government's demand for the retention of bombing aircraft for frontier police work bringing discord into the international melody of peace'.

It was not the police bombing reservation that brought about the demise of the Geneva Disarmament Conference. Effectively it was ended when the German delegation walked out on 14 October 1933 complaining of the 'humiliating and dishonouring exactions of the other Powers'. Germany sought Gleichberechtigung (equality of rights) and this, in effect, meant not disarmament but rather rearmament. That attitude doomed the Conference and although it lingered into 1934 it was already dead in 1933 although not certified.

The tragedy for Great Britain was that attendance at the Conference, of necessity, put a halt to rearmament. British military preparation, particularly in the air element, stagnated, at a period when time was of the essence. The years could not be made up in the time remaining before war was again declared. Well may Spaight describe them as 'the years which the locusts ate'.

By 1930 the Services in the United Kingdom had become seriously run down. The Army, smaller then than it had been in 1914, was unprepared for Continental involvement. This fact, coupled with the growing fear of the threat posed by bombers, was a significant element in both Britain's defensive and offensive positions. Enemy possession of the Low Countries it was appreciated would increase the threat to Great Britain in general and London in particular. It would also create additional problems for offensive action should Germany become the enemy. The Royal Navy had barely sufficient naval forces for operations in Home Waters and many had seen long years of service. Any threat posed by Japan in the Pacific would have been difficult to meet without seriously depleting the forces considered necessary in the North Sea and Atlantic approaches.

Hyde. op. cit., p.292


Spaight, op. cit., p.29

Ibid., p.31
The R.A.F., with the continual deferment of the 52 squadron scheme, was a paper air force. The bomber force comprised light, single-engined biplanes with performances scarcely better than the aircraft of 1918. Britain was almost defenceless in the air. But generally bomber development was taking place and London's vulnerability was all too readily perceived. There was certainly no comparable target offered to any R.A.F. bomber force. The questions being asked by politicians and concerned public were: should Britain seek the security offered by a bomber deterrent force, or should immunity be sought by multilateral disarmament?

Economically and financially Britain in 1930 was in a state of crisis. Certainly there was a vast pool of unemployed though skilled labour, but the times hardly seemed propitious for large scale military spending - especially since the notion of rearmament was rejected by the majority of public opinion. In any case, could industry have coped with a massive requirement for aircraft in a short time? The aircraft industry was very small in 1930 and had had no experience of mass production between 1918 and 1930 or even later. Survival had been the main aim. The British government had neglected the commercial opportunities offered by the expansion of civil aviation despite the fact that the British Empire offered a world-wide potential market. It even neglected to seize the opportunities offered by Britain's successes in the Schneider Seaplane Trophy in 1927, 1929 and 1931. The British aircraft industry only survived because some selected firms continued to receive small orders at irregular intervals from the Air Ministry for both airframes and aero-engines. Significantly also, the British aircraft industry had no research organisation of its own and depended on the work done by government agencies such as the Royal Aircraft Establishment at Farnborough.

Under the 'ring' policy of family firms established by the British Government certain selected firms received favoured treatment in the way of orders for airframes and aero engines. The work was provided for firms deemed the most suitable or those whose survival was seen as desirable. In the 1930 Census of Production there were 38 aircraft firms

19 Ibid., p.129
listed but only 16 in the government organised 'ring'. These
16 provided 90 per cent of the gross output by value of
aircraft and engine orders and employed 90 per cent of the
work force.\footnote{Peter Fearn, 'The British Airframe Industry & The
The system guaranteed the survival of some
firms and, it was hoped, provided a suitable base from which
to launch further expansion should increased production become
a necessity.

One disadvantageous effect of the 'ring' system was that
the Air Ministry ended up with an excess of one-off aircraft
types. The proliferation of different airframes caused
problems when standardisation or servicing was considered.
The Boulton and Paul Sidestrand is a good example. A twin-
engined medium day bomber but able to operate safely on one
engine, it entered service with No. 101 squadron in 1928.
Only 18 production models were constructed and they remained
with 101 squadron until 1934 when they were replaced by
Overstrands with which two squadrons were equipped.\footnote{Owen Thetford, Aircraft of the Royal Air Force since 1918
(London: Putnam & Co., 1971), pp.112-115} Even in
the later 1930s some aircraft were built to only equip one
squadron. The Fairy Hendon entered service with No. 38
squadron in November 1936 and was only replaced in January
1939 by Wellingtons.\footnote{Ibid., pp.250-1,}

The May Committee in 1931 listed 44 different airframe
types and 35 different engines in service with the R.A.F.\footnote{Fearn, op.cit., p.244}
A multiplicity of airframes and engines was not the only problem
facing aircraft firms in the 1930s. A design revolution,
especially in the United States and Germany, was also
occurring concurrently. Monoplanes were appearing, metal was
replacing wood and speeds were increasing dramatically because
of streamlining, retractable undercarriages and variable pitch
propellers.

The use of wood for the construction of aircraft had
meant that they were produced more cheaply, their construction
was simplified and they required fewer specialist workers. On
the other side of the coin they needed to be protected from
the weather, their in-built strength was unmeasurable and
because production tolerances were less stringent, different
aircraft of the same type produced dissimilar performance
figures. Metal airframes made aircraft easier to store and
meant they could be subjected to grosser handling. Another
advantage was that their tensile strength could be gauged.
Hendon II (K 5085) of No. 38 Squadron. (Charles E. Brown Photo.)

Sidestrand III (J 9187) of No. 101 Squadron. (M.o.D. Photo.)

Three-seat Vickers Wildebeest Mk. IV prototype K4164 with 825 h.p. Perseus VIII. (Vickers Photo.)
However, to build metal airframes required that firms establish large design teams, equip their factories with special tools and jigs and expand. For firms already experiencing financial difficulties the prospect of such expenditure to produce a prototype that Air Ministry may reject was a daunting prospect.\(^{24}\)

Unfortunately the Air Ministry allowed themselves to be deluded. For too long they persisted in calling their fabric covered biplanes 'all-metal'. The great increase in strength provided by metal was ignored. The increase in speed to be gained by streamlining was also overlooked. Perhaps, however, the aircraft firms were reluctant to make the switch to the production of truly all-metal aircraft. Prior to the commencement of rearmament in 1934, aircraft orders were too small and irregular to contemplate radical alterations to production techniques.

Before 1933 it would have been electoral suicide for any political party in Britain to suggest rearmament. The valid hope appeared to be disarmament. A Preparatory Commission on Disarmament had held desultory meetings since 1925 and they did ultimately produce a loosely worded Draft Convention. The nations of Europe finally gathered in Geneva in February 1932 to hold a Disarmament Conference. But the fate and the effects of this conference have already been discussed. Europeans, and the French in particular, simply saw British efforts as another example of perfidious Albion in action. Lack of visible military capacity and therefore lack of bargaining power had neutered British plans and hopes. Confirmation of the death of any hope of disarmament came with the failure of the Western Air Pact in 1935. But already by this stage air rearmament in principle, if not in fact, was well under way.

Baldwin in 1932 had defined the threat posed to Britain by bomber aircraft and in 1933, with the failure of the Geneva talks, saw security as dependent upon the achieving of parity with potential enemies. The existence of the R.A.F. was only justifiable if a bomber force was in being. The industrial capacity of Great Britain was to be focused on the construction of a bomber fleet capable of countering, or if necessary, pre-empting any potential enemy. From 1934 until 1937 the major concern of the aircraft industry was the production of bombers to give credence to the government's deterrent policy.

Unfortunately the bomber expansion programme followed no rational master plan. Too many orders were made on an ad hoc basis and national resources were wasted in both materials and manpower. A further hindrance to any controlled, measured

\(^{24}\) Fearn, op.cit., p.240
expansion, was the fact that the need for more bombers coincided with a technological revolution in aircraft design. The industry was having to face up to the prospect of converting to a mass production system while at the same time radically altering their infrastructure and construction methods. Planners at the Air Ministry were also in a quandary. They were having to consider orders for aircraft while still having doubts of the precise definition and tactical requirements of a strategic air offensive.25

It was also becoming clear to some that fighter aircraft were rapidly becoming an increasing threat to bombers. For bomber defence a combination of speed, defensive fire power and armour protection was required. At the same time, and this was certainly so by 1934, it was realised that the potential enemy was Germany. Possible targets were therefore having to be sought at increasing ranges from British bomber bases. A juggling act was required to equate fuel loads with bomb capacity in order that significant damage could be done to potential German targets - this at a time when the aircraft available were not suited to the task. The major difficulty was that speed, defensive armament, armour protection, range and endurance were all directly related. Any increase in one area meant a reduction in others.

Time was another critical element in short supply to Air Ministry planners and aircraft manufacturers. The delays to rearmament occasioned by not wanting to be seen as compromising the Disarmament Conference, the lethargy induced as a result of the acceptance of the Ten Year Rule, the fact that the National Government was elected in 1931 firmly committed to pruning public expenditure, plus the acceptance of an armaments' truce so that no new squadrons were added to the R.A.F. from November 1931 to March 1933, all helped to create a situation for the R.A.F. that was becoming desperate. Added to this list must be the appreciation that the design, construction and acceptance by squadrons of new aircraft entailed a broad time span. On average in the 1930s, from specification to acceptance took five and a half years for fighters, six and a half years for medium bombers and eight years for heavy bombers.26

25 Smith, 'Planning and Building the British Bomber Force, 1934-1939', p.38

Even after aircraft were initially accepted on squadron they were not necessarily front-line aircraft. Some aircraft were issued to a squadron for a year. During that time note would be taken of the modifications required to the aircraft to make it finally acceptable and capable of fulfilling its planned role. Modifications however are not necessarily small adjustments; they may require major rebuilding. On the Wellington for example, with its geodetic construction, any work on the fuel tanks required the removal of the wings. Modifications were frustrating to both users and manufacturers alike because they were both costly and time consuming. They could also be so radical as to change the weight or performance of an aircraft and place it outside its original specification.

In 1936 the British government introduced the Shadow Factory Scheme. The Committee of Imperial Defence had studied Britain's industrial resources and had selected several firms which they believed to be capable of becoming involved in the production of military requirements. Five motor vehicle firms were allocated to the Air Ministry. Rearmament, in the time frame now considered necessary, was beyond the capacity of the regular aircraft constructors but the scheme had dual purposes. Partly it was to ensure that adequate reserves could be built up for the R.A.F. But perhaps even more importantly it was to provide the selected firms with experience of involvement in the aircraft industry so that their assistance could be sought should even greater rearmament become necessary.

The plan for the Shadow Factory Scheme was that the government accepted responsibility for the construction, equipment and maintenance of the factory space. Private industry selected the machinery required and provided the work force but simply managed the extensions. They only built components for aero engines or airframes as distinct from entire aircraft. Three factories were initially involved with components of the Bristol Mercury XVII air-cooled radial motor and two with the airframes for Battle and Blenheim bombers. Air Ministry arguments for limiting construction to components only centred around the extra costs involved in duplication of jigs, tools, gauges and plant should entire engines or aircraft be built at each plant. It also was of assistance to the Bristol Company who had overall responsibility in that

27 Smith, 'Planning and Building the British Bomber Force', p.57, note 40

28 Fearon, op.cit., p.245

29 Thustan James, 'Getting Going at the Shadow Factories' in Aeroplane; November 3, 1937, p.530

30 Ibid., p.530
it simplified their problem of technical supervision. The plan had one disadvantage, perhaps, in that it overlooked industrial vulnerability should a war break out and one component be destroyed by bombing. Such a happening would have created industrial bottlenecks.

Despite the fulsome praise accorded the scheme in Aeroplane magazine there were problems. Some traditional manufacturers were reluctant to hand over their designs to possible potential rivals. Other firms were reluctant to build aircraft with whose design they had not been involved. Fairy Aviation, for instance, wanted to produce a larger version of the Battle rather than switch to an aircraft selected by the Air Ministry.\textsuperscript{31} It is within these kinds of arguments that the seeds were sown which saw the production of aircraft in numbers which vastly exceeded the planned production runs despite the known fact that they were unfitted for war. But we will return to that discussion.

In retrospect it is easy to recognise the dilemma facing Air Ministry planners and the aviation industry when considering rearmament requirements. Although the problems are readily identifiable solutions, even now, are much less apparent. Indeed, with regard to meeting aircraft requirements, surely there were no 'quick-fix' solutions? All the problems required long-term planning and in the 1930s, as the years progressed, time became increasingly telescoped. By 1937 it was a commodity in desperately short supply. Perhaps, as has been suggested, it provided the classic example of British wartime 'muddling through'.\textsuperscript{32}

The introduction of the Shadow Factory Scheme also coincided with a rise in domestic consumer demand – the result was a labour shortage. The increasing armament and domestic demands meant not only having to acquire sub-contractors but also the need to introduce night shifts. Vickers' Weybridge employed 1,466 skilled workmen in 1933 but by 1939 they had a force of 4,844 with 1,000 employed on night shift.\textsuperscript{33} Unfortunately, labour shortages provided other unwanted corollaries. They resulted in the dilution of skills in the work force at the time when plants were switching to operations requiring increased rather than decreased expertise. These labour shortages, or lack of skills, were the major reasons for delayed deliveries of components.

Production delays provided major headaches. Protracted delays could have meant that the aircraft affected were, when finally produced, not even suitable for use as trainers yet

\textsuperscript{31} Smith, 'Planning and Building the British Bomber Force', p.44

\textsuperscript{32} Ibid., p.60

\textsuperscript{33} Ibid., p.46
alone be considered for front-line operations. At that stage the question should then have been asked, does production continue? It may have been asked in the case of the Whitley, originally ordered under Specification B3/34, but the answer was too long in coming. Production continued for 77 months and six times the number originally planned were built, many of which never even left the Aircraft Storage Units.\^\text{34}

Delayed orders meant the R.A.F. was forced to accept obsolescent and sometimes obsolete aircraft. The Vildebeest is a good example. (The spelling was originally 'Vildebeeste' but it was changed in 1934.) The specification for this torpedo bomber was originally set in 1925 but in 1930 it was still undergoing testing at the R.A.F. Experimental Establishment at Martlesham Heath.\^\text{35} First delivery of the aircraft to the R.A.F. was made in 1933 with production completed in November 1937. Production delays to the Beaufort replacement meant that there were still 100 Vildebeests in service in September 1939 with the last two being destroyed in action as late as March 1942.\^\text{36}

Several influences were at work on the Air Ministry planners by 1936. They were aware that the manufacturers had to be provided with orders if they were to retain their required workforce in the Shadow Factories. The R.A.F. also had an urgent requirement for aircraft - even if they were obsolescent they could still be used for the increasing aircrew training now being undertaken. There was also the political and public need to provide concrete evidence that the first-line strength was in fact growing. From these conflicting needs the Air Ministry could only hope that quality and not simply quantity would result.\^\text{37}

In order that production could be increased the Air Ministry saw only two options. Firstly, short cuts in production methods would have to be taken. Some stages of the selection process they decided could be abandoned without prejudice to the finished article. The theory was fine, but only provided no major faults were built into the production models. If modifications were required later, delays were cumulative and costly.

The second option was even more debateable. It was seen that production could be stepped up by continuing to produce aircraft in which even the Air Ministry no longer had confidence. The value seen in this option was that a work-

\^\text{34} Higham, \textit{op.cit.}, p.453

\^\text{35} Fearon, \textit{op.cit.}, p.246

\^\text{36} Thetford, \textit{op.cit.}, p.504

\^\text{37} Higham, \textit{op.cit.}, p.450
force was kept in being until more acceptable aircraft reached the construction stage. In order that the requirements of expansion Scheme C could be met in 1937 it was suggested, in 1936, that construction of bombers be concentrated on the Blenheim, Wellesley, Heyford, Battle and Whitley. Perhaps the aim to achieve parity for short-term political reasons was acceptable as a stop-gap. It was however badly flawed when the construction of unwanted and unsuitable aircraft was allowed, and even encouraged, to continue. Of these five aircraft not one complied with Air Ministry requirements when squadrons were formed.  

In any criticism of the aircraft supplied by the Air Staff for its aircrew to fight a war, not all attention should be focused on the manufacturers. The Air Ministry with their specification system applied a brake on industrial initiatives. When the Air Ministry finally decided on what they required in a new aircraft they provided their specifications to firms specialising in that type of airframe construction. The firms then produced plans for their perception of the Air Ministry needs. Several different prototypes would be ordered and then the best selected to go into production. Those firms which only produced plans and then an unacceptable prototype, if the drought on orders continued, soon found themselves in financial difficulties. But military aircraft development was seen by the Air Staff to be their concern; the manufacturers simply built what the Air Staff wanted. There were of course some 'private ventures' when a firm with a plan for what they saw as a superior military aircraft, and with the courage to take risks, would produce an aircraft which they would then attempt to sell to the Air Ministry. Between 1926 and 1936 about one in three 'private ventures' were selected for R.A.F. use compared, over the same period, with only one in six which met the Air Ministry specifications. Significantly, the Mosquito, Spitfire, Hurricane, Blenheim and the Lancaster, all involved, to a lesser or greater extent, some element of 'private venture' schemes.

Government decisions and Air Ministry requirements did, however, help to preserve design teams in the aircraft industry. Rearmament, to a large extent and for a long time, was directly influenced by Treasury requirements and was based on the perception of what it was believed the country could afford. The methods used resulted in the wastage of valuable resources of manpower, materials and equipment, and also exposed production weaknesses in the aircraft industry. Rearmament was also a slow process as British industry and

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38 Smith, 'Planning and Building the British Bomber Force', p.48

39 Fearon, op.cit., p.246
technology had failed to keep up with American and European advances. Britain stayed too long with biplanes even after the superiority of monoplanes had been fully displayed. But, despite this litany of failures, the industry did 'muddle' through. Unfortunately, the wartime momentum was not maintained after 1945.

By the end of March 1933 the R.A.F. bomber force totalled 28 squadrons but of these twelve were from the Auxiliary Air Force (A.A.F.) or part of the Special Reserve. Of the 28 squadrons 21 were trained for day operations only and of these only ten belonged to the Regular air force. And from these ten, two were engaged on experimental work and existed in name only while another two were earmarked for service with the Field Force, should it be required. As a consequence, there were only six day bomber squadrons in the Regular air force and of these three had only just been declared operationally efficient. The eleven day bomber squadrons in the A.A.F. and Special Reserve were mostly under strength in aircraft and at many different stages of training so their availability for first-line duty was highly problematical and would certainly require time.

The night bomber force had a higher percentage of squadrons operationally ready for first-line operations. All that this meant, however, was that of the seven squadrons, five Regular and one Reserve Squadron were operationally fit. But in 1929 A.A.F. units had been declared unsuitable for night operations. Thus, in 1933, the R.A.F.'s bomber strength was six day and five night squadrons. Rearmament did not start a moment too soon. There was no war reserve because, as the Air Member for Supply and Research had said 'the amount of money we have allotted to us is quite insufficient to build up any reserves at all'.

Against the growing demands for bombers from many different sources it must be noted that not all sought unlimited R.A.F. rearmament. Even the C.A.S. Sir Edward Ellington, in May 1934, was arguing that 62 squadrons would provide for all needs even up until 1939. This premise, however, was based on the assessment that the German Air Force would only achieve parity with the French Air Force by that stage; that France and the Low Countries were Britain's allies and that the airfields in the Low Countries would not be available to be used by Germany. Perhaps there was also the growing suspicion that 62 squadrons was the limit that could be fully trained and equipped by that time.

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40 Wernham & Frankland, op.cit., pp.36-7
41 Ibid., p.38
42 Gibbs, op.cit., Vol.1, Pt.2, p.108
After 1934 the R.A.F. went through a period of what Robin Higham called 'rearmamental instability'. The urgency was given to rearmament, there was a scramble for manpower, materials and facilities, and expansion was contemplated beyond the industrial means. Between 1934 and 1941 there were 55 types of aircraft considered only 18 of which went into mass production. Of these 18 only eight exceeded a production run of more than 5,000 models.

To conclude this section it is appropriate to examine in a little greater detail some of the bomber aircraft that R.A.F. bomber aircrews had to go to war in, in 1939. None were suitable or capable of fulfilling their planned operational role but some were less able than others. It is no coincidence that the Battle will be the first to be discussed.

Basically the Fairey Battle was an experimental aircraft built under Specification P27/32 issued in April 1933 to provide the comparison between fast, light bombers and the larger twin-engine mediums. The Battle first entered squadron service in May 1937. But even as a light bomber it was early appreciated that it was under powered. The other factor that should have ensured there were no gross production overruns was that in 1936 the Air Ministry issued Specification B12/36 calling for heavy bombers. Time however was the crucial and deciding element. The heavy bombers were theoretically eight years away while large production facilities were poised to build Battles. By having received a large order for Battles, Fairey were able to expand and experiment with mass production methods. Later the Austin Company as a Shadow Factory were also involved in manufacturing Battles. The Battle performance was never exceptional but it was further reduced when the variable pitch propeller had to be replaced by a fixed one. There were also engine problems when the Merlin F unit, made by Rolls-Royce and accepted without full testing in the aircraft, suffered a succession of cracked cylinders.

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Higham, op. cit., pp.444-5


Smith, 'Planning and Building the British Bomber Force', pp.48-51
The need to meet the demands of various expansion schemes meant that by the summer of 1937, despite its known inadequacies, the Air Staff were bound to accept the Battle. Under Scheme F as many as 23 squadrons out of a total bomber force of 68 squadrons were to be equipped with an unsatisfactory aircraft. Parity was the aim; the need was not, at that stage, a force with which to fight a war, it was to prevent war. But because of delays in the production of medium and heavy bombers Battles continued pouring off the assembly lines. By December 1940 no fewer than 3,100 had been produced which was two and a half times as many as had been originally planned. As with the Whitley, many never left the Aircraft Storage Units. Fairey Battles were finally declared obsolete in July 1944.\footnote{Thetford, \textit{op.cit.}, p.294}

When Air Vice Marshal Arthur Harris took command of No.5 Group at Grantham in October 1939 he said himself that rarely before 'had he been so depressed'.\footnote{Sir Arthur Harris, \textit{Bomber Offensive} (London: Collins, 1947), p.33} The first reason he gave was that he considered the aircraft with which a large proportion of the Group was equipped, was unsatisfactory. This brings us then to the Handley Page Hampden.

The Hampden was designed to Air Ministry specification B9/32 issued in 1932 and, by September 1939, there were eight squadrons in the R.A.F. equipped with this aircraft. Together with the Whitley and the Wellington when war broke out they formed the first-line. On paper Hampdens appeared to be capable of fulfilling their role, but their operations by day proved disastrous. They lacked power-operated gun turrets, the fixed gun firing forward was virtually useless while the hand operated rear guns above and below the fuselage had limited traverse which created dangerous blind spots. In addition crew accommodation was cramped and uncomfortable. It was only in 1937 that space was created for a navigator but it had entailed the loss of the nose turret.\footnote{Wernham & Frankland, \textit{op.cit.}, p.221} Crew comfort was rarely a consideration in the building of the bomber force and oxygen systems and the provision of heating were low on the priority lists. Cold was a constant enemy. The Hampden however provided the classic low point in crew comfort - empty beer bottles or the like were the toilet arrangements.\footnote{Norman Longmate, \textit{The Bombers} (London: Hutchinson, 1983), p.77} Harris's summation on the Hampden in the night role is a fitting epitaph 'at least it was there and it worked'.\footnote{\textit{Ibid.}, p.153}
The Whitley was another bomber in the first line when war broke out. Perhaps like other aircraft it had survived in squadrons *faute de mieux*. Although it was fractionally faster than the Hampden its lack of speed was still a handicap. It was also a notoriously cold aircraft at a time when all bomber aircrew were freezing in their cockpits. It had not flown prior to 1936 but with the Harrow they had appeared to offer the only prospect of Expansion Scheme F being met. The service trials at Martlesham did not augur well for the Whitley's future. There were problems with both lateral and longitudinal stability, the manually operated nose turret appeared useless, while the turrets in the mid-upper and tail positions had restricted vision and narrow firing arcs. Armstrong Whitworth had been advised 18 months prior to the trials of these defensive deficiencies but quantity and not quality was the priority. The necessary modifications would be carried out at a later date. Turret failures were a major problem in Bomber Command at this time and coupled with the limited availability and productive capacity of Frazer Nash to produce power operated turrets, was not readily curable. Two hallmark exemplify Bomber Command in September 1939—quantity had been sought rather than quality and o'er reaching optimism had largely replaced long term planning.\(^{51}\)

The final first-line bomber to be considered is the Vickers Wellington the main-stay of Bomber Command until it could be replaced by larger four-engined bombers. The final operational flights of the Wellington in the European theatre took place on the night 8/9 October 1943.\(^{52}\) The Wellington was considered both reliable and capable by the Air Staff but its acceptance meant incurring the risks associated with its geodetic construction. The advantages gained by the technical benefits of the system and the increased structural strength had to be balanced against production and servicing problems. Geodetics gave increased strength provided there was structural continuity. Bombers, however, required large gaps in their structure for bomb doors, gun turrets or later, radar domes. As late as 1937 the Air Ministry still entertained doubts over geodetic construction methods. Geodetics meant there was less requirement for obtrusive bulkheads, wing and fuselage space was freed and the aircraft's strength was increased. Geodetics also provided the disadvantages of high tooling-up costs, increased man hours in production, problems in mass production and servicing difficulties.\(^{53}\) Again it was the Air Ministry hope that the Wellington would be successful because other aircraft did not appear to be

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51 Smith, 'Planning and Building the British Bomber Force', pp.51-3

52 Thetford, *op.cit.*, p.516

53 Smith, 'Planning and Building the British Bomber Force', pp.53-6
measuring up to the requirements of war. The Wellington may have performed a useful function as a night bomber but it was a failure in the planned role of a self-defending day bomber.

The bomber aircrew in the R.A.F. in September 1939 went to war in aircraft better than the recently discarded biplanes but still far removed from meeting the requirements of modern combat. Obsolescent aircraft provided another reason why it became necessary to establish the Pathfinder Force later in the war.

Larger bombers were on the way by 1936 under specification B12/36 but their production would take time. But yet again the specification system created problems. Limits were placed on wing width so that the aircraft could fit in existing hangars. Shorts, who promised early delivery provided they were awarded a sizeable order, built the Stirling. Wing restrictions for this aircraft always meant that crews were forced to operate at altitudes lower than they considered desirable. Handley Page started work on a twin-engined bomber but engine production delays caused them to build a four engined version and the Halifax was the result. Avro, after failing with the Manchester produced the Lancaster. During the first years of the Second World War Bomber Command suffered because of inadequate aircraft. But even when finally equipped with Stirlings, Halifaxes and Lancasters (not to forget Mosquitoes), improved aircraft did not immediately solve the bombing problem. This required the formation of the Pathfinder Force in an effort to more effectively carry the war to the enemy.

Rearmament had encountered many difficulties. Long term planning had been forced to take second place to the achieving of a mythical parity. The industrial base on which expansion had depended had been too narrow for the demands to which it was subjected. Rearmament had also been hindered by the rapid technical advances being made. This made it difficult not only to predict operational requirements but also to reach a consensus on specifications to be issued. Too many options had to be kept open for too long when it would have been more desirable to confirm some form of standardisation. The Wellington, Whitleys and Hampdens were virtually all that were available from 1937. The larger bombers were in the pipe line and would eventually reach the first line. The first requirement was to be able to stay in the war until more suitable weapons with which to fight became available.

From 1937 the emphasis in rearmament turned from the preparing of an offensive bomber force to the building of fighter defences capable of deflecting any knock-out blow attempted by the German Air Force. The basis of British air
strategy was changed from a belief in the offensive to a hope for the defensive. The prime mover in this volte-face was Sir Thomas Inskip, Minister for Co-Ordination of Defence, in a note dated 9 December 1937 which he addressed to the Secretary of State for Air.\textsuperscript{=4}

Inskip saw the R.A.F's purpose in being as the prevention of a knock-out blow by the Luftwaffe. Once this had been deflected then the Air Force could gradually build up its offensive forces so that, as in the Great War, victory would result from a combination of long term economic pressures and increasing striking power. Perhaps some senior officers in the R.A.F were aware, even in late 1937, of the problems their service faced should war occur in 1939. Perhaps they appreciated that re-equipment would not be complete; that there would be too many obsolescent aircraft in the first line; that no true heavy bombers would be available and that training and organisation had been subordinated to expansion.\textsuperscript{=5} Possibly the acceptance of Inskip's Report was fortuitous but at least an inadequate Bomber Command was not required to attempt to confirm the correctness of Trenchard's offensive theory.

Poor equipment, even for capable and enthusiastic workers, means a comparatively lower standard of output. So it was for Bomber Command between 1939 and 1942. Aircraft with mediocre equipment and performance meant poor returns from any strategic bombing campaign. The aircraft were meant to be efficient carriers of the weapons of destruction - the bombs. Until the arrival of the larger four engine bombers the Hampdens and Whitleys in particular must be considered unsatisfactory. But were the bombs they carried capable of causing the destruction intended?

\textsuperscript{=4} Webster & Frankland, \textit{op.cit.}, Vol.4, pp.96-98

\textsuperscript{=5} Smith, 'Planning and Building the British Bomber Force', pp.60-1
5. Deficiencies in the R.A.F. Before 1939

Bombs

The modest bombing offensive carried out by the R.A.F.'s Independent Force towards the end of the Great War may not have contributed significantly to final victory in that struggle. But it did provide, for those willing to learn, valuable lessons in the requirements of a strategic bombing offensive. In some areas answers to problems were found; in others only the problem was identified - the solution had still to be sought and found. Unfortunately for the crews of Bomber Command between 1939 and 1942, the lessons provided by earlier experiences had either been forgotten or the intelligence so painfully acquired was not made available to them. The learning process had to be repeated, at considerable cost.

With the passage of time the minor successes of the Independent Force, both directly in the damage created and indirectly in the fears generated, became grossly exaggerated. A bombing offensive was accepted as a possible way of avoiding direct military involvement on the Continent. Perhaps wars could even be won by bombers alone. However, in the 1920s and early 1930s war in Europe was hardly a consideration. In any case did not Great Britain have, for much of that time, at least ten years to prepare? The national economy in any case dictated that until 1934, rearmament had only a low priority.

Despite the severe military cut-backs imposed in 1919 the R.A.F. had survived and its continued survival was guaranteed by the prominent and economical role it played in colonial policing operations. Unfortunately the techniques and equipment in both aeroplanes and bombs that were required in various colonies, mandates and protectorates from Africa to India including, importantly, the Middle East, did not prepare the R.A.F. for another European war. The small bombs left surplus in vast numbers in November 1918 were sophisticated enough to subdue recalcitrant tribesmen. They could be dropped accurately from low level in daylight by aircraft whose performance was only marginally better than that of the aircraft of 1918 vintage. Modern, high performance aircraft would have been a burden in remote areas where extremes of temperature predominated and limited servicing facilities and rough airfields were the norm.

Developments in aircraft and bombs were therefore not an urgent requirement. The 230 pound, 112 pound and 20 pound bombs of World War One met all requirements. When the targets were mud huts or tribesmen caught in the open the weapons used were both efficient and effective. Economics and the Ten Year Rule meant that research and development was radically curtailed and a static situation prevailed until virtually the mid-1930s. Time was not seen at that juncture as a critical element.
Successful military operations are generally dependent upon good equipment, realistic tactics, efficient personnel and detailed planning. The R.A.F. was no exception. But there is also one other vital factor - the weapons must be adequate for the given task. Bomber Command's destructive capacity was severely restricted for almost three years in World War Two and one reason was the inefficient bombs with which it was equipped.  

A bomb is a container for either high explosive or incendiary substances (it may also contain gas, chemicals or propaganda leaflets but these are not relevant to this discussion). A bomb will also have a pistol or fuse to enable it to be handled with a margin of safety. A pistol is a mechanical device either to initiate detonation or set in motion some form of delayed action mechanism usually timer or chemical. A fuse is a more complicated mechanism combining striker and detonator but it provides a wider range of options extending from air to under-sea bursts. The bomb also has various lugs to enable it to be attached to the bomb carrier and safety pins which remain attached to the carrier when the bomb is released. Finally there is the tail unit which the R.A.F. armourers attached to the bomb when preparing it for use. Tail units were sensitive to knocks so they were usually attached late in the preparation sequence to prevent possible disturbance to the flight of the bomb and hence its accuracy.  

The explosive used in British aircraft bombs from 1916 was Amatol, a mixture of Trinitrotoluene (TNT) and Lyddite. Unfortunately its relative ineffectiveness remained unknown until comparisons could be made with the damage resulting from equivalent German weapons dropped on English targets during the Blitz of 1940-1941. Amatol was then gradually replaced by Cyclonite, Torpex, Ametex and Minol.  

Bombs can also be categorised into incendiaries, high explosive weapons, or those for special purposes. As the name implies incendiaries are designed to destroy their target by fire. The high explosive (H.E.) range of weapons includes general purpose (G.P.) bombs, medium capacity (M.C.) bombs and high capacity (H.C.) bombs. Among the special purpose weapons are those designed for anti-personnel use, to attack submarines, armour piercing for shipping attacks and others such as the bouncing bombs used in the attacks on the Möhne and Eder Dams on the night of 16/17 May, 1943.

1 J.B. Tait, 'Accurate Bombing' in Royal Air Force Quarterly: Vol.XIX, No.2, April 1948, p.81


3 Ibid., p.41
The term 'capacity' does not relate to the destructive potential of a particular bomb but is instead a measure of the weight of explosive given as a percentage of the total weight of the bomb. This percentage is known as the Charge/Weight Ratio (CWR). Weapons in the G.P. range had a CWR of about 30 per cent but falling as low as 23 per cent; M.C. weapons approximated a CWR of 50 per cent while the H.C. range had a CWR of 70 per cent or even higher. German bombs on the other hand had a significantly higher CWR and used aluminised Triolit as the explosive which later tests showed to be nearly twice as powerful as the Amatol used in British weapons.

The bomb problem was not one that was solved during the First World War. In general the maximum size of weapon employed was the 230 pounder although 520 pound examples, lightly cased, were dropped by the Independent Force. There were also occasions when 550 pound bombs with armour piercing noses were used plus a few weighing 1,650 pounds. But bomb size was directly related to aircraft capacity and performance and the larger machines did not become available virtually until hostilities had been concluded. A large 3,300 pound bomb had been developed in the First World War for use with the Handley Page V/1500 but neither that bomb nor the aircraft were used operationally.

The potential of incendiary bombs was not appreciated during the First World War so their development between 1918 and 1939 lagged behind even the desultory research and development programmes for H.E. weapons. According to Jones, German Gotha crews in 1917 'were disappointed with the results of the incendiary bombs ... The sound idea of creating panic and disorder by numbers of fires came to nothing owing to the inadequacy of the material employed'.

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2. MacBean & Hogben, *op.cit.*, p.43
3. Divine, *op.cit.*, p.191
The failure of incendiary weapons was symptomatic of the message that Lord Tiverton had been trying to impart for much of the First World War. He was aware that particular targets required either specific bombs or the mixture of H.E. and incendiary weapons. The proof of Lord Tiverton's theory was finally provided with the highly successful attack carried out by Bomber Command on the Hanseatic city of Lübeck on the night of 28/29 March 1942. A total of 234 R.A.F. bombers dropped more than 400 tons of bombs, two thirds of which were incendiary, on the Altstadt area comprising mainly old, half-timbered houses. 10 Rumpf called the attack an 'historical watershed of the bombing war'. 11 For most of the inter-wars period however the incendiary had remained a discredited weapon.

Two rival bombing theories dominated discussions between 1918 and 1939. They centred around the estimations of the damage that could be created by the use of either fragmentation bombs or weapons producing significant blast effects. Perhaps the definitive answer was not arrived at before 1939 but the all-too visible effects of blast provided by German bombs on British targets quickly convinced doubters. Blast weapons, with a considerable leavening of incendiaries, would be the loads for the aircraft of Bomber Command. Fragmentation bombs were only produced for later use by aircraft supporting ground operations because they were efficient anti-personnel devices. 12

What was lacking in the years 1919 to 1939 with regard to bomb requirements was an adequately funded research and development programme. Firstly, there was the need to consider the size, shape and weight of bombs in order to ascertain their ballistic properties. Secondly, information was required of the particular qualities of selected bombs with regard to the penetration and blast effects necessary to destroy specific targets. To obtain these answers, 'live' drops on simulated targets were required. Economic stringencies determined that 'live' bombing practices did not take place.

The other reason that 'live' testing did not occur has already been mentioned. It was considered that the bombs available for the R.A.F. in its colonial policing role were adequate. The policing role also had other long term disadvantages. To achieve accuracy bombing was usually from a low level which meant that high level attacks were not

10 Middlebrook & Everitt, op.cit., p.251
even practised. There was also the general acceptance that bombing would be carried out visually. Air force minds were not able to contemplate the requirements of a bombing force in European conditions against a determined and capable enemy. Bombing and aircraft requirements for modern war went unrecognised. Even the production of large bombs was seen as unnecessary and the C.A.S. (Sir John Salmond) ruled in July 1932 that nothing larger than the 500 pounder was required.  

Despite evidence to the contrary provided by the activities of the Independent Force, there was also a general acceptance of the notion that the release of several small bombs at a target was preferable to the release of one large one. This theory was based erroneously on the belief that even small bombs could create significant damage. Releasing several, it was hoped, would increase the changes of securing at least one hit. Too many plans prior to World War Two were built on the insubstantial foundations of hope. They were not based on either experience or scientific testing. Consequently, there were only light and medium bombs available in 1933 ranging from the 20 pound anti-personnel weapon up to the 500 pounder. There were neither heavy bombs nor incendiaries.  

In January 1934 a Bombing Committee was formed in the Air Ministry under the Chairmanship of Air Marshal Ludlow-Hewitt (D.C.A.S.). This Committee was charged with considering the multiplicity of potential targets in the event of an European war and the resulting requirements in aircraft, equipment and bombs. Instead of attempting to anticipate future needs, they adhered to the known aircraft, equipment and bombs. Their conclusions were based on what could be achieved by the force in being, equipped as it was with biplanes and with a bombing policy directly related to what would be obsolescent aircraft in the event of another European war. Foresight was conspicuously absent.

Indicative of this head-in-sand attitude was the rebuff given to the C-in-C Air Defence of Great Britain Command, Sir Robert Brooke-Popham. In a letter dated 31 January 1935 he suggested that the standard bomb be a 250 pounder and that any below that weight be scrapped. But he also suggested that consideration be given to the provision of weapons, up to 2,000 pounds in weight, for the heavy bomber force for use against such targets as bridges or naval vessels in port. Both suggestions were rejected by the Bombing Committee. Firstly, they argued that an aircraft capable of carrying

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13 Neville Jones, The Beginnings of Strategic Air Power, p.66

14 Wernham & Frankland, op.cit., p.53

15 Neville Jones, The Beginnings of Strategic Air Power, pp.83–4
two 250 pound bombs could carry four of 120 pounds. With four bombs the chances of securing a hit were improved. Their argument embodies the fallacy that the consequences of bombing rely principally on the number of bombs dropped rather than their individual weight. Secondly, they rejected the larger bombs on the grounds that aircraft designers would be unable to cope and that the bombers available would have their performance reduced if they were required to carry heavier loads.\(^{16}\)

Brooke-Popham replied that the Air Ministry Commission which investigated the bomb damage done to German targets in the Rhineland immediately after the war had reported that damage created by weapons under 230 pounds was minimal. The largest bombs had of course created the greatest damage. If the bomb should fall in open country, even in area bombing, it does not matter whether it was large or small. He was also able to advise the Commission that he had been assured by Aircraft designers that they could cope with any problems arising from the requirement for their aircraft to carry bombs up to 2,000 pounds in weight.\(^ {17}\)

The battle had however been lost and a sub-committee of the Bombing Committee, meeting for the first time in May 1935, pronounced that they saw no necessity for the production of any bombs over 500 pounds in weight.\(^ {18}\)

After the mid-1930s, even with the likelihood of war rapidly increasing, it appears that little attention was given to bombing requirements. There is no record of any attempt being made to assess the amount of bombing effort required against those targets which clearly merited heavy bombs. As a result of this neglect the design and production of heavy bombers to carry those weapons was also largely ignored. In any case the heavy bombs simply did not exist. The consequence when war came was an inadequate strike force.

Between 1937 and the outbreak of war in 1939 R.A.F. bomber pilots were provided with few opportunities to become acquainted with the weapons they were to use. Because of bomb shortages, 'live' practices were virtually unknown. Bombing ranges where such practices could take place were practically non-existent and certainly almost inaccessible. Under these conditions the degree of accuracy likely to be obtained in wartime was directly related to the results of practice bomb drops on bombing ranges in known areas, in daylight and good

\(^ {16}\) Wernham & Frankland, *op.cit.*, p.52

\(^ {17}\) Neville Jones, *The Beginnings of Strategic Air Power*, pp.84-5

weather, and from medium altitudes facing no opposition. Realism was non-existent. Bombing effects also continued to be significantly over-estimated and again related to experiences in the First World War. Then, if the 120 pound bombs had been successful therefore 'the 250 pound G.P. [was] a potent weapon, the 500 pound devastating'.

Despite its failure to advance the bombing cause and equipment the Bombing Committee was still in existence in 1937 and in that year it suggested for the third time that a bomber development unit be established for both bomb and aircraft testing. For the third time it was rejected by the Air Ministry. However, in 1938 the Air Staff became more deeply involved in the War Plans of Bomber Command. Many would say it was not before time. In October 1938 Group Captain J.C. Slessor, (Deputy Director Plans) wrote that 'We appear to be neglecting practical research and experiments bearing on the relative vulnerability to air bombardment of various kinds of targets and on the types of bombs and tactics, which will bring about the destruction with the least expenditure of effort of each type of target'.

The focus had come almost too late. Bomber Command went to war having trained for, and with a belief in, the efficacy of day bombing. Crews and Air Staff alike were rapidly disabused. They were forced into a night role for which they were ill-equipped and where searchlights, smoke screens, decoy lighting and fires and the vagaries of the weather meant that targets were not even found yet alone struck with inadequate bombs.

Before leaving the subject of the deficiencies in the bombs provided for Bomber Command in the early years of the Second World War, it is instructive to consider the chronological developments which took place between the wars in both G.P. and incendiary weapons.

The redevelopment of the G.P. series of bombs was started in 1922. Economic restrictions however played their part and there was a significant lack of research and development funding. Additionally, bomb size and weight had to be limited to the available aircraft. Bombs were standardised in type and shape so that their design and manufacture would create no major problems. The hope was that they would prove to be 'reasonably' efficient. The 250 and 500 pound versions,

19 Tait, op.cit., p.80
20 Neville Jones, The Beginnings of Strategic Air Power, p.118
Inert filled, were tested for their ballistic capabilities in 1925 with a CWR of 23 per cent. Although the CWR was increased, even by 1927 no 'live' drops had been carried out against selected ground targets. Penetration testing was done in 1927 by firing bombs from a gun into vertical concrete walls simulating the floors of multi-story buildings. The 500 pound trial was considered partially successful and 'indicated the improbability of such a target resisting a bomb of such a type and weight'. But bombs dropped from aircraft do not necessarily act like shells fired from a gun. Rarely, if ever, will free falling bombs strike their target at right angles. Nor will they necessarily always strike nose first—glancing blows are just as frequent. So in 1928 further ground trials were held with concrete wall targets tilted at an angle to simulate drops from 2,000 and 10,000 feet. Test results this time were inconclusive with some rounds even being deflected when striking wooden bracing. The effects of reinforcing could have been even more marked.

In 1928 also, planning was started for the 1,000 and 2,000 pound weapons with production on the smaller commencing in 1932. Manufacture however ceased with the C.A.S's (Marshal of the R.A.F. Sir Edward Ellington) ruling limiting bomb size to 500 pounds in 1935 and was not recommenced until June 1938. Consideration in 1938 was also again given to the possibility of 2,000 and 4,000 pound weapons. It was only in late 1939 that production of either the 250 or 500 pound bombs got fully under way. To commence operations when war broke out the R.A.F. was equipped with 20 and 40 pound fragmentation bombs and the 250 and 500 pound G.P. types. By the end of 1941 the R.A.F. had dropped 181,790 weapons of either 250 or 500 pounds. In the same period they had dropped 30,829 of the 40 pound fragmentation type, 10,650 of the 1,000 pound variety and 482 of a G.P. version weighing 1,900 pounds.22

G.P. weapons had two major drawbacks—too much metal and too little explosive. Medium capacity weapons were not available until late 1941 and even then remained in short supply.

As has been said the potential of incendiary bombs was not appreciated during the First World War. This fact, combined with the low priority afforded bombs in general prior to the Second World War, meant that minimal research or development took place with regard to incendiary weapons. In the early 1920s the Ordinance Committee had been asked to examine the feasibility of incendiaries but investigation was to be carried out 'without great expense'.23

21 MacBean & Hogben, op.cit., p.44
22 Ibid., p.48
23 Ibid., p.58
Incendiaries had been used by the Independent Force in conjunction with H.E. and these Baby Incendiary Bombs (BIBs) were still in production in 1939. However the need for a heavier incendiary was recognised in 1931. But the wheels of the armament industry ground only exceedingly slowly and it was not until August 1937 that the 25 pound MK.1 incendiary went into production.24 The theory was that the weapon would land and then commence ejecting seven magnesium alloy fire pots at ranges up to 15 yards from the main body. With the nose section of the weapon also containing fire-raising materials it was hoped eight fire centres would be created. Even though the weapon was now in production ballistic trials did not take place until 1938. Perhaps of greater moment, 'live' drops and testing against specific target materials did not take place until April 1939 by which stage 660,000 units had been produced.

The trials were a failure. If the incendiary struck a hard surface it shattered. It if struck a soft area it buried itself to such an extent that it failed to give fire potential over the theoretical range. The Ordnance Committee recommended that the weapon be scrapped. However, in the hope that something useful could be salvaged from the fiasco, attempts were to modify and strengthen the basic structure. After testing, an order for 500,000 weapons was lodged early in 1940 with production of the first 100,000 of the modified version to commence in December 1940. Other counsels intervened however and in October 1940 the decision was made to cancel the project. Again, just as with aircraft orders, cancellation was too late to stop production of the initial order. By the time, in June 1941, when the manufacture of an unsatisfactory weapon did cease, 400,000 units had to be scrapped.

Fortunately, the R.A.F. did not have to go to war in 1939 without an incendiary bomb. The hexagonal cross sectioned, blunt nosed, stick-like, four pound incendiary, was a success.25 Its design was simple, it was easy to carry and fit in containers in the bomb bay of the aircraft, the incendiaries separated well when released and above all, it worked. Perhaps its penetrative capacity was not completely known in September 1939 but by then there were five million available and they were being produced at the rate of 60,000 per week.

The appreciation of the effectiveness of incendiary attacks did not come quickly. The fact that incendiary bombs could create more damage than the G.P. bombs available to Bomber Command in the early stages of the war passed unremarked. It was only after the enforced change to area

24 MacBean & Hogben, op.cit., pp.58-9
25 Ibid., pp.59-61
bombing and the visible effectiveness of the mixture of H.E. and fire bombs that the 'boffins' started to take an increased interest in incendiary development.\textsuperscript{26}

Despite their unsuitable aircraft and inadequate bombs some crews did manage to aim at their specified targets. Unfortunately many of the bombs they dropped failed to explode. These unexploded bombs (UXBs), according to Verrier, could have been as high as 25 per cent of the load.\textsuperscript{27} The main cause was possibly a result of the failure of the tail unit which caused the bombs to fall flat rendering the nose fusing system inoperative. Counts were made at various German oil installations, and they showed that 12.2 per cent of bombs dropped by the United States Army Air Force (U.S.A.A.F.); 18.9 per cent of those dropped by the R.A.F. and 24 per cent unidentified, had failed to explode. On one oil installation in the Ruhr a British investigatory team had found a failure rate of 29 per cent.\textsuperscript{28}

With all the inadequacies and the problems facing Bomber Command crews, particularly in the early war years, it should occasion no surprise that there would be a requirement for such a group as the Pathfinder Force. The wonder was that its establishment did not eventuate until August 1942. It was badly needed.


\textsuperscript{27} Anthony Verrier, \textit{The Bomber Offensive} (London: B.T. Batsford Ltd., 1968), p.195

\textsuperscript{28} Webster & Frankland, \textit{op.cit.}, Vol.3, p.242
6. **Deficiencies in the R.A.F. Before 1939:**

**Bomb Aiming and Bomb Sights**

The first recorded occasion on which bombs were dropped from the air in the furtherance of military objectives was during the Libyan war between Italy and Turkey in 1911. Italy had lagged in the imperial race in the late nineteenth century, had been forced to yield Tunisia to France, had failed disastrously in Ethiopia and was attempting a so-called 'peaceful penetration' of Libya - then a part of the Turkish Empire. Turkish forces resisted the attempted encroachment and at one stage Aviator Lieutenant Giulio Gavotti dropped four small projectiles from his aircraft in support of the Italian efforts. Perhaps the reporting of this first bombing mission set the standard for later years when the fear of aerial bombing almost reached hysterical proportions. However, in 1911, attack from the air was unprecedented and who could accurately foretell future developments? The Gazzetta Del Popolo spoke of a 'bomb on enemy camels. Terrorised Turks scatter upon unexpected celestial assault'.

The bombs weighed approximately two kilograms, were suspended from string along the aircraft's fuselage and their accuracy was dependent on the pilot's eyesight and unpractised judgement as to the precise moment of release. They were small beginnings. But by the end of the First World War Great Britain possessed an aircraft, the Handley Page V/1500, able to carry two 3,000 pound bombs and with the range to bomb Berlin from bases in England. Bombs of that size required sophisticated carriers and aiming mechanisms more accurate than simply using the pilot's eye. By 1918 the crude aiming devices provided for Royal Naval Air Service pilots, the Royal Flying Corps, and the Royal Air Force had been superseded by the early mark of course-setting bombsight (C.S.B.S.) designed by Lt. Cdr. Wimperis in 1917.

The greatest advance made by the C.S.B.S. was that it allowed bombs to be released, with some provisional guarantee of accuracy, without requiring that the aircraft be flown either directly into the wind or directly down-wind. It allowed for increased flexibility in bombing tactics but was far removed from being a precision sighting device. Modified course-setting bombsights, despite being primitive and inaccurate, were still the standard issue for the R.A.F. bomber force when war broke out in September 1939.

Unfortunately economics had played a significantly retarding part in firstly, Trenchard's master plan for the R.A.F., and secondly, the urgent rearmament programmes from the mid-1930s. Trenchard's emphasis was on the creation of a firm foundation for the R.A.F. - a basis from which expansion could take place if required. He stressed the

1 Knight, *op.cit.*, p.3
2 Neville Jones, *The Origins of Strategic Bombing*, p.169
importance of the infrastructure, the assembled bricks and mortar. Some permanent bases which he established plus Cranwell College for Officer Cadets, Halton for aircraft apprentices and the Air Staff College for senior officers originally at Andover but now at Bracknell, are still his monuments. Trenchard did not set out to create, through vast expenditure on research and development, a modern, technically skilled and equipped air force. But when necessary, he wanted these standards to be achievable. He largely provided the foundations for an air force which many in the 1930s believed was capable of bringing to reality the horrors imagined by so many at that time.

Prophets of doom from the air proliferated during the 1930s not only in the United Kingdom but also across Europe. Their sombre warnings were nothing new because as early as 1864 Victor Hugo's assessment that flying machines could mean the end of war, had not been widely accepted. The First World War and the air attacks by Zeppelins and Goantas on the British Isles, and London in particular, had done nothing to remove the horrific potential offered by raids of greater intensity in any future war. Those in the 1930s attempting to foretell the shape of wars to come were motivated by the perceived need to overcome the inertia of successive governments and to promote investment in armaments, as well as the ancillary effort to simply make money. Fear of the bomber was generated by widely read authors of fiction, politicians (particularly when in Opposition), as well as by respected military analysts and, not least, by the influential press of the day.

The early writings of H.G. Wells and his film of 1934, Things to Come, set the standards of destruction to be anticipated from future aerial assaults. In the House of Commons during the 1930s the air lobby, particularly among ex-servicemen, formed an effective and articulate pressure group. Rear Admiral Murray Sueter, Captain Frederick Guest and Lieutenant Colonel Moore Brabazon are good examples and when they were supported by professional politicians such as Winston Churchill, who used air defence needs as the whip to lash dilatory governments, they formed a bloc of considerable authority. The lack of air power contributed largely to Churchill's rehabilitation in politics even if it did not immediately restore his political fortune. It must be said however, that as Chancellor of the Exchequer, Churchill was noticeably more reticent in providing the necessary appropriations for air defence needs that he so aggressively had promoted when in Opposition.

Uri Bialer, 'Elite Opinion and Defence Policy: Air Power Advocacy and British Rearmament during the 1930s' in British Journal of International Studies, Vol.6, No.1, April 1980, p.45
Military analysts in the 1930s all agreed on the vital importance of air power and the threats it posed. P.R.C. Groves, Air Commodore L.E.O. Charlton, Captain Norman Macmillan and J.M. Spaight all strove to alert the British Government in particular and the British people in general, to the dangers created by the build-up of air forces in Europe and the urgent need for priority to be accorded to defence planning. David Divine obliquely referred to those writers as being part of 'the Air Force propaganda machine, building up apprehension in order to secure funds against the competition of the older Services'. Such criticism however, could not be directed at Captain Liddell-Hart who also, as early as the 1920s, had argued the need for priority to be accorded the R.A.F. in defence planning.

The Press in the 1930s, in the days before television and when wireless was still a comparative household novelty, also exerted a powerful influence. The Observer and the Daily Mail in particular, both emphasised the necessity for air rearmament in leading articles, cartoons and caricatures. Even The Times, despite its unequivocal support of the appeasement policies being pursued, in an editorial on 12 June 1938 repeated the warning of the dangers of aerial attack in that 'the development of the bomber has brought the front line of war to the very doors of a nation which for centuries has been safe from invasion. And the object of the bomber is not to defeat the rival air force but to terrify into submission populations whose women and children and homes are attacked and destroyed by fire, explosion and gas'.

Bombing accuracy had improved during the years of peace although it had not been because of either expensive modifications to existing equipment or the provision of new, but rather because pilots were doing more theoretical training and carrying out more practical sorties on bombing ranges. The facts that these practices were always on the same, well-known bombing ranges; were conducted in good weather; in daylight hours; from medium altitudes and against nil enemy opposition were all ignored. The achievements of the R.A.F. in their colonial policing operations also played their part in this military and civil delusion process.

Despite the lessons of the air exercises held in Great Britain each year, where weather very frequently played a major disruptive part to the bombing programme, the possibility of having to accept a reduced performance by R.A.F. bomber crews in

Divine, op.cit., p.199


Aeroplane, July 31, 1935, p.144
Aeroplane, August 5, 1936, p.189
Aeroplane, August 18, 1937, p.192
a European war was not considered. On the contrary their accuracy was expected to improve.

Even the rapid developments taking place in aircraft design and performance in the late 1930s gave no significant impetus to recognise the need to improve bombsights. Higher speeds and increased operating altitudes were ignored as sources of potential bombing errors. Bombing practices continued from altitudes which would prove to be dangerously low in wartime. Thus the accuracy of the C.S.B.S., from operational levels against enemy opposition, remained an unknown factor. For low level bombing there was, simply, no specific bombsight. The possibility of having to undertake extensive night operations was also ignored. Bombing practices were carried out on ranges marked by lights, never in blackout conditions and often from as low as 6,000 feet.\(^7\) Realism was practically non-existent.

In the later, rushed rearmament programmes, there was also the fact that aircraft were delivered to squadrons lacking much of their operational equipment including bombsights. Air Chief Marshal Sir John Steel, as C-in-C Bomber Command in 1937, expressed his concerns at equipment shortages to the Air Ministry and these were repeated by his successor Ludlow-Hewitt that same year. He viewed the condition of his Command so seriously that if there 'is any danger of war within the next twelve months or so the state of unpreparedness of this Command can only be regarded with the greatest anxiety'.\(^8\)

The fear of air attack in the 1930s in Churchill's words had 'become obsessive in men's minds, and also a prime military factor'.\(^9\) This was certainly true if the bomber was used as a terror weapon but even then its ability to destroy was grossly over-estimated. As a weapon of precision, the strategic bomber in 1939 was a failure. The crews lacked the ability and aids necessary to locate their targets, they lacked the bombs to destroy their targets and in particular they lacked a bombsight to enable them to place their bombs with any degree of precision.

Before considering the bombsight problem in a little more detail it is necessary to have at least a nodding acquaintance with the theory of bombing. The problem for the bomb aimer in an aircraft was to reach a position in space where, if a specific type of bomb was released, it would hit the particular target at which it was aimed. In order for this to happen the numerous factors that affect the trajectory of the bomb just before and after release must be considered. These factors are the

\(^7\) Neville Jones, *The Beginnings of Strategic Air Power*, p.65

\(^8\) Ibid., p.112

particular bomb ballistics, the wind velocity at the bombing level, aircraft attitude at the point of release, the height of the aircraft above the target to be hit and the airspeed of the aircraft. All these factors determine the trajectory of a real bomb once it has been released from its carrier. Some of the terms which will be encountered in the discussion of bombing theory appear in Figure 1 on Page 79.

Bomb ballistics are governed by the shape, size and weight of the bomb. The more streamlined the shape the less will be the air resistance and consequently the greater the forward travel of the bomb after release. The bomb size also is a determinant in the amount of forward travel - the greater the size the greater the air resistance and hence a reduced forward travel. As far as weight was concerned, considering the same size and shape of bomb, the greater the weight the greater the forward travel of the bomb after release.

The qualifying term for bomb ballistics was the Terminal Velocity (T.V.). If an ideal bomb could be produced, its passage through the air would not be hindered by air resistance because of its perfect balance and stream-lining. Due to the earth's gravitational effects this ideal bomb would continue to accelerate after release towards the ground at 32 feet per second per second (32 feet/sec/sec.). That is to say after one second it would have reached a speed of 32 feet per second and after two seconds a speed of 64 feet per second. As distinct from this theoretical, ideal bomb, a real bomb will have a downward acceleration of less than 32 feet/sec/sec., depending on its ballistic properties. Ultimately this real bomb will reach a point where gravitational acceleration ceases because it is balanced by air resistance. This real bomb will then continue falling at a constant speed. The constant speed is known as the Terminal Velocity. The better the bomb ballistics the higher the T.V. with the ideal bomb having a T.V. of infinity.

When a real bomb is released from an aircraft in still air it will continue in the same direction as the releasing aircraft had been flying prior to release but will start to lag behind the aircraft due to air resistance. It will strike the ground in line with the fore and aft axis of the releasing aircraft provided the aircraft has initiated no turns.

When a real bomb is released and a wind is blowing at the bombing level, the same situation applies. Prior to release the aircraft and the bomb have the same velocity whether considered in relation to the air or to the ground. The velocity relative to the ground has two components; the velocity of the aircraft relative to the air and the velocity of the air relative to the ground. Immediately after release the bomb begins to lose its forward speed but it, and the aircraft, continue to move with the velocity of the air relative to the ground. There is thus no resistance to this component after the bomb is released any more than there was while it was attached to the aircraft. The
Fig. 1 The effect of wind and drag on the bombing problem.

understanding of this particular point is necessary if one is to avoid the trap of thinking that the bomb is actually blown by the wind after release from the aircraft. If the flight path of this real bomb could be viewed continually from the releasing aircraft the bomb would stay in line with the aircraft's fore and aft axis but down wind of the aircraft's track. The point of impact is down wind of the aircraft's track because the bomb has a reducing component of motion in the direction of the aircraft's heading, compared with the aircraft, but an equal component in the direction of the wind.

Mention has already been made of the calculable ballistic properties of a particular bomb and this was one of the values that had to be manually set on the Course Setting Bomb Sight (C.S.B.S.) in use in Bomber Command in September 1939. This instrument was a vector bombsight which in theory, provided all the settings of wind velocity, height and airspeed had been accurate, would continually show the point on the ground where the weapon would impact if it was released at that moment. The bomb aimer's task was to ensure that the aircraft was directed in such a manner that at some stage the briefed target would appear in his sights. This was accomplished by giving instructions to the pilot as to the direction of turn required. 'Left, left', 'right' or 'steady' or 'steady' were the calls from the bomb aimer and the intonation was normally indicative of the amount of turn required. Gross correction requirements by the bomb aimer were often accompanied by an expletive. There would be several such utterances from other crew members if the bomb aimer called 'Dummy Run!'

The major bombing error normally arising with the use of the C.S.B.S. came from setting an incorrect wind velocity or airspeed. A five miles per hour (m.p.h.) vector error meant a 61 yard bombing error from 10,000 feet and an 85 yard error from 20,000 feet. A ten m.p.h. vector error produced bombing errors of 122 yards and 170 yards respectively.\(^{10}\) It must be noted that aircrew in 1939 and 1940 had no means of determining spot winds at their bombing height over the target. They could possibly have calculated average winds during their flight if they had been able to fix their position, but these were not accurate enough for use as the bombing wind. The wind which was required to be set manually on the C.S.B.S. was the wind velocity at the bombing height over the target. The wind, however, is a variable quantity with neither speed nor direction remaining constant. Also with unforecast wind speeds occasionally reaching jet-stream magnitudes, bombing errors at such times could be gross. Later in the war selected crews determined the winds at bombing heights over the target and these were broadcast to the Main Force crews in an effort to improve accuracy.

\(^{10}\) Tait, op.cit., p.85

Also note: that although settings on bomb sights and altitude measurements were in feet, bombing errors in the R.A.F. were conventionally measured in yards.
A vital element, in order to achieve bombing accuracy using the C.S.B.S., was that the bomber had to be flown straight and level during the bombing run right up to the release point. The bombsight was levelled during the bomb run using two spirit level bubbles and these levels had to be continually checked by the bomb aimer, while still directing the aircraft by issuing instructions to the pilot. Unfortunately, small changes of aircraft attitude gave a magnified error in the bombsight as to the indicated point of impact of the bomb on the ground. When adjustments to the heading of the aircraft were required, turns had to be flat and any turns meant that the C.S.B.S. had to be realigned with the magnetic compass. All those who have used the C.S.B.S. will remember the pregnant words of their bombing instructors of the dire consequences of the failure to keep 'red on red'.

A false setting of height on the C.S.B.S., also produced errors. At 200 m.p.h. a 100 feet setting error produced bombing errors of 12 yards at 10,000 feet and 9 yards from 20,000 feet. A 300 feet setting error gave 36 yards and 27 yards bombing errors from 10,000 and 20,000 feet. Altitude measurement in an aircraft in the early years of the Second World War was dependent on the use of pressure altimeters which showed the height of the aircraft above the barometric pressure level set on the sub-scale of the instrument. If a pilot wanted his altimeter to read zero feet when he landed then it was necessary for him to know the barometric pressure at ground level at the aerodrome of intended landing and to have this information set on his altimeter sub-scale. Therefore to know his height above his target it was necessary to know the barometric pressure at ground level. This of course, could only be a forecast quantity and was thus subject to errors. A 1 millibar error in pressure setting meant a 30 feet error in height. A 3 millibar error meant a 12 yard bombing error from 10,000 feet. Later in the war radio and radar altimeters which gave increased precision were used to determine heights above the surface.

Heading errors at the moment of release also produced bombing errors. A one degree heading error at 200 m.p.h. produced a 41 yard bombing error from 10,000 feet and a 58 yard error from 20,000 feet. A one degree heading error, whereby the target passed to one side of the drift wires, was easily produced. The pilot was flying under instruction from his bomb aimer. The bomb aimer was giving instructions to turn left, left, for example but neither the pilot nor the bomb aimer could

11 Air Ministry, Bombs and Bombing Equipment.
   (London: Air Ministry, 1952), S.D. 719, p.278

12 Tait, op.cit., p.85

13 Ibid.
know exactly the amount of turn required. The pilot would have lost sight of the target by this stage because it would have disappeared below the aircraft’s nose and he could not make the turns using his direct-reading type of compass because of turning and acceleration errors inherent in this instrument. Also it must be remembered that direct reading compasses gave an imprecise indication of heading. Additionally they were subject to errors provided by the variation of the earth’s magnetic field and the deviation created either by the large quantities of metal in the aircraft structure capable of being magnetised, or the magnetism induced in the structure by the magnetic field of the earth. Thus the pilot was forced to use his directional indicator. This instrument based on a gyroscope was subject to precession so turns were made by trial and error.

Another source of error which must be mentioned is that incurred when the bomb aimer failed to press the bomb release at the precise moment that the target was in the sight. At 200 m.p.h. a one tenth second delay meant a bombing error of ten yards; a one fifth delay at the same speed gave a 19 yard bombing error.\(^{14}\)

Finally, in the consideration of bombing errors, the eye of the individual bomb aimer must be considered. At the bombing school at Manby in 1940 several bombing instructors were in turn asked to set the bomb sight up on the target. The sighting point of each was noted. The bomb sight in the simulator was four feet above the floor and the greatest distance between the instructors’ aiming points was two inches. That may appear insignificant but converted to 10,000 feet it meant that the bomb strikes would have been 140 yards apart. And that 140 yard error was prior to the introduction of random line or range errors.\(^{15}\) A line error is a bomb placed to the left or right of the target; a range error is a bomb which falls short of, or beyond, the target.

Taken in isolation some of the bombing errors that have been discussed may appear trivial. What matters was that all the errors of whatever size were independent and could have been cumulative. Small errors were not necessarily absorbed by a larger one. Naturally, the average error of a number of bombs dropped in a particular set of circumstances would be less than the error of the least accurate bomb because errors would cancel. In bombing assessments, however, the criterion was not the average distance of all the bombs from the target because that included those subject to cumulative errors which would have marked the outer limits of the bombing pattern. In practice the bombing pattern was normally determined from the point of impact of the 70 per cent of bombs nearest the target. Bombing during

\(^{14}\) Tait, *op.cit.*, p.85

\(^{15}\) *Ibid.*, p.80
most of the war rarely achieved the accuracy suggested as being possible by theoretical figures. There were too many distractions of a lethal nature.

For bombing to be effective it is essential that it be accurate. It could be assumed that accuracy was less important when heavier bombs came into service later in the Second World War but such an assumption would be fallacious. Accuracy of delivery was demanded of both the 12,000 pound Tallboy and the 22,000 Grand Slam because they were aimed at precision targets and were available only in limited numbers. Tall Boys were first dropped on 8/9 June 1944 on a railway tunnel at Saumur in a successful attack led by Wing Commander Leonard Cheshire. Grand Slam bombs, originally named Tall Boys Large, were not dropped operationally until 14 March 1945 when the Bielefeld viaducts were attacked by a force carrying one Grand Slam and thirteen Tall Boys. The parallel viaducts, each carrying a main railway line, suffered grievous damage. Only 41 Grand Slams and 854 Tall Boys were dropped in the war, confirming their limited availability.

Another factor relevant to the limited use of Tall Boys was that only the Lancasters of 617 and IX Squadrons were modified for their carriage. An additional three squadrons received modified Lancasters before the end of 1944 but never in fact carried out Tallboy operations. In the case of the Grand Slam bombs conversion of the Lancasters required a strengthened airframe, more powerful engines, removal of much of the defensive armament and the pilots’ armour protection and, in some cases, even the removal of the wireless operator and his equipment.

Targets, of course, can be destroyed either by a large number of small bombs or a small number of large bombs always provided they are accurately placed. Targets can also be destroyed by a small force employing highly skilled bomb aimers or a large force crewed by bomb aimers of lesser ability. Late in the war, with only limited numbers of Tall Boys and Grand Slams available and equally limited numbers of modified aircraft to carry them, accuracy was a sine qua non because the larger force was simply not available.

Bombing accuracy can never be too high. Operational planning must always take into account the accuracy to be anticipated from the force employed and make adjustments accordingly prior to the particular attack.

16 Tait, op.cit., p.86
17 MacBean & Hogben, op.cit., pp.154 and 142
18 Ibid., p.152
Bomber Command accuracy in the early years of the Second World War was lamentable. It further deteriorated as the war progressed as poorly trained crews replaced the pre-war trained casualties in the front-line squadrons. The force was ill-equipped and insufficiently trained for night operations over Europe where extreme weather conditions and determined enemy resistance frequently overcame the best endeavours of the bomber crews. Another factor which must also be borne in mind in the early years of the bomber war was that the damage created by a particular bomb tonnage was consistently and grossly overrated. This resulted in too many targets being attacked with too few bombers. The principle of the necessity for concentration had not yet been grasped. The other lesson that was only slowly learned was that Bomber Command was unable to strike precision targets. It was for this reason plus the fact that attacks on urban areas were seen as a method of further hurting the German industrial economy, that the tactic of area bombing was adopted.

The turning point for improved bombing results was reached in 1943. Radar now assisted in target location and specialist Pathfinder Force crews then marked the aiming points for Main Force crews using coloured target indicators. New Bombsights, the MK.XIV, entered service use and although by no means foolproof, it offered the potential for improved bombing accuracy. Extended training periods and time provided the opportunities for more efficient bombing during 1944 and 1945. The accuracy achieved in the bombing assault on enemy communications prior to the invasion of Europe was better than even Harris had believed was possible. In his memoirs Harris admitted that he 'doubted whether we could achieve the extraordinary precision needed if the project was to succeed'.

Bombing accuracy is dependent on two factors; being able to find the target and then being able to hit it. It is economic madness to build a large bomber force but fail to provide it with the equipment necessary for accurate bomb aiming. The cost of accurate navigation and bombing systems is minute compared with the cost of the bomber force. Accurate bombing means improving the cost effectiveness of a strategic bombing offensive because it reduces the size of the force necessary that will ensure a more rapid end to a war.

Bomber Command, at least until 1943, was not a truly effective offensive force. The new, heavy bombers were slowly coming off the assembly lines and the latest equipment to improve navigation, target finding and bomb aiming was either being


20 Harris, Bomber Offensive, p.197
designed or tested. In March 1942 the Lancaster entered service and with it came the MK. XIV Bombsight. This was a gyro stabilised vector sight with an attached computer which provided some of the parameters for an attack which previously had been manually applied. The MK. XIV was followed by the Stabilised Automatic Bomb Sight (S.A.B.S.) MK. IIa, based on tachometric principles and used effectively by 617 Squadron in the winter of 1943-44. A tachometric bombsight requires that the target be kept in sight on the bomb run until the sighting angle and the bombing angle coincide. At that point the bomb should be released. But even a layman can appreciate some of the bomb aimers problems provided he is aware that cloud and/or industrial haze are the norm on at least 65 per cent of the days in a European year.\textsuperscript{21} This, without considering enemy defensive measures. The principles of vector and tachometric sightings are shown diagrammatically in Figures 2 and 3 on Page 86.

Too often, certainly in the first two and a half years of war, the success or failure of a bombing raid was measured, not by the damage done, but by the percentage losses of the bomber force. But a three per cent aircraft loss on an unsuccessful raid must be added to the other losses incurred in attempting to complete the destruction. Perhaps a 15 per cent loss rate on a successful raid provides a better credit balance when damage to the enemy is measured against one's own losses. The Nuremberg raid of 30/31 March 1944 provided a loss rate of almost twelve per cent of the force despatched and that raid was a disaster. If the target was considered as requiring destruction then the raid, it would be expected, would have been repeated. In fact the next major raid on Nuremberg did not occur until 2/3 January 1945.\textsuperscript{22}

But we have gone ahead of ourselves in time. This section was intended to show the problems that Bomber Command faced in bomb aiming early in the Second World War. After the defeat of France in 1940 Bomber Command was the only offensive weapon that could be directed against an all-conquering enemy. The bombing offensive had to be maintained and its tempo increased. New machines, weapons and equipment were in the pipe line but in the meantime it was necessary to compromise and hope. Apparently for Great Britain 'the only defence lay in counterattack; the only hope of victory lay in disposing the more powerful bombing force'.\textsuperscript{23}

\textsuperscript{21} Knight, \textit{op.cit.}, p.22

\textsuperscript{22} Middlebrook & Everitt, \textit{op.cit.}, p.646

SIGHTING PRINCIPLES

Aircraft guided along drift wires until target coincides with Los

Vector Sighting Principle

Fig. 2 Vector sighting principle.

Tachometric Sighting Principle

Fig. 3 Tachometric sighting principle.

Air Chief Marshal Sir Michael Knight, *Strategic Offensive Air Operations* (London: Brassey's [UK], 1989), pp. 22-3
7. **Bombing Photography**

In all wars the knowledge of conditions behind an enemy's lines has always played a prominent part in the planning of both offensive and defensive actions. To be able to see what went on 'on the other side of the hill' provided unique advantages to the possessor of such information. But as wars developed from simply the clash of armies on a battlefield to the long term struggle between opposing economic systems and industrial capacity, merely being able to see provided inadequate understanding of an enemy's capacity for war. In this circumstance it became necessary that the preparations for war of a potential enemy were recorded and measured not only by day but also by night when purely visual observations were considerably restricted. Although, by 1918, it had been proved that photographs could be taken from an aircraft at night their potential usefulness had not been fully recognised.

Aerial photography was prophesied by Theodore Maurisset in 1839 but the earliest known photograph from a balloon is one taken over Boston in the United States of America in 1860. Other early photographs were also taken from kites in 1895, rockets in 1912 and even pigeons in 1903. In that year Julius Neubronner, in Germany, patented a camera weighing two and a half ounces to be attached to a pigeon. Negatives measuring one and a half inches square were obtained from this source but their usefulness could never be guaranteed.

Despite the known value of aerial photography in providing information of vital strategic and tactical importance, in the assessment of artillery or bombing accuracy, for mapping purposes and in providing naval, military, airforce and industrial intelligence, its development between 1918 and 1939 stagnated. Just as navigation, gunnery, bomb sights and aircraft developments were largely ignored the need to keep apace with photographic advances remained unrecognised.

Colonel T.E. Lawrence ('Lawrence of Arabia'), in a letter to the Daily Telegraph on 30 October 1920, extolled the value of aerial photography in the production of maps. He pointed out the cheapness, accuracy, speed of production and the increased amount of detail that could be provided by installing cameras in aircraft. He continued his letter stressing the need for further research and called for co-ordination between surveyors and the Royal Air Force, under conditions that involved minimal financial outlay. As Aircraftsman J.H. Ross he was somewhat scathing of the lack of developments that had occurred. In a letter addressed to an another airman friend, dated 1 December 1922, he wrote 'I've been on the point of beginning photographic work . . the last rumour is that I may go into a class . . on Monday. The
next proper course begins about January so they say: but they say a lot of rot in Farnborough!\footnote{1}

A 1936 appreciation of the state of photography in the Royal Air Force revealed a lack of organisation, shortages of trained personnel, an inability to interpret photographs and generally low standards of workmanship. In October 1936 Air Chief Marshal Sir J.M. Steel recommended the establishment of a Photography Section in the Air Ministry and this was formed early in 1937. On 7 January 1938 Air Chief Marshal Sir Edgar Ludlow-Hewitt, then the head of Bomber Command, applauded the value of photography in the Royal Air Force. He wrote that it 'was most evident during the operational exercise which was recently held in this Command how exceedingly valuable and essential photography will be in war in order to obtain the required information of the results of raids, and of enemy activities, so as to enable the Bomber Commander to direct operations. Owing to the speed of modern aircraft and the height at which it may be necessary to fly, visual observation will be of comparatively [sic] little value.'\footnote{2}

Prior to the Second World War training programmes in the Royal Air Force had attempted to ensure that the crews of all bomber aircraft were capable of carrying out any photographic mission. Under war-time conditions aircrew losses, the urgent need for replacements, plus the necessity of reducing the length of training courses, combined to show the inherent weakness of pre-war policy. High flying unarmed Spitfires became the gatherers of intelligence. Bomber aircrew lost their interest in photography and many regarded the later installation of cameras in their aircraft as an unwarranted intrusion. They viewed the cameras, installed to confirm the ability of crews to find and destroy their briefed targets, as an affront to their professionalism and their integrity.

In 1930 an unnamed Chief Flying Instructor who later achieved high rank displayed his antipathy towards camera installations in bombers. 'Don't talk to me about Photography' he said, 'it's of no use. When a war breaks out you get the biggest b......bomb you can find, go and drop it on the b.....s and come back for another.'\footnote{3} However, the crucial response to this statement, conclusively answered by the Butt Report on 18 August 1941 was, 'but where have those bombs been dropped?' Bombing cameras held the unwanted answers of wasted bombs, fruitless bombing sorties and lost lives. For too long the answers were unrevealed or, even worse, ignored.


\footnote{2} Ibid., p.20

\footnote{3} Ibid., p.22
When, early in the war, it was appreciated that the major strategic effort of Bomber Command would have to be concentrated on night attacks, strenuous efforts were made to improve navigation and bombing accuracy. Before the war a contract had been agreed upon for infra-red projectors for bombing training. These projectors were capable of producing a beam of radiation upwards with a diameter of 5,000 feet at an altitude of 5,000 feet. Aircraft cameras loaded with infra-red film would then produce a dotted line on the film when the camera shutter was opened provided the bomber was within the radiation zone. The system was never tried until 1941 but then target sites were established on private and public property and the infra-red installations were maintained by civilians assisted by the police and Home Guard. They provided a way for civilians in different walks of life to feel that they were 'doing their bit' for the war effort.

There were, however, many obstacles to be overcome. Initially the filaments in the lamp projectors proved unsatisfactory; next, the radiation area and altitude was shown to be insufficient, then the infra-red filter, which allowed an identifying morse character to be flashed at each site, also failed. All these problems were overcome and bombers, operating up to 18,000 feet, attacked such varied simulated targets as the Northampton Power Station, iron works at Melton Mowbray and the Conway Bridge in North Wales. Efforts to site infra-red equipment at Blenheim Palace (already a popular target for simulated daylight bombing) were hastily revised when it was learned that the Palace had been requisitioned and was being used by a secret combined services radar research unit.

Bombing simulation by night using infra-red equipment depended upon setting the time of bomb fall on the camera control. A normal bombing run was carried out but instead of pressing the bomb release button the bomb aimer pressed a button ('Mickey Mouse') which opened the camera shutter. The camera shutter remained open for the pre-set time of simulated bomb fall and then closed automatically. The last dot or dash on the time recorded on the film marked the position of the target at the moment of the simulated bomb impact. The position of the simulated bomb strike was the centre of the final photograph. Both line and range errors could be calculated from this data and, by reference to the wind velocity used by the bomb aimers, the causes and the degree of bombing errors could be accurately assessed. To encourage competition and stimulate enthusiasm, Groups within Bomber Command drew up monthly infra-red bombing results and published them in a format similar to the well-known Football League tables.
At the outbreak of war very few operational bombers were equipped with either cameras or the photo flashes necessary for satisfactory bombing photographs to be obtained. Nevertheless the primary aim of night photography remained virtually constant throughout the war. Aircraft cameras and flashes were designed to provide positive evidence of where a particular bomb fell and enable its effectiveness to be rapidly assessed. Night photographs provided the measure of the capability of individual bomb aimers in Bomber Command and was a direct means of ensuring increased accuracy. Photographs also provided valuable intelligence particularly with regard to enemy decoys, defences, and the effects of particular bombs on varying targets.

Early in the war cameras and flashes, when used, were designed to operate to provide a picture of the bomb strike. Inaccuracies in both flash fuses and camera controls combined with the increasing weights of attack meant that it became impossible to determine from individual photographs which aircraft had dropped which bomb. Towards the end of 1942 bombing photography requirements were adjusted. From that time crews were adjudged to have completed their photographic task provided that, at the time of bombing, they had secured a photograph of the area on which their bomb would fall. This revision meant that camera controls could be simplified and the flash could be released with the first bomb or, in the case of the Pathfinder Force, the first Target Indicator (T.I.). To obtain the best results photographically, and to enable the best value to be obtained from these results, it was early recognised that fully automatic photography, in parallel with bombing, was essential. Camera controls and flash fuse settings were set prior to take-off and the bomb-aimer carried out the bomb run free from at least one distraction. Perhaps however, the thirty or so seconds after the call of 'Bombards gone!' - while crews waited for photographic flash ignition and before they could resume evasive actions - were the longest time intervals in the lives of bomber aircrew. Releasing the photo-flash simultaneously and automatically with the first bomb reduced by at least ten seconds the time of carriage of a potentially destructive weapon whilst in an area of acute danger. Straight and level flight for either bombing or photography over a heavily defended target provided many life times for bomber crew survivors and death for very many others.

By 1942 considerable improvements had been introduced not only to automation of the photographic system but also to the photo-flashes which provided the necessary illumination for satisfactory bombing photography. Bombing photography was made possible by using a 4.5 inch photoflash which provided nearly 200 million candle-power over a period of 30 milliseconds. The flashes were pre-set to explode at 0.6 of
the aircraft's altitude and their activation was by means of a manually set barometric fuse. Their accuracy was subject to two errors: inherent and crew (as a result of bombing from either higher or lower than the briefed altitude or, because of a failure to be in straight and level flight at the moment of release). After release the flash trailed behind the bombs due to its poor aerodynamic shape so, rather than having the camera pointing directly downwards, it was tilted rearwards - the amount depending on the speed of the aircraft. Rearward tilt for Mosquito aircraft was thus greater than that for the Lancaster. Although it was essential that direct light from the flash did not enter the camera lens it was vital that the camera's field of view included the area of maximum illumination directly beneath the flash. Figure 4 on Page 92 clarifies some of the terms used in bombing photography.

Evasive manoeuvres during camera operation meant that the aircraft camera was not pointing in the right direction. This meant that any photographs taken were obliques of areas in directions away from the target. In the event of a dive after bomb release (a popular action to gain speed), the camera tilt angle would be increased and the camera would then be aimed further away from the target area and further outside the photoflash illumination area. Various situations are shown in the three diagrams on Page 93. At one stage the Air Staff tried to convince crews that evasive action in the target area increased their chances of becoming a casualty but their hypothesis was heard with considerable disbelief.

Bombing photography assumed greater importance as the war progressed. Prior to a raid it provided a valuable briefing source; during the raid it provided confirmation of target attacked, bombing accuracy and damage assessment; post raid photography showed the damage caused and its possible influence on the enemy war effort.

W.E. Jones, Bomber Intelligence (Leicester: Midland Counties Publications, 1983), p.30
Figs. 5-7 Photographic Errors when Bomber not Level at Time of Photoflash Ignition

8. Deficiencies in the R.A.F.
Before 1939:

Training

One single factor stands out as the dominant reason for the survival of the Royal Air Force as a separate entity in the difficult economic years of the 1920s and 1930s. During this long period of financial restraint the R.A.F., as the newest and smallest of the British armed services, was especially vulnerable to attacks launched either collectively or individually by the War Office and the Admiralty. The R.A.F. survived as an independent force because it was accepted as being capable of carrying out a policing role in far flung colonies, mandates and protectorates where the employment of the British Army would have been prohibitively expensive and its success not necessarily guaranteed. Britain, weakened by war and facing economic decline but still anxious to maintain a dominant imperial role, saw aerial policing as offering a continuation of that dominance. For their part the R.A.F. leadership saw the deserts, swamps and mountains of their policing operations as providing 'Splendid training grounds'¹ for both equipment and personnel. By 1929 it was confirmed and applauded by the Air Staff that 'the use of air power as an instrument in the control of semi-civilized countries [had become] a permanent feature of our system of imperial defence'.²

Survival of the R.A.F. was a direct consequence of financial stringencies. This, however, did not mean that the economic floodgates were opened for the R.A.F. but remained closed for the Army and the Royal Navy. On the contrary, all the Services were expected to operate on minimum budgets until virtually the mid-1930s. All facets of military life were affected and training was no exception. Money, ultimately, was made available for expansion of the R.A.F. but the major allocations came very late on the scene and aircraft design, construction and development are long term processes. Also, too many of the Air Ministry planners appeared to have been locked into a World War One time warp. How was the Air Force vote spent then, particularly in the crucial years of the 1930s? What consideration was given to the importance of aircrew training, the provision of suitable aircraft, the requirement to be able to cope with the navigational problems, the provision of bombs, bomb aiming devices and bomb release gear and, finally, the tactics to be employed to achieve the aim of the bomber force?


The R.A.F.'s policing role in Britain's informal empire in the Middle East, in Africa and on the North West frontier of India, even though it helped confirm the Air Force's survival as a separate service had not required its officers to possess a forward outlook. What was good enough yesterday to subdue militant but illiterate and poorly equipped tribesmen was certainly going to be sufficient for the same task tomorrow. Air pacification was successful and made economic sense. Casualties and damage for both sides were minimal and frequently the mere threat of air attack was sufficient to ensure tribal compliance. But aerial policing, while providing a credit balance for Treasury and helping to confirm the R.A.F.'s autonomy, also had a debit side. The R.A.F. became a victim of its very successes. Aircraft, training, and equipment became too specialised in the air control role. Attacks were carried out by day, at low level, against only rifle fire opposition and using small, anti-personnel bombs. There was no requirement for high level bombing nor was there a need to consider either defensive armament for the bombers or tactics. Operations became stereotyped. Of course it was cost-effective but it was neither preparation nor training for war against a major European power nor, as it happened, the Japanese.

The object of all Royal Air Force training in 1918 was to equip adequately all personnel to enable them to provide their most effective performance in their particular wartime role. Unfortunately even during the First World War it became obvious to many well before 1918, that pilot training was inadequate. This fact was not necessarily because of shortcomings in the training organisation but was rather the result of several different pressures. By 1918 time had become a vital element. Casualties and manpower demands meant that the R.A.F. had been unable to build up a reserve of any strength. When losses in both pilots and aircraft increased, the lack of reserves meant that pilots went into action on the Western Front still unfamiliar with either their machine or the tactics to be employed. Broad training in war-time is, of course, an unaffordable luxury and must, of necessity, be replaced by specialisation. However, too narrow a focus in training can also create problems. Training for pilots broadened during the 1920s and 1930s and aimed at making them assets to the R.A.F. not only during their time on the Active list but also for their period on the reserve. Perhaps the greatest mistake made during the inter-wars period was the underestimation of the time available for preparation. Too much training was left to the operational squadrons with the result that their efficiency and readiness were severely impaired. Peace-time training aimed for too long at simply producing pilots when it should have been graduating pilots trained for a special role particularly either bomber or
fighter. In the autumn of 1919 the continued survival of the R.A.F. still depended on an Act of Parliament that had been accorded urgency to meet the immediate demands of a difficult war situation. The grounds for the continuation of the R.A.F. as a separate service, when compared with the credits of either the Royal Navy or the Army, were very insubstantial indeed. It fell to Marshal of the Royal Air Force Sir Hugh Trenchard to draft the blueprint to make the presence of the R.A.F. acceptable and its future guaranteed. In his preface to the memorandum on the Permanent Organisation of the Royal Air Force, issued in December 1919, Trenchard expressed his core beliefs concerning the existence of the Royal Air Force. He wrote that, 'The necessities of war created it in a night, but the economics of peace have to a large extent caused it to wither in a day, and we are now faced with the necessity of replacing it with a plant of deeper root. As in nature, however, decay fosters growth, and the new plant has a fruitful soil in which to spring'. Trenchard accepted the needs for financial restraints and aimed at building a small force capable of expansion without the loss of either efficiency or any requirement for basic organisational changes. He saw the need as 'first and foremost the making of a sound framework on which to build a service, which while giving us now the few essential service squadrons, adequately trained and equipped, will be capable of producing whatever time may show to be necessary in the future'. Trenchard stressed the vital importance of thorough training for officers and men and underlined the need for technical experts 'for the development of the science of aeronautics . . . navigation, meteorology, photography and wireless are primary necessities if the Air Force is to be more than a means of conveyance'. The proposed allocation of only fifteen million pounds a year for implementation of the scheme created both immediate and long term problems. Unfortunately they were cumulative and by the 1930s the deleterious effects of continuing economies were becoming all too evident.

In the early 1930s peace appeared well established. The R.A.F. had confirmed its position as an independent Service and now, in theory, training should have been able to be given broadly, thoroughly and unhurriedly. Unfortunately practice differed widely from the theory. Pilots on graduation from the training environment had done little more than learn how to control elementary training aircraft in good weather and in

Boyle, op.cit., p.351
Hyde, op.cit., p.65
Wernham & Frankland, op.cit., p.21
Hyde, op.cit., p.65
daylight hours. Until 1936 that meant, on average, they had completed fifty hours solo flying on training aircraft during a twelve month period. A total of only fifty hours flying during a twelve months' period is barely sufficient to keep even an experienced pilot in current flying practice. It was totally inadequate for trainees as it meant advancing through the training programme before any opportunity for consolidation had been provided. Extensions to the training programmes in 1936 - despite the fact that the training time was reduced from twelve to ten months - still only provided for a total of seventy hours solo flying before graduation. Again, the hours flown and the training provided were still totally insufficient. Graduates from the Flying Training Schools were posted to their operational squadrons having done no night, formation, or long-distance flying, and were unversed in the skills of practical navigation. Some simulated instrument flying training had been given but only when dual and then only in visual conditions. Actual instrument flying was not provided because of the risk of collision. The successful completion of initial pilot training meant that graduates were familiar with the local flying area of their particular base and had demonstrated an ability to successfully carry out circuits and landings with a degree of consistency. When it is noted that one of the 'essentials' of training was 'economy in flying hours' the total inadequacy of the system can be more readily appreciated. Too much of a bomber pilot training in the 1930s was left to the operational squadrons which meant a considerable reduction of their efficiency.

Another factor which caused problems in the R.A.F. during the 1930s was that the Service lacked an historical ethos. Nowhere was this more true than in the training environment. While the Army and the Royal Navy possessed traditions, had historical texts to which they could refer, and had their own recent experiences, the R.A.F. had only a fifty month background of war. The consequence was that air force decisions tended to be individualistic while the other services were more often collective. There was also another facet to this particular problem - normally, in a war situation, both the Army and the Royal Navy fought as units be they battalions, platoons or ships' crews. On the other hand, the fighting element of the R.A.F. - a much smaller group than in either of the other two services - fought almost as individuals in the First World War and trained, at the most, in pairs for most of the 1930s.


Ibid., p.20

Ibid., p.19
Thus, training for either the Army or the Royal Navy was concerned primarily with the psychology of the mass whereas for the R.A.F. it centred principally on the individual. Without considering the technical requirements of R.A.F. training this made the creation of a good air force officer a more difficult task than the recognition of what made a good army or navy officer. Army and navy officers were trained to lead while air force officers, certainly during their first years of service, were trained to be led. Promotion requirements in the R.A.F. centred principally on competency. Candidates had to be able to fly better, shoot straighter, navigate precisely, and bomb more accurately than their peers before their promotion was considered. Whether or not the particular individual was a good administrator or planner were secondary considerations. Technical superiority was a prime requirement for a squadron commander because he led a group of critical and skilled individuals and was also responsible for the operational training of new aircrew on his squadron.

Another particular problem for the R.A.F. during the 1930s was that personnel changes were both frequent and continuous. Two reasons can be advanced to explain this situation. Firstly, the continual change-over of officers (who largely comprised the fighting element) was the direct result of the Short Service commissioning scheme. In 1934 volunteers were recruited to serve four years as pilots on the Active List followed by six years on the Reserve. A vast proportion of the four years' Active Service was consumed by basic training, operational training, transit overseas, leave and sickness. For the average pilot to reach an acceptable standard on a twin-engined night bomber squadron took at least two and a half years. This left a bare eighteen months of productive duty before being moved to the Reserve of Air Force Officers. Of course there were some officer pilots on permanent commissions but, in the junior ranks, for every three pilots on a short service commission there were only two with a permanent commission.\(^\text{10}\) Pilot turnover was considerable, on-going, and ultimately detrimental to squadron efficiency.

The second reason to explain frequent postings was the during the 1930s there were a high percentage of R.A.F. squadrons serving overseas. In 1934 there were ten single-engined bomber squadrons based in the United Kingdom and thirteen overseas. Of the twin-engined squadrons, five were home based and two and a half were abroad.\(^\text{11}\) Another factor was that the squadrons serving overseas were not simply


\(^{11}\) Ibid., p.65
detached; they were permanently based and had to be continually supplied with air and ground crews from the United Kingdom. Climatic conditions on some outposts were so extreme that postings were frequently only for six months although in that situation four six months periods were spent at different locations. But generally, by 1938, postings overseas were for three years reduced to two years for those serving in either Aden or Iraq.12 With the R.A.F. at minimum strength, a large turnover of Short Service officers and frequent postings, squadrons rarely ever were able to establish a foundation on which operational efficiency could be improved. The United Kingdom based squadrons could lose, either by posting or retirement, half their strength each year.13 This required that training, rather than consolidation in the operational role, consumed an inordinate amount of the meagre flying hours available for pilots.

Service flying hours in the R.A.F. in the 1930s were conditional on many, often conflicting requirements. The weather conditions played a major part and in the United Kingdom, particularly in winter, squadrons could remain earth-bound for lengthy periods. Low cloud and reduced visibility may appear to offer good prospects for instrument flying practice but in fact the reverse was true. Few aircraft were equipped with wireless or navigation aids so the aircraft remained on the ground. Extensive stratus-type cloud, providing a low cloud base and reduced visibility, meant no flying. Nor could aircraft enter frontal cumulonimbus type clouds without a grave risk of disaster. Scattered cumulus with high cloud base and good visibility were the requirements and, if the risk of collision was to be avoided, cloud flying had to be controlled. In 1934 no R.A.F. squadron met the planned requirements for the blind flying syllabus.14 This appears to have been an acceptable situation in that cloud flying meant the risk of collision and required the provision of special equipment. Instrument flying was not easy and although the English weather provided a high incidence of cloudy days not all were necessarily considered suitable for this exercise.

Further distractions to the training commitment were provided by the preparations necessary in the selected squadrons for the annual Hendon Display. The limited flying hours available were fully used by the crews practising their routines. Hendon was followed by the Annual Air Defence of Great Britain Command exercise in July or August. Armament training camps, because of their importance, could also consume a considerable portion of the available training year.

12 Flight, April 21, 1938, p.384

13 MacLean, op. cit., p.65

14 Ibid., p.63
and always at a time when so much other basic training had still to be completed. Up to seven weeks could be taken by a squadron to complete high altitude bombing and air to air gunnery requirements away from their home base. Bombing and gunnery ranges were of necessity in remote areas but even then local body and individual objections to such encroachments were frequent. Other interruptions could be provided by requests for aircraft to present themselves as targets for artillery, searchlight, sound locator and Observer Corps training. Finally, there was also leave, sickness and the requirement for aircraft servicing that further reduced potential flying time. An assessment that bomber pilots only averaged 150 hours flying in a year goes a long way to explaining operational deficiencies. It also helps to show that squadron training was protracted, inefficient, wasteful and unsuccessful.

Before commencing a more detailed examination of aircrew training in the R.A.F. in the later 1930s in preparation for war, two other points must be made arising from the lecture delivered by Wg. Cdr. MacLean in 1934. In the discussion that followed the lecture Air Marshal Sir Robert Brooke-Popham stressed the need for the maintenance of pilot skills. Was he inferring that 150 hours per year was insufficient? Secondly, the Chairman of the meeting, Air Chief Marshal Sir Edward L. Ellington, focused on the importance of navigation 'In this country' he said 'and in Europe periods of cloud are very considerable, and I think that in war-time, as the anti-aircraft defences (including the defences by fighters) become more efficient, there will be a tendency for bombers to take a route across the sea where they will not encounter defences; and in that connection navigation is of great importance'.

Ellington, from May 1933 until September 1937, was Chief of the Air Staff and thus in a position to ensure that corrective measures were taken to overcome identified shortcomings. These were critical years for the R.A.F. bomber force and the failure during his term of high office to develop a navigational capability, after acknowledging its importance, was to have dangerous repercussions between 1939 and 1942.

There is a broad consensus, still maintained, that flying training in the R.A.F. was of a very high standard. Pilots were held in high regard in the 1930s not solely from the mystique attached to their profession but also because of their obvious skills. The Hendon Air Displays provided the opportunity for a self promotion exercise for an individual and for the R.A.F. Ostensibly, reporting of the Hendon display was supposed to adhere to a 'no limelight' convention

15 MacLean, op.cit., p.57
16 Ibid., p.68
but photographs of participating aircrew still appeared in journals. In general terms, pilot training for much of the 1930s was excellent but its limits were prescribed - it was restricted to daylight hours in good weather. It produced good pilots on short range aircraft and tended to emphasise pilot ability. But the system did not produce operational bomber pilots. The problem in the 1930s was that the training system had remained locked into the doctrines of the Great War. Development and innovation were stifled. It was blithely assumed that the established order would provide whatever was demanded of it, if or when it was required. Change was resisted and worst of all, decisions were made and adhered to even though palpable evidence was readily available that it had been a bad decision. Squadron training for recently graduated bomber pilots, unfortunately, fell into this latter category. With the limited flying hours available the conflicting needs of operational flying and conversion training could not be met. Squadron efficiency deteriorated.

Agreement in principle was reached as early as 1935 that training schools would be established that would ensure pilots were operationally trained prior to being posted to their first squadron. But in fact the status quo was maintained. Squadrons were expected to convert to type newly appointed pilots, provide formation practice, night flying, instrument flying, armament training and navigational experience. The dominant reason was economics. Extending the training period required time, longer courses, syllabus revision, new aerodromes and buildings, and an increased number of instructors.

Instructor shortages were always a counterweight to arguments for extending the training period. Any increase in the number of instructors required meant a reduction in the efficiency of the front line squadrons. In reality it was a Hobson's choice situation. Either operational efficiency on the squadrons declined because qualified staff were posted to training units or it declined due to the regular influx of half trained, inexperienced pilots.

In expansionary periods the controlling factors were the number of instructors available and the amount of training required. The number of instructors available was determined by the size of the R.A.F. Expansion and fuller school training to operational standard may have been the aim in 1935 but the three features, size of the R.A.F., expansion required and the amount of extended training considered necessary, were mutually exclusive elements.

Perhaps some figures will help to clarify the problem. In 1934 there were approximately 1,000 pilots in the R.A.F. although not all were operationally qualified. Expansion
Scheme A approved in July 1934 required 1,000 extra trained pilots in the four years between 1935 and 1939 above the normal, anticipated graduation in the same period, of 1,200 to 1,600 pilots. To meet this almost doubling of pilot graduates would have required the transfer to training establishments of approximately ten per cent of the experienced operational pilots then serving on squadrons. Expansion Scheme C approved in May 1935 called for an additional 2,000 pilots above the normal graduation rate between 1935 and 1937. Scheme F approved in February 1936 was even more extreme. It aimed at 4,000 extra pilots between 1935 and 1939. To meet the requirements of Schemes C and F would have meant the transfer of 40 per cent of operational pilots to the training system.¹⁸

The navigation of R.A.F. aircraft in 1934 was the responsibility of a pilot. The importance of navigation had been recognised in the First World War and had been confirmed by Trenchard in 1919 when defining the requirements of an independent air force. The C.A.S. in 1934 Sir Edward Ellington was in agreement. His assessment was that the effectiveness of a bomber force was dependent upon the navigational abilities of the crews. What then was the state of navigational training being provided for pilots in the mid-1930s? Was it fostered, developed and encouraged up to 1939? Or was it ignored?

It would appear that those in a position to determine the standards required failed to appreciate both the essential nature and the problems of accurate navigation. Perhaps they lacked a sense of urgency. Ellington, the CAS in a vital period, clung doggedly to his opinion that no war was possible until 1942. When asked in 1936 to explain his basis for that notion he said 'Because our rearmament programme will not be completed until then'.¹⁹ Unfortunately it was only lip service, in the main, that was paid to training and the requirements necessary to provide competent navigators. The importance of navigation was constantly reiterated. Even when other aircrew became available, navigation continued to be entrusted only to pilots. The German authorities viewed the same problem from a different angle. They agreed on the essential nature of navigation but their solution in peace time training was to make the navigator the captain of the bomber aircraft.²⁰


¹⁹ Hyde, op.cit., p.494

In 1934 navigation in the R.A.F. bomber squadrons was 'Bradshaw navigation'. Knowledge and familiarity with the local flying area and an ability to map read were the requirements. 'Bradshaw navigation' embraced the skill, when on longer range exercises, to be able to read the name of the next sighted railway station to confirm the aircraft's position. Plotting charts were unusable in open cockpit aircraft so pilot navigation techniques were all that were required. Navigational aids were neither fitted in the aircraft nor provided by ground stations. Communication air-ground-air was rarely possible. When available the most immediate form was by the use of wireless telegraphy (W/T) and required Morse code ability. It was a lengthy process. Even the provisions made for navigators in the new generation of so-called 'heavy' bombers such as the Wellington, Whitley and Hampden were meagre in the extreme. Cabin space for navigators appeared almost an afterthought.

The syllabus of training for a pilot at a Flying Training School (F.T.S.) in the 1930s included an allocation of lecture hours to 'pilotage'.

21 Pilotage embodied many nuances. To some it meant simply pilot navigation. Others extended the meaning to include 'point to point flying by following a succession of landmarks on the ground ... [or] ... following railway lines or highways or rivers or coastlines and acting on plain hunches in the pinches'.

22 The doyen of R.A.F. navigators until his retirement in 1955, E.W. Anderson, defined pilotage as the navigation of an aircraft during the arrival and departure phases of a flight but excluding the en-route phase.

23 This latter definition however provides scope for instrument arrivals and departures without reference to ground features and is thus broader than any teaching provided at an F.T.S. in the 1930s.

The future leader of the Pathfinder Force, D.C.T. Bennett, defined 'Air Pilotage' in 1936 as 'the manoeuvring in the vicinity of the airport in connection with the landing and take-off'.

24 Air pilotage may embody some navigational techniques but it is not air navigation. However, it is what


was taught to trainee pilots at an F.T.S. in the 1930s. Navigational training at the F.T.S. was minimal and concentrated on map reading. It was all that was required of a pilot at that stage of his training. Some elementary deduced or 'dead' reckoning (DR) navigation training was given but practical flying exercises were limited. A more comprehensive training in navigation was seen as necessary only for flying boat or bomber pilots. Flying boat pilots were given school navigation training as part of their course at R.A.F. Calshot on Southampton Water. Bomber pilots were supposed to be trained within their operational squadron. This training was to be provided by Air Pilotage officers who had qualified as staff navigators (s.n.s) after a thirteen week course at the Air Pilotage School at Andover.\[^{25}\]

Confirmation of the failure of the Air Staff either to promote interest in navigation or advancement opportunities for navigation specialists, can be obtained from a study of the Air Force List for 1933. There were 1,346 officers from Flight Lieutenant to Group Captain in that list and while 184 had qualified in the ordinary course in engineering and 98 in signals 'only 38 had passed the ordinary specialist course in navigation'.\[^{26}\] Also, in the Air Ministry in 1933 while aircraft, engines, armament and instruments all had Assistant Directorates concerned with specific developments, navigation was ignored.

Finances, again, were the key to the problem hindering the development of the bomber force. Despite the fact that the offensive was the accepted doctrine for the bombers, the limited funds allocated for scientific and technical research were mainly spent on attempts to improve the defensive systems. There had been only two possible courses of action: either accept the pessimistic forecasts that nothing could stop the bombers getting through and therefore attempt to improve the counter-offensive capacity of British bombers or, alternatively, attempt to develop measures to invalidate the premise of the bomber's inviolability. In 1933, had war been imminent, then the first option must have been pursued but the accepted validity of the much criticised Ten Years' Rule provided sufficient justification for the selection of the second.

Although there were Assistant Directorates working in specific areas of the perceived needs of the bomber force this is not to say that rapid advances were necessarily being made. In fact the opposite is more nearly true and bomber aircraft provide a good example. For too long the Air Staff clung to their belief in the suitability of the light, short-range, two

\[^{25}\] Mackenzie-Wood, op.cit., p.97

\[^{26}\] Wernham & Frankland, op.cit., p.50
seater, single-engined bomber. When economies were required and, because in 1933 no potential European enemies could be identified, they seemed to provide the logical answer. Perhaps their acceptability, despite only having limited range and bomb-load capacities, was justified on the grounds that they would not be required to fight a European enemy. Certainly, in 1939, no plans had been made to cope with such a situation nor had much intelligence been gathered on either possible targets or their susceptibility to attack. However, there was another important reason for maintaining a force of light bombers—they had a dual role to fulfil. Their primary function was their part in the defence of Great Britain but they also had a secondary role in the Defence of India Plan, valid since 1929. In the event of a war with Russia, twenty-four squadrons of British-based bombers and fighters would go to the assistance of the Army to attempt to preserve the independence of Afghanistan and for the protection of India's northern frontier. Light aircraft, cheap to build and maintain, capable of operating in primitive conditions and not requiring either large aerodromes or prepared runways, fitted in well with Treasury requirements for economy. The secondary role of the bomber force, for which there was a plan, would appear to have dominated the primary role for which no plan existed.

Despite the existence of an Assistant Directorate concerned with scientific investigation into the bombs provided for the R.A.F., too little attention was paid to the damage they would create if they hit their targets. Suggestions made in 1923, and repeated in July 1932, of a possible need for heavier bombs were rejected by Chief of the Air Staff Sir John Salmon who ruled 'that no bomb heavier than 500 lb was required'. Economic demands and planning deficiencies resulted in cheaper and lighter bombs just as the same parameters had combined to produce cheaper and lighter bomber aircraft.

Navigation in 1933 was not regarded as a science and nor was it seen as requiring scientific investigation. Most believed, because it had been their experience, that navigation was a matter of looking over the side of the aircraft and relating what could be seen on the ground to the information provided on their topographical maps. Observation and practice were all that were necessary were the fond but delusive beliefs. Although this premise had its doubters no encouragement was provided for officers wanting to specialise in navigation. There were no posts for specialist navigators and few officers were prepared to waste their time in an area which provided, at that time, a singular lack of opportunity.

27 Wernham & Frankland, op.cit., p.42
28 Ibid., p.52
As has been explained, even basic training on operational squadrons created enormous difficulties. The belief that full navigation training could be provided on squadron was a costly misconception. It was known that such a system would be unworkable in the event of hostilities and it distorted the picture of the efficacy of the training process. In addition, theory must be supported by practical application in air navigation training. In the bomber squadrons flying hours were simply not always available for long range navigational training flights. What must be noted is that the number of hours of flying available to squadrons, certainly in peacetime, was limited over particular periods be they weekly, monthly, three monthly, or yearly. These limitations were imposed because of the need to fit in planned servicing for the aircraft. After a certain number of flying hours for each aircraft on a squadron, specific servicing of engine, airframe or instruments was required. Some of these checks were carried out on a daily basis but others are necessary at weekly, monthly or other specified intervals. It would be hopelessly inefficient to have all the aircraft of a squadron unable to take the air because servicing was necessary. Therefore the hours to be flown for each aircraft were controlled. Further restrictions on flying could also be imposed by weather, crew availability or even Government imposed restraints for purely economic reasons. Not unexpectedly in the 1930s, but unfortunately all too frequently, the number of flying hours considered necessary to carry out crew training, night flying, instrument flying, formation flying, armament training, defence exercises and continuation training exceeded the hours available. Flying was restricted and training suffered.

School training of aircrew in 1934 was devoted solely to pilot instruction. At this time, the only other aircrew flying were air gunners and all were squadron-trained. In 1934 there were a few full-time air gunners but generally, if an air gunner was required for a particular exercise, he was selected from qualified armament tradesmen. Flying for them was an interruption to their normal ground duties but it meant a little extra in their pay packets. Provided aircraft technology remained static the requirement for school training of other than pilots was unnecessary. Aircraft had open cockpits, possessed a limited radius of action, airborne or ground based navigational aids were virtually unknown, and the aircraft had limited performance capabilities. Pilots were given instruction in navigation at the F.T.S. and this training in map reading was adequate for aircraft capable of little more than those of 1918 vintage. The navigational requirements for the modern aircraft being developed, or those joining squadron service such as the Hampden, Whitley, Wellington and Wellesley, remained largely unconsidered.
These new aircraft with enclosed cockpits and vastly increased performance capabilities in speed and range added significantly to the complexity of the duties required of their crews. Two man crews, even if they were pilots, were no longer sufficient to control and direct an aircraft grown considerably larger, capable of remaining airborne for five or six hours or more, and requiring the management of increasingly complicated aircraft systems. The all-weather capacity which the new aircraft embodied meant that more attention would have to be given to training in instrument and night flying techniques. They also required a navigator. A map reading ability alone was now insufficient for an aircraft capable of operating over the sea or above the clouds, out of sight of land, for several hours.

The first response in Air Ministry to the acknowledged increased crew requirements imposed by the new generation bombers, was an attempt to increase pilot training. Pilots were to be given an extended navigation course during their P.T.S. training. It was yet another decision never implemented.

In 1934 the first link was forged in the chain that would result in the pilot relinquishing responsibility for his aircraft's navigation. This is not to say that the long term result was either immediately or readily apparent. Nor was the transition to be without numerous perturbations. But in 1934 the Air Ministry in its wisdom, aware of the deficiencies of the squadron trained air gunners, decided that they would be replaced by school-trained Air Observers. Trainees were to be selected from airmen in appropriate skilled trades and after graduation would be part-time aircrew, part-time ground crew. Their training at the Air Observers' School (A.O.S.) was to embrace bombing and gunnery. Only the minimum of training would be completed at the A.O.S. with the squadrons being required to convert the new Air Observers both to aircraft type and role. But the wheels of change ground only slowly and the first A.O.S. at North Coates did not commence training until January 1936.29

It is at this juncture that the crewing arguments regarding the bomber force and who was to be responsible for the bombers' navigation, became commingled. Most, in both high and low places in the R.A.F., were in agreement that precise navigation was going to be of vital importance for the bombers with both long range and endurance plus an all-weather capability, that were shortly to come on squadron strength. However there was marked disagreement as to whether a pilot or another crew member was going to be responsible for that navigation. Both arguments will be considered in parallel in chronological sequence.

29 Mackenzie-Wood, op.cit., p.106
The importance of a thorough training in navigation was stressed by the Deputy Chief of Air Staff (D.C.A.S.) Air Vice Marshal Courtney in June 1935. 'The increasing speeds and ranges of aircraft, the probability that bombing squadrons will in war have to fly long distances over the sea to their objectives, the likelihood that squadrons will have to fly for long periods either in or above the clouds, and the tendency towards a more general adoption of night flying, all seem to emphasise the need for more thorough navigational training ... We are rapidly leaving behind us the days when ... we could solve our difficulties (in navigation) without going to the trouble and expense of proper navigational training.]

The first identified threat to the pilot as navigator concept was that posed by Air Chief Marshal Ellington in April 1936. His instruction was that bomber aircraft would carry one pilot, one observer, and air gunners and wireless operators as required. Of course this meant that the pilot had dual responsibilities as both pilot and navigator. It was pointed out by Air Commodore Sholto Douglas, the Director of Staff Duties (D.S.D.), that the long-range, all-weather capability and possible night role of aircraft now in or about to enter service, meant that one man could not be both pilot and navigator.

Another problem arose with aircraft such as the Wellesley and Blenheim which only had provision for one pilot. The Hampden was another aircraft where a similar problem arose. Certainly it could carry more than one pilot but to change over pilots in flight required a certain amount of contortional ability. In these aircraft, if the pilot was unable also to act as navigator, another crew man trained in navigation would have to be carried. Who was to be that crew man?

It was also very readily apparent that, with North Coates only having commenced observer training in January 1936, an acute observer shortage was in the offing. Even the retention of some of the squadron trained air gunners as observers would barely ease, yet alone cure, the problem. The link between the observer and the navigational requirements was becoming clearer. There were two options; the observer had to receive navigation training or another pilot would have to be carried.

30 Mackenzie-Wood, op. cit., p.98
31 Ibid., p.102
Air Commodore Sholto Douglas as we have seen, had already identified the problem. His suggestion that the observers be trained as navigators had not been pursued. The Deputy Director Plans (D.D. Plans) in Air Ministry opted whole-heartedly for the two pilot solution. The mental strain of flying long sorties in war-time and the fillip to crew morale knowing there was another pilot available if necessary, were two of the reasons he advanced. His third reason was somewhat esoteric. He saw the navigation of a bomber even over land as a vital and complicated task. So vital in fact that it must remain the province of the aircraft captain. Neither second pilots nor observers could be considered for such an onerous responsibility. The D.D. Plans at that time was Group Captain A.T. Harris who will be encountered again in this narrative.

Group Captain Harris was correct in his assessment of the difficulties of the navigational task for bomber aircraft. In August 1936 Flight Lieutenant D.J. Waghorn produced a paper on 'Navigation in the RAF'. It was a sombre indictment of the training and capabilities of those responsible for the navigation in the R.A.F. bomber force. Technical advances in aircraft he claimed had outstripped the ability of the crews to use them to the best advantage. He advocated long range navigation exercises using astronomical observations (astro) as the primary aid. The errors of D.R. were cumulative and therefore they could be gross on flights where the accuracy of meteorological forecasts was doubtful. Waghorn discounted the use of wireless to determine an aircraft's position because of its possible inaccuracy and because, in certain circumstances, it could reveal the aircraft's position to an enemy. He admitted that astro also had inherent errors but they were not necessarily cumulative and the use of an aircraft sextant did not reveal the aircraft's position to the enemy.

Air Commodore Garrod, the acting A.O.C. No. 23 Group gave his support to the paper and included some additions of his own. He called for increased instrument flying which would necessitate the fitting of wireless in the aircraft and homing facilities on the ground.

Harris took the opportunity offered by the paper to make a plea for the simplification of navigation. Time was not available, he believed, for lengthy navigational courses and a

32 Mackenzie-Wood, op.cit., p.106
33 Ibid., p.103
34 Ibid., p.100
35 Ibid., p.101
few experts would be insufficient in war. Experts, he contended, surrounded themselves with 'clap-trap' whereas he sought 'simple and practical' methods. In some respects Harris was correct. Navigation is a simple task. It is an amalgam of simple mathematics and careful assessment. But the task is carried out under difficult conditions for long periods and mistakes are dangerous. Just as there are a few exceptional pilots and a few bad pilots, with most being average, so there are a few exceptional navigators, some bad ones and most average. But both pilots and navigators require an adequate training and then continual practice. There are few short cuts that can be safely taken.

However it is in the attack that he then launched against unspecified senior officers in the R.A.F. that he must gain greater support. He saw that 'navigation was probably the most important aspect of operational efficiency but the general attitude to it was deplorable and the standard of efficiency lamentable ... senior officers had had neither knowledge of it nor interest in it, and the junior officers who had in the past been responsible at the Air Ministry for navigation equipment and methods had not carried enough guns to get vital requirements properly co-ordinated and put across.'

In February 1937 it was decided that where possible bombing aircraft would carry two pilots. This provision included the Whitleys, Wellingsons and even the Hampdens whose pilots normally got to their positions via the cockpit canopy. It also included aircraft only known by their specifications Pl3/36 and Bl2/36 but later to be identified as the Halifax and Stirling respectively. It was agreed that special arrangements would have to be made for the navigation of those aircraft unable to carry two pilots. These aircraft, the Battles, Wellesleys and Blenheims, were seen as only presenting a short term problem. When they were replaced by the new, larger bombers, all would then be able to carry two pilots. To overcome the immediate problem however it was decided to provide navigation training for observers 'similar to that given a pilot at Flying Training School' with training to be completed on squadron.

36 Mackenzie-Wood, op.cit., p.101
37 Ibid., p. 102
38 Thetford, op.cit., p.296
40 Mackenzie-Wood, op.cit., p.107
The two pilots per aircraft requirement meant a dramatic increase in the number of pilots required. It also required that the numbers of pilots for staff navigator courses ('s.n.') be increased. Despite the importance of navigation, the Director of Training (D. of T.) Air Commodore Leckie, arranged for some pilots to attend civil schools to gain their navigation qualification before they began their squadron instructional duties. For some reason, the fact that neither Air Service Training at Hamble nor the Imperial School of Air Navigation at Notting Hill provided either practical work or flying training, was not seen as important. Navigators are taught not born as such, and flying experience is an essential ingredient. It was not provided.

Bomber Command's problems were on-going. Squadron training was known not to provide either trained pilots or effective operational squadrons. But the system was allowed to drag on, seemingly for the lack of any conceivable alternative. The A.O.C. Bomber Command Air Chief Marshal Steel, shortly before he relinquished his command to Air Chief Marshal Ludlow-Hewitt, pointed out in September 1937 that squadron training was being delayed by both equipment shortages and the lack of navigation trained observers. The fact that navigation training for observers at this time was only being provided as a stop-gap for those aircraft unable to take two pilots, was apparently overlooked. But the pressures were increasing not only for navigation-trained observers but also that they be full-time aircrew. On taking command, Ludlow-Hewitt pressed for both these points. He also wanted his force to have an all-weather capability. In theory Bomber Command was supposed to be all-weather but that had not eventuated from the training-on-squadron system that was policy.

Ludlow-Hewitt found an ally in Sholto Douglas. He also pressed for full time air observers. 'We have created an Air Force of long range and high offensive potential. If we are to use this potential in war and give full scope to its training in peace, a highly skilled full time observer is just as much as essential as is any other member of the crew, not excluding the pilot.'

Unfortunately for those aircrew who would have to bear the brunt of the bomber battle from 1939 to 1942, the call for full time observers, navigationally trained, was not unanimous. The Air Member for Personnel (A.M.P.) Air Marshal Mitchell was one questioning voice. His opposition to full time observers, trained in navigation, was based largely on economic grounds. In October 1937 observers were only recruited from skilled R.A.F. tradesmen in selected trades.

41 Mackenzie-Wood, op.cit., p.109
42 Ibid.,
Training of their replacements while also paying for the observer training, he saw as adding considerably to the air estimates. Further he argued that to recruit direct entry observers would seem to disadvantage those in the skilled trades from where the service entry observers had been selected. Candidates for observer duties, it was agreed, had to possess the qualities akin to those of pilot recruits. Promotion therefore had to be assured to attract the right material. But promotion in ground trades, even highly skilled ones, was a slow process. Thus, observer-trained ground tradesmen would be significantly disadvantaged.

Air Marshal Mitchell's final argument was that the observer need was only a temporary aberration. The aircraft requiring observers were scheduled for replacement in the near future and the bomber force would then have aircraft all carrying two naviagationally trained pilots. Since the need for observers was not on-going, why not train a few more additional pilots? 43

Fortunately, although it had taken a long time and implementation was to take even longer, the general Air Staff view prevailed. Full time air observers were agreed to be a necessity. Perhaps the D.C.A.S., Air Vice-Marshals Peirse, was the final initiator when he wrote in November 1937 that 'The types of aircraft now coming into the Service take a heavy load considerable distances at high speed. The delivery of that bomb load at the target depends as much on accurate navigation and bomb aiming as on piloting, and the air observer is, depending on the type, partly or wholly responsible for these duties. To expect a really high standard of efficiency in those duties from an air observer who spends part of his time on technical ground duties is to expect too much'. 44

Finally, in December 1937 the decision was made. In order that the perceived observer shortage would be corrected prior to 1940, observers would be recruited from civilian life. Air Chief Marshal Sir Cyril Newall, who had succeeded Ellington as C.A.S. on 1 September 1937, ruled that observer training in navigation was to be to the same standard as that provided for pilots. But again there was compromise. The logic of full time observers was found acceptable but it was to be applicable only to direct entry observers who were to make up 50 per cent of observer trainees. Observer graduates who were also skilled tradesmen would be part-time aircrew until such time as their ground trade position could be filled. 45

43 Mackenzie-Wood, op.cit., p.110
44 Ibid., p.111
Perhaps, since the inadequacy of navigation training for pilots was so comprehensively appreciated, the decision to train observers only to the standards of pilots may seem somewhat surprising. But it must be remembered that two forces always impinged on training needs. Economics determined the numbers that could be trained while time largely defined the amount of training. Economics were always a problem and time was an undefinable quantity.

Decisions may be long in the making but they are made in an instant. Their implementation is another matter. A major handicap for observer training was the shortage of a suitable aircraft. The Anson was sought but they were mostly assigned to the General Reconnaissance (G.R.) squadrons. Until their replacement aircraft arrived, Ansons remained in short supply. Equipment and manuals were also in many cases non-existent or at least in short supply. The lack of instructors was a further disadvantage. The observers being trained at civil schools were being taught theory by master mariners with no aviation experience.

A major handicap to any great expansion of trained observers was the marked lack of volunteers. While pilot recruits came forward in considerable numbers those seeking training as observers were noticeably fewer. Perhaps part of the reason for this was that on graduation, despite having to have similar qualifications initially as pilot trainees, observers merely became corporals on probation for twelve months. This situation was not corrected until December 1938.  

Ludlow-Hewitt's report on Bomber Command training for 1937 confirmed the deficiencies. The lack of night flying was a good example. It was only undertaken at F.T.S. on nights when the visibility was such that a pilot could keep the aerodrome flashing beacon in continuous sight. Navigational training flights over the sea could not be undertaken because of a lack of safety equipment. Too much of the navigation training at civil schools was theoretical because of a lack of training aircraft. His final criticism was that training in the use of astro, under investigation since 1935 and finally accepted as a standard service method of navigation in November 1937, was still only being undertaken on squadrons. There, the lack of equipment, sight reduction tables, trained navigators experienced in the use of astro and flying time for astro exercises, were all in critically short supply.

In May 1938 it was finally conceded that in the event of war extended navigation training for pilots would not be possible. The decision was made that in that extremity

46 *Flight*, July 28, 1938, p.91
47 *Flight*, December 22, 1938, p.584
responsibility for the navigation of a bomber aircraft would pass from the pilot to the observer. Prior to this decision, although an observer may have been doing the navigation, it remained the pilot's responsibility. Although the linkage between navigation and the observer was being strengthened the chain was by no means complete. The decision meant however that now an observer was required in every bomber aircraft and greatly increased the need to step-up recruiting and training. Both were problem areas.

Increased navigation training was, by August 1938, being carried out by using civil schools and the drastic measure of virtually withdrawing two bomber squadrons from the front line. The use of civil navigation schools continued to increase during 1938 and observer recruiting was assisted by improved conditions of service. In December 1938 the Air Council announced that observers on graduation would be promoted to the rank of sergeant. Pay was also improved rising from nine shillings a day to twelve and sixpence. Flight magazine noted that the observer will then 'enjoy all the advantages of the sergeants' mess and will be treated by aircraftmen with the respect due to a senior non-commissioned officer'. The writer in Flight saw the improved terms and conditions as offering 'a most alluring prospect'.

Politicians and the public alike in 1939 clung passionately to the hope that a major war could be averted. Unfortunately too much of that hope was born from the knowledge of Great Britain's lack of preparedness. Realists knew there would be a war but hoped that it could be deferred until greater military strength was available. But even in February 1939 controversy still marked decisions in the R.A.F. Again it concerned the navigation question; who was to be responsible, the pilot or the navigator?

Although the observer was to be responsible for navigation in the event of war, pilots were still being trained to the same standard as observers. Some pilots were even receiving training in astronomical navigation which was not yet available to observers. This meant that three men were being trained for the heavy bombers and two for the so-called light bombers. The suggestion was made that if the observer was made responsible for the navigation in peace as well as war, navigation training for pilots could be reduced.

48 Mackenzie-Wood, op.cit., p.151
49 Flight, December 22, 1938, p. 584
50 Aeroplane, December 21, 1938, p.802
51 Flight, December 22, 1938, p.569
Ludlow-Hewitt vehemently opposed the notion. He wanted the aircraft captain to be not only capable of doing the navigation but also responsible for how well it was carried out. It was a good example of out-moded thinking because it showed a lack of appreciation of the mutual dependence inherent in the crew of an aircraft. Was the captain responsible for how well the air gunner or the wireless operator performed? He was not, nor could he be, but he was utterly dependent upon them to perform as well as they were able. If they failed, or the observer failed, or he failed, then death could well result.

Fortunately clearer thinking prevailed and in May 1939 the observer was made responsible for an aircraft's navigation and his training extended. In June 1939 observers started on the study of astro navigation. Pilots were to receive only sufficient navigation training to enable them to cope with emergencies.

There is another final aspect of the pilot/observer controversy which should be discussed before attention is turned to other deficiencies in Bomber Command in September 1939. This is the myth of infallibility and superiority that was certainly allowed to develop, even if it was not actively encouraged, concerning the role and capacity of the pilot of an aircraft. Those in the highest places all wore the pilots' brevet of a double wing. The fact was that the Royal Air Force had been, and was, a pilots' air force. As technology advanced others had, perforce, to be accepted into aircraft crews but they were looked on as lesser mortals. Prior to the Second World War great difficulties were experienced in attracting volunteers for training as observers. The Air Ministry should have looked more closely at what they were offering. They failed to provide even the prospect of a full career for wearers of the half wing. During the war the differentiation was accentuated. The reason was that in the main those selected for training as observers, or later navigators, were mostly those who for one reason or another had failed to be accepted or qualify as pilots. The same system was even perpetuated post-1948. But in this era navigators who displayed a capacity for command were then given a pilots' course despite having previously been rejected. To possess great authority required the wearing of pilots' wings. The Air Ministry, at regular intervals, issued Air Ministry Orders confirming the equal opportunities and career prospects for pilots and navigators but for too long it was a delusion. If equal opportunities were available there was no requirement for that fact to be continually re-emphasised. Happily the situation would, in the 1980s, appear to have been corrected.

* Mackenzie-Wood, op.cit., p.153
9. The Navigational Problem

In 1992, when commercial airliners are able to span the oceans and the continents of the world with regularity and safety employing no human navigator, when man has shown his ability to journey accurately through the inner reaches of space, it is becoming increasingly difficult to comprehend the problems faced by air navigators in the 1930s and 1940s. The use of accelerometers and virtually precessionless gyros in inertial navigation systems, or an ability to 'fix' one's position by the use of satellite information, have rendered the human aircraft navigator redundant, at least in the civilian environment. Furthermore, were it not necessary to satisfy the natural human desires for personal reassurance, aircraft could be flown, and landed, as accurately as they are now, without any need for pilots on the flight deck. However, pilots and navigators are still required in military aircraft because they can provide the flexibility that is not always possible in mechanical or electronic instrumentation. Enemy counter measures require crews to assess information, to make judgements, to reject original plans and to be able to formulate new ones. An air force navigator today no longer has the same problems that Bomber Command navigators faced in the early 1940s; perhaps he has become more of a systems monitor, with built-in flexibility, but he is still considered necessary. He was no less necessary in the 1940s but his work and responsibilities then differed significantly from those he would face today. A successful bomber operation in the Second World War was the result of good planning and close crew cooperation with each man doing his part. It would be somewhat invidious to nominate the most essential crew member in a heavy bomber because if one failed, be it the pilot, navigator, bomb aimer, air gunner or wireless operator, at best, the mission could be abortive; at worst, crew and aircraft were lost.

Many senior officers in the R.A.F. during the 1930s were much more certain about the most vital crew member. They frequently stressed that in a bomber aircraft accurate navigation was an essential requirement. General Trenchard had defined the navigational problems for both day and night bomber squadrons in November 1917, in a paper entitled 'Long Distance Bombing'.¹ Later, in 1919, in his considerations of the imperatives in the establishment of a permanent, independent R.A.F., Trenchard had been at pains to emphasise the vital nature of specialised pilot training.² Navigation was considered an important element of this training. The importance of specialisation and navigation instruction during the 1930s were frequently acknowledged.

¹ AIR 1/725/97/7, 'Long Distance Bombing', 26 November 1917

several examples have already been given in this work, in the section on training in the R.A.F. prior to 1939. At various times, with increasing frequency and from all levels of the R.A.F. hierarchy the importance of navigation in general and those responsible for bomber navigation in particular, was reiterated. The needs were known and acknowledged. But recognition and acknowledgement of the problem was only one side of the question; the failure of both Air Ministry and Bomber Command leaders to respond adequately, was the other.

Until 1935 it had been accepted that long range navigation training was required only for those marked for service on flying boat or night bomber squadrons. In both cases navigation was a pilot's concern. Flying boat pilots, however, received navigation training as part of their course at Calshot, on Southampton Water. Night bomber pilots, on the other hand, were to be trained in navigation only after they joined their squadrons. This on-squadron training, of course, was to the detriment of operational training. It was carried out by experienced officers in the front line squadrons, but because these officers did not always accept that ab initio navigation training was a primary role, instruction was not always either given, or taken, seriously. Efforts to fill the identified navigational needs of bomber squadrons, up until September 1939 and beyond, remained dangerously inadequate.

In May 1939 Air Commodore A.A.B. Thomson, head of 3 Group Bomber Command, advised his headquarters that his squadrons, by day, if forced to fly above cloud could only navigate to within approximately fifty miles of a briefed target. Although his words may have appeared pessimistic to the Air Staff in fact they indicated an accurate appreciation of the true state of navigation affairs in all the Bomber Command Groups. Bomber aircraft had been built to fulfil three functions; their range and performance had to meet specific requirements and then, having found their target, they had to have the capacity in terms of bombs and bomb aiming equipment to ensure its destruction. Despite protestations, even from the highest levels, preparations for another European war were unrealistic. The full extent of the problems that would face Bomber Command crews were not comprehended. Too many in authority carried on with the hope that 'everything would be alright on the day'. Major navigational problems, it was hoped, would be overcome by practice and experience should war eventuate. Neither scientific research nor operational experimentation were seen as absolutely necessary. Efforts had been made to improve the state of navigation in Bomber Command after 1937 but it was too little and it was far too late. Revised course syllabi and increased training do not immediately produce better trained crews. Implementation of decisions regarding training required time, instructors, equipment, training aircraft and money. A decision to improve navigation training, even if it received whole-hearted

Webster & Frankland, op.cit., Vol.1, p.112
support, would not produce better navigators for two years at the very least. In 1937 there were a multiplicity of needs requiring urgency and unfortunately navigation was not seen as warranting 'most urgent' treatment.

When war broke out in September 1939 Bomber Command squadrons were inadequately trained and equipped to meet many of the demands placed on them for offensive operations. The first bombing raid carried out by the R.A.F. in the Second World War was directed against German naval units in Wilhelmshaven and others at anchor off Brunsbuttel at the southern end of the Kiel Canal. Target selection had been made with care. Admiralty and Air Ministry planners believed that immediately war began Germany would attempt a blockade of British ports. To reduce not only this threat but also German naval power in general, Western Air Plan 7a (W.A.7a) had been jointly agreed in August 1939. But target selection had involved other elements. There was also the need to avoid offending potential allies by placing the lives of German civilians at risk. Finally, by an attack on what was clearly a military target, it was hoped that the German authorities would not be provoked into launching a retaliatory terror attack. This raid merits close analysis because it revealed problems for Bomber Command which would prove to be extremely persistent.

On 4 September 1939 fifteen Blenheims and fourteen Wellingsons left their various bases in East Anglia for the daylight attack. Three Blenheims from 110 Squadron attacked German naval units and, from low level, scored hits with four bombs all of which failed to explode. Due to poor weather conditions - low cloud and reduced visibility - the other Blenheims failed to locate a target. Five Blenheims were lost. Of the Wellingsons, most turned back or were unable to locate a target because of the heavy rain and low cloud. One formation of three aircraft from IX Squadron, flying at 5,000 feet, met such fierce anti-aircraft fire, that they withdrew without attacking. Another formation of three aircraft also from IX Squadron, led by Squadron Leader Lamb were attacked by German fighters. Both the Wellingsons accompanying Lamb were shot down.* One aircraft dropped its bombs on Esbjerg, in neutral Denmark, 110 miles to the north.

What problems had been revealed by this raid? Primarily, it should have confirmed the navigational deficiencies. Some of the Blenheims had employed observers on loan from the general reconnaissance squadrons. By the standards of the

* T. Mason, 9 Squadron (London: Beaumont Aviation Literature, 1965), p.43

Note: Although Mason's work does not conform, IX Squadron is one of the few bomber squadrons in the R.A.F. still identified by Roman numerals.
time these observers had received a superior navigational education - certainly far better than that provided for Bomber Command crews. Yet only three Blenheims and six Wellingsons located their targets. Poor flying conditions no doubt were a factor but inadequate training and lack of bad weather flying practice had played significant parts in this attack. Secondly, no great concern was displayed over the fact that several of the bombs which actually hit their targets failed to explode. Another lesson that had not yet been learned was that the theory of self-defending bomber formations was badly flawed. At this stage anti-aircraft fire was believed to have caused most of the losses. This belief would come up for serious reconsideration following the next major raids directed against German naval units on 14 and 18 December 1939. On these two attacks thirty two Wellingtons were involved and no fewer than seventeen had been lost, mainly to German fighter aircraft. Finally, there appeared to be a lack of appreciation of the advancement that had taken place in German radar equipment. Even at this stage of the war, Fireva early warning radar sets were in use and, although they lacked a height finding capability, they had a detection range of approximately 50 miles.2

Bomber Command early in the war suffered severely in the attempt to carry out a day offensive. Due to heavy losses in day operations it was early forced into a night role for which it was ill-equipped and untrained. Over the next two years it slowly became apparent that navigation was the critical element in determining the success or failure of a bombing mission. Unfortunately, for too long, too little was done to assist the hard-pressed crews.

The acceptance of the Butt Report of 18 August 1941 marked the turning point. It was the catalyst that had been needed to give an impetus to the efforts to provide improved or new aids to increase navigational accuracy. The inertia in Bomber Command was finally about to be overcome. At last the problem of navigation was to be confronted. Improved training and better navigational aids to enable the bomber force to at least reach the general target area, would be provided. The use of the phrase 'general target area' was deliberate and needs to be understood. One problem was to get the bomber to the target area; the next problem was to identify the target. The 'general target area' meant within approximately five miles of the target, remembering that defined an area of about 75 square miles around the target. Target location and identification would require more sophisticated aids and new tactics which, in 1941, had still to be provided. The first requirement was to ensure that a greater concentration of bombers was achieved in the vicinity of the briefed target.

*Panter, op.cit., Vol.2, p.61*
For Bomber Command 1941 had been another year of crisis. It was by then apparent to those in command and to the War Cabinet that its achievements were negligible. For a force which had promised so much the actual results must have been a bitter disappointment. Of course the Ministry of Information, reconstituted by Chamberlain after the outbreak of war, had made the fullest use of R.A.F. communiqués to boost British morale but the information provided was largely unconnected with actual results. Consequent upon the Butt report those in authority were only too well aware of the actualities of the British bombing offensive. They also knew many reasons for its failure. Unless tangible results were forthcoming the continuation of the offensive had to be in doubt. Improved navigational and bombing aids, increased training, more efficient heavy bombers, new tactics and the formation of the Pathfinder Force were the provisions that finally made Bomber Command an effective force. At heart was the belated acceptance that a successful bombing offensive was utterly dependent upon a marked improvement in navigational accuracy. What then was the precise nature of the navigational problems which had plagued Bomber Command for so long?

Air navigation can be defined as the art of guiding an aircraft through the air from one place to another, of determining its position during that movement when required and ensuring that it arrived at a pre-determined point or place within the limits of space or time required by its operational role. In the Second World War navigators in Bomber Command were required to provide instructions to their pilots which would ensure that their aircraft arrived at their briefed target within a specified time frame and then returned safely to base, or an alternative destination. Their task was easily defined. Execution was another matter when the variables of weather, oxygen shortages, cold, noise, enemy action, lack of navigational aids and the often numbing effects of fear are considered.

Good air navigators did not need to possess an extensive mathematical ability. But they had to be able, rapidly and accurately, to complete the multitudinous number of small additions, subtractions, multiplications and divisions that arose. These calculations had to be completed under the most distracting conditions. There was also no great need for any deep theoretical understanding of maps and charts, magnetism and compasses, radio or astronomy. A good navigator used them all, but understanding in shortened war-time training came largely from familiarity. The secret of becoming a good navigator lay in making the most of the training provided, preparation before flight, quickness and accuracy during flight and ensuring that one remained in constant practice. Navigation was an art, all too readily lost through lack of exercise.
A good navigator never assumed; he always checked and rechecked before he confirmed. All the information that the navigator received as to the aircraft's progress had to be assessed before being accepted, rejected or stored for later consideration. There was also the need for the navigator to guard against any tendency to relax towards the end of a long or dangerous flight. The work rate, and the same careful attention to detail, had to be maintained until the aircraft had landed. Induced inertia could be fatal. For this reason Bomber Command laid down specified activity rates for its navigators based on minimum requirements for each and every hour of the flight.

Before a closer examination of the navigational problem is undertaken it is necessary to have a good appreciation of the problem of accurately defining the direction of the fore and aft axis of the aircraft. During the 1940s this direction was called the 'course' but for convenience, the more modern expression, 'heading', will be used in this narrative. The heading of an aircraft is the direction of the fore and aft axis measured normally from true north (as distinct from magnetic or compass north) in degrees from 000 or 360 (True North), through 090 (East), 180 (South) and 270 (West). Conventionally, the degree signs are omitted. Although it has rarely been identified as such it can be argued that the inaccurate definition of an aircraft's heading was a major contributor to navigational difficulties and errors in bomber aircraft during the Second World War. The inaccuracy could have been due either to careless flying by the pilot or, the navigator being unable to keep up with rapid heading changes during evasive manoeuvres. Yet other sources of possible errors were those arising from poor compass adjustment or changes in the magnetic fields in a particular aircraft.

For the major portion of the 1930s bomber pilots flew open cockpit aircraft and their navigation was the same as in a car - they looked where they were going and tried to identify navigational signposts. Pilots were not required to fly accurate headings because they were over countryside with which they had become increasingly familiar. Bomber crews by 1940 were in enclosed cockpits and the aircraft flew by night, above cloud and over water or over an unfamiliar and unfriendly land. Accurate heading flying became a requirement but it was not always provided.

Aircraft compasses at the beginning of the Second World War, like so much other navigational equipment, were very primitive instruments and no doubt often highly inaccurate. Initially they were pilot-type compasses wherein the red end of a freely suspended magnetic needle would align itself with compass north which was the resultant of the combined effects of the earth's magnetic field and the magnetic fields of the
particular aircraft and its equipment. The direction of the earth's magnetic field, although cyclic over a period of 960 years, is known and its values are provided on isogonals printed on the plotting charts used by aircraft navigators. The annual rate of change of the isogonals is also known (and small) but to avoid frequent chart reprints the mean change is either printed in the margin or on the actual isogonal. These isogonals provide a measure of the angular distance between True North (the direction of the geographic North Pole) and Magnetic North (the direction of the North Magnetic Pole). This angular distance is known as variation and is measured in degrees east or west according to whether the north seeking pole of the compass needle lies to the east or west of true north.

Figures 8 & 9
The other influence on an aircraft compass needle is that induced by the magnetic fields of the aircraft and its ancillary equipment. That is to say there can be a difference between the directions of Magnetic North and Compass North and this angular difference is known as deviation. Deviation is measured in degrees east or west according to whether the compass north direction lies to the east or west of the direction of magnetic north.

Figure 10

The navigator maintains the air plot in degrees true but the pilot flies by the magnetic compass. With Var 20°E and Dev. 10°W what compass heading corresponds to a true direction of 280°?

\[
\begin{align*}
M + V &= T \\
M &= T - V \\
&= 280 - 20 \\
&= 260M \\
C + D &= M \\
C &= M - D \\
&= 260 + 10 \\
&= 270 C
\end{align*}
\]

This was the calculation required every time there was a change of heading in aircraft using pilot-type compasses and was completed either by using a mnemonic 'variation east, magnetic least, variation west, magnetic best', or applying algebraic formula with easterly variation and deviation being given a + sign, and westerly variation and deviation being given a - sign.
Although variation and deviation are both measured in degrees east or west there is an important difference between them. Variation is a constant depending on the aircraft position above the earth and is not influenced by the direction of its fore and aft axis. Deviation on the other hand is a function of heading so for every heading there is a particular value of deviation. Additionally, while variation change is generally slow and regular, deviation change is irregular and its values could be altered by bomb loads, undercarriage up or down, particular electrical circuits in operation (especially if a magnetron valve was employed in radar equipment), or a careless pilot having put his headset close the compass.

Compass swings were carried out on all aircraft at regular intervals or when compass accuracy was in doubt. Adjustments were made to the compasses at that time and as much correction was applied as was possible. Residual deviations were annotated for each aircraft on deviation correction cards situated at each compass position. Navigators, as part of each hour's activity when airborne, were expected to check their compasses using an astro compass. This was a mechanical instrument which, when properly lined up on a celestial body (sun, moon, planets or stars), confirmed the true heading of the aircraft.

Direct Reading or pilot-type compasses were subject to many possible errors in addition to deviation which at least could be calculated. Aircraft vibration, periodic and random aircraft accelerations, temperature, turbulence and scale and alignment errors could all play a part. The situation was improved somewhat for navigators when Distant Reading Compasses (D.R.Cs) were installed in bomber aircraft from 1942 onwards. By this time it had become very difficult to position a direct reading compass in an aircraft cockpit so that it was at once clearly visible to the pilot but yet unaffected by the possible random magnetism of surrounding components.

With Distant Reading Compasses the magnetic detecting elements of the compass were positioned in a part of the aircraft - fuselage, wing tip or tail - as free as possible from random magnetism. The introduction of these compasses also saw the elimination of turning and acceleration errors.
because of the use of gyros. Heading indicators (called repeater units) were provided for pilots and navigators where they were required and where the instrument could be read accurately. Another advantage of the D.R.C. was that it also provided a facility for feeding local variation and deviation into the compass so that the repeater units indicated the true heading of the aircraft. Another advantage of the D.R.C. was that drives were available for use with automatic navigation instruments. This facility was invaluable in the case of the Air Position Indicator (A.P.I.) which automatically recorded in latitude and longitude the air position of the aircraft no matter what turns had been made or what changes in air speed had taken place. The A.P.I. entered service about 1942 and was a great advance for navigators. Ostensibly the A.P.I. removed the need to maintain a manual air plot but because of some faults that occurred in the equipment, navigators often maintained their manual plot as a precautionary measure or as a check.

For a navigator in Bomber Command his primary task was the determination of the wind velocity (W/V), that is the direction from which it was blowing and its speed. Unfortunately for the navigator the wind velocity is infinitely variable in both direction and speed with altitude, time and place. Thus, if navigation was to be properly accomplished, it was essential that the wind velocity was measured frequently. At the meteorological briefing prior to a bombing raid forecast winds at various altitudes were provided for the navigator to prepare his flight plan. Inadequate and often incorrect data frequently made forecast accuracy doubtful and, occasionally, disastrously in error. Once in the air the navigator needed to know the actual wind that was affecting the aircraft during its flight, the wind that could be expected to influence the next part of the flight, and the wind at the bombing level over the target. Virtually all the navigator's efforts were directed toward obtaining information that would ultimately provide an accurate wind velocity.

To more fully comprehend the navigational problems it is necessary that a few basic definitions of navigational terms are made clear. In all cases the terms are the English nomenclature; the American usage was often at variance. The topic of aircraft heading has already been discussed at length so we can move on to define 'track'. The track of an aircraft was the direction of the path of the aircraft over the ground. It could be the required track which was the line between two places on a chart which it was desired that the aircraft follow. Alternatively, it could be the track made good; the path that the aircraft had followed over the ground.
The angular difference between heading and track was called drift and was measured port or starboard. Port drift meant that the track was less than the heading; starboard drift meant that the track was greater than the heading. Heading, track and wind direction were measured in degrees from 000 to 359 with east being 090, south being 180 and west being 270. Heading was identified by T (true), M (magnetic) or C (compass) but wind direction was always in degrees true without identification. Thus a wind blowing from the north east at fifteen miles per hour would be given in a navigator's log as 045/15. Track was usually identified by the letters 'Tr' or 'TMG' in the log.

The remaining two definitions to be understood are airspeed and groundspeed. The airspeed of an aircraft is the speed at which an aircraft passes through the air. This is the speed indicated on the airspeed indicator. In order to find true airspeed (TAS), the indicated reading has to be corrected for position error and air density. Air density is a function of height (or pressure) and temperature and is found by using the Dalton or a similar computer. The groundspeed (G/S) is the speed of the aircraft over the earth's surface and is the resultant of the aircraft's heading and TAS and the direction and speed of the wind.

With these definitions in mind the effects of wind on an aircraft can now be considered. Should there be no wind at the level a flight was being conducted (a most rare occurrence) then heading and track would be the same, as would true airspeed and groundspeed.

When an aircraft flies directly into the wind heading and track are the same, but the groundspeed is the true airspeed minus the wind speed. If the aircraft is flown directly downwind then while heading and track remain the same, the groundspeed is now true airspeed plus wind speed. If the wind is blowing from left or right, port or starboard of the required track, then heading and track differ by the angular amount of drift. In this circumstance true airspeed and groundspeed differ according to whether there is a head or tail wind component affecting the aircraft. The different situations are shown diagrammatically in Figures 11, 12, 13 and 14 on Page 127.

The six defined elements, windspeed and direction, heading and true airspeed, track and groundspeed were the components of the triangle of velocities with which the navigator was continually confronted. Given any four of the
Aircraft flying East (090 T)  

Wind from the East

TRACK (TR)  

HEADING (HDG)

WIND VELOCITY (W/V)

(G/S = TAS - WIND SPEED)

(a) **Aircraft Flying into a Headwind**

Fig 11

Wind from the West

---

W/V

Aircraft flying East

---

HDG  

TR

(G/S = TAS + WIND SPEED)

(b) **Aircraft Flying Downwind**

Fig 12

Wind from the North

---

W/V

HDG EAST

Starboard Drift

a Drift Angle

---

TR

Port Drift

HDG EAST

Wind from the South

(c) **Aircraft Flying Crosswind**

Fig 13

Fig 14
values the remaining two could readily be found. This the navigator did either by vectorial solution, plotting the vectors to scale on his chart, or graphically, using a mechanical navigational computer such as the Course and Speed Calculator Mk2 used early in the war. This instrument was superseded in 1942 by the Dalton Computer, in wide use in the R.A.F. for the remainder of the Second World War. Solutions using either computer were quick and accurate. Another advantage of these hand-held computers was that on the reverse side of the metal portion there was a slide rule for the solution of time and distance problems. The correct solution of the triangle of velocities problem meant that a bomber would arrive at its target, or back at its base (such things as enemy action or bad weather permitting) at the time that the navigator had calculated. The correct solutions to the problems meant not only an effective mission but also survival and job satisfaction for the navigator.

While on the ground, in the flight planning stage, the navigator drew the required tracks on his chart. Then, using the wind velocities provided by the meteorological officer, he calculated the headings required to fly those tracks and the groundspeeds that would be achieved. He started with four knowns - track, true airspeed, wind velocity (speed and direction) - and solved the other two, heading and groundspeed. Using the calculated groundspeed for the measured distances he could then calculate how long the flight would take.

Once in the air the navigator started a manual air plot. This involved keeping a vector record of the headings flown and airspeeds maintained. The navigator supplied the pilot with the heading to be flown and the airspeed that he required. If the pilot wanted to turn to avoid clouds or anti-aircraft fire he advised the navigator of the new heading he was steering. The navigator noted the time the turn was made and kept his chart up-to-date with the new direction being flown. That system was known as deduced reckoning which became corrupted to 'dead' reckoning or D.R. At any time under this system, the navigator could plot the air position of the aircraft. That is he could calculate at any time the position where the aircraft would be, provided it had been unaffected by winds. Only rarely did the air position agree with the ground position, that point on the ground above which the aircraft was situated at a specific time.
The difference between the ground position and the air position was the wind effect from the time that the manual air plot had been started. Consider the following diagram:

An aircraft set heading from Point A at 1000 hours. The heading being flown was 090°T. At 1100 the navigator looked over the side of the aircraft and was able to recognise the feature on the ground immediately below, which we will call Point C. Point B was the air position of the aircraft at 1100 i.e. after one hour's flight, the length of AB was the TAS for one hour measured on the latitude scale. The vector BC represented the wind for one hour. The wind always blows from air position to ground position so it can be seen that it is a southerly wind. The direction is 180°T and the distance BC, using the latitude scale of the map, represented the windspeed. Had the air plot been started at 1030 from A, then the distance BC would have had to be doubled to find the windspeed. The procedure was then repeated with the air plot being restarted at 1100 from Point C. A heading vector is drawn in the direction 090°T and, when possible, the aircraft's ground position is again determined. The line AC was the track made good (TMG).
It was this system of D.R. which caused Bomber Command navigators so much trouble in the early years of the Second World War. Their primary method of determining the ground position of their aircraft was by pin points - looking over the side, recognising ground features and being able to relate them to their topographical maps. The system in fact had not been startlingly successful even in navigation training flights in England, in a known environment, in non-blackout conditions and in good weather on short range exercises. Evidence of failures is provided by reports on the Annual Air Exercises. When a portion of the flight involved transit over the sea, operating in an unfamiliar area, in blackout conditions, in poor, often appalling weather or in face of enemy searchlights, guns and aircraft, it was rarely successful.

Two facts should be noted regarding the D.R. procedure that has been described. Firstly, the wind found was the average wind since the air plot was started. It did not necessarily bear any relationship to the actual wind blowing above Point C in the diagram. What the navigator needed to know was the wind, or winds, that were going to affect his aircraft after leaving Point C. He could have correlated the forecast winds with the found average winds and provided new forecast winds for himself, but the knowledge of meteorology that this demanded was beyond most observers and navigators during the war. All he could do was to keep on checking. The raid on Nuremberg on the night of 30/31 March 1944 showed that forecasting and navigation problems had not been solved even that late in the war. That night the Pathfinder Windfinder aircraft leading the raid had difficulty determining the actual wind with speeds varying up to twenty knots and direction at least 20 degrees. If the experienced P.P.F. crews were having problems then it was highly probable that raw crews were utterly baffled. But we will return to the Pathfinder role in the Nuremberg raid in a later section.

The second feature of D.R. navigation that must be noted was that the navigator had, by some method, to determine the aircraft's ground position. If the ground was not visible or the aircraft was over the sea and pinpoints were unobtainable, there were only two options for the navigator in the first two years of the war. He could attempt to determine the aircraft's actual position by using position lines obtained by radio, or else position lines obtained by astronomical observations ('astro').

A position line (P/L) is a line obtained from observations of a terrestrial or celestial origin. A single position line does not tell the observer exactly where he is situated. Its use is that he knows that at the time of observation he is somewhere on that line. If two position lines intersected then, in theory, that was the position of the observer at the common time of the observation. The expression 'in theory' was deliberately chosen because, depending on the aid used, position lines have bands of error about them in an effort to compensate for known or random errors. But these considerations do not require explanation in this brief summary of an air navigator's tasks.

Consider the following situations:

**Case 1: Fig. 16**

The aircraft departed A at 1000 to bomb B. The wind was from the north so the heading flown was less than the track. At 1030 the navigator obtained a P/L CD of infinite length. The information this provided for the navigator was that the wind was stronger from the north than he had allowed for and he was now starboard of his required track. But he did not know how far along the track he had progressed.
**Case 2; Fig. 17**

Same situation, but this time, at 1030, the navigator obtained a P/L EF, again of infinite length, but at right angles to the required track. This P/L does not tell the navigator whether he was port or starboard of, or on, his required track. The information it provided was how far along an undetermined track he had proceeded since 1000.
Case 3: Fig. 18

Same situation, but now both P/Ls are combined. Using the forecast wind, the DR position at 1030 was on the required track. But the intersection of the two P/Ls was the actual position of the aircraft. It was to the starboard of the required track and was slightly ahead of the DR position so the aircraft has been achieving a better groundspeed than forecast. By joining the air position to the 'fix' (the intersection of the P/Ls), the average wind since 1000 can be calculated. Using the found wind velocity and the new required track to reach the target, a new heading and groundspeed can be calculated to arrive at B. This new, calculated heading was drawn from the 1030 fix position to restart the air plot.
Case 4: Fig. 19

Finally, if three P/Ls have been obtained, they were brought to a common time and the aircraft position was at the point of intersection. If, as was more likely, their intersection was a triangle ('cocked hat' in navigational parlance), then the actual position of the aircraft was the estimated centre of the triangle.
For navigational purists, please note that these four explanations have been simplified somewhat. No allowance has been made for bands of error about the position lines, the possible need to transfer position lines to have them at a common time, nor for the fact that from the fix time at 1030 the navigator would have to D.R. ahead to calculate the new required track, heading and groundspeed.

Until 1942 the only P/Ls available for Bomber Command navigators were those obtained by using either radio or astro. Radio or wireless bearings were of two particular types. Position lines could be obtained by taking a bearing from a transmitter on the ground using equipment in the aircraft. Alternatively, a signal could be transmitted by an aircraft, measured at a ground station and the bearing then relayed to the aircraft. There were, however, a number of disadvantages when a navigator attempted to determine his position using radio position lines. If he was using equipment in the aircraft he had to be careful to identify the transmitter. Radio transmissions were often subjected to enemy interference. Sometimes the interference was designed to prevent signals being heard but at other times it was used to provide false information. An enemy ground beacon could use the same frequency as a friendly beacon and, provided the transmission were synchronised, the bearings obtained in an aircraft were useless. When this system was used in Britain to confuse German bombers it was called 'meaconing'.

Radio bearings using aircraft equipment were also subject to coastal refraction. Land is a poor conductor of radio waves while the sea is a good conductor. The velocity of a radio wave is therefore slightly lower over land than over the sea. A radio wave which crosses the coast line at any angle less than a right angle is refracted. The bearing measured in the aircraft due to this bending process could be as much as twenty degrees in error.

Another error was known, ambiguously, as night effect. Night effect is the error in bearings due to the reception of signals from both sky waves (reflected from the ionosphere) and the ground waves. If they are in phase at the receiver then the signal is strengthened. But the height of the ionosphere is infinitely variable so the sky and ground waves do not remain in phase. If they became 180 degrees out of phase, provided they are equal in magnitude, the signal from the transmitter will be completely cancelled. Night effect could also be experienced during the day although then sky wave reception is considerably reduced.

Another misleading problem with radio bearings was that a good signal may appear to have been received but the accuracy could never be guaranteed. A five degree error at a range of 120 miles from a transmitter meant a position line error of ten miles.

The major problem with transmitting a signal from the aircraft for a ground station to measure was that the aircraft's position was revealed to all equipped with direction finding equipment on that frequency. Friend or foe knew where you were—a highly unfavourable situation in wartime.

If the bomber navigator during 1940 and 1941 was unable to identify pinpoints because of cloud, or if his wireless was unusable for any reason, he was left with astro as the last means by which he could attempt to determine his position. The system appeared to offer all the advantages; it was self-contained in the aircraft and only required an accurate watch, sextant and appropriate tables; it did not reveal the aircraft's position to the enemy; it could not be jammed or interfered with by the enemy and, on a reasonably high proportion of nights—even in the European winter—some of the stars, planets or the moon would be visible from aircraft, at times. Unfortunately, training for observers in the use of astro to obtain position lines had been almost totally ignored.

When the Royal Air Force became established on a peacetime basis in 1920, a long navigation course was conducted at the School of Naval Co-operation and Aerial Navigation at Calshot. The course was for pilots who would be posted to maritime squadrons, and the curriculum included nautical astronomy and sight taking.

In 1935 the School of Air Navigation (as it was now called) moved to Manston. At this stage it was planned that prospective long range bomber pilots would also be trained in navigation, and presumably astro, at the school. But in July 1935 the idea had to be abandoned because of a shortage of instructors and facilities consequent upon R.A.F. expansion schemes.

In 1936 the School of Air Navigation was formed to provide training for maritime pilots, squadron navigation officers and navigation specialists. The intention was that navigation training would be provided by squadron navigation

* Aeroplane, May 13, 1936, p.604
* Mackenzie-Wood, op.cit., p.3
officers for bomber pilots only after they joined their squadrons. Navigation training for all pilots, apart from maritime, had, in reality, barely advanced from where it had been in 1918.10

The first experimental course in astro navigation was not held until June 1937 but it was November of the same year before it was accepted as a standard method of navigation in bomber squadrons. Astro training then started for pilots on bomber squadrons under the instruction of squadron navigation officers. Those bomber squadrons which had a pilot trained on a three or four week course in astro navigation received one sextant and one set of astronomical tables for sight reduction.11 Training on the squadrons was unsatisfactory for reasons already discussed in the section specifically devoted to pre-war training deficiencies. It need only be reiterated here that poor training, equipment shortages, and the slowness in modifying aircraft to make astro observations possible, all combined to provide observers with few opportunities to practice astro navigation and thereby build up confidence in the system.

Even in July 1940 observers in Bomber Command, who were now responsible for navigation, had not received instruction in astro during their basic training. Time was not available for instruction in astro at the Operational Training Units and neither could observers be sent on specialist courses without breaking up established crews. In any case, the standard they had reached in D.R. navigation barely warranted the addition of the complications of astro training to an inadequate syllabus. Limited air space for flying training, the reduced performance of the training aircraft available, and the British weather, virtually ruled out any question of providing suitable training in astro navigation in the United Kingdom.

Despite the fact that observers were basically untrained in astro navigation, and certainly had not had time to gain the necessary confidence and accuracy in its use, the switch from a day to a night offensive was made early in the war with the implicit belief that the 'bomber would get through'. R.V. Jones wrote of the 'complacency' he encountered when he suggested that the provision of additional aids to navigation be considered.12

10 Mackenzie-Wood, op.cit., p.100

11 Ibid., p.113

The question of whether navigation is an art or a science is debatable. However, there is no doubt that good navigators are only made by sound training and constant practice. Astro navigation was the classic example. Constant practice on the ground and in the air was essential to reduce the time taken to obtain a 'fix' and build up self confidence. There was a mystique about using astro and many felt that it was only for the more gifted navigators. Others, even after having been trained, would only use it as a last resort. Navigators were inhibited against attempting to use astro. They lacked faith through lack of practice. Navigators in general tended to avoid methods which provided potential for error. Consequently, astro was rarely used because the calculations and corrections necessary required care, and they provided considerable scope for error. Also, during the time the sextant was being used, the pilot had to pay careful attention to his flying so that heading and airspeed alterations were kept to a minimum. Astro was avoided because largely it was unpopular with crews for reasons which depended upon whether one was a pilot or an observer.

There were two more disadvantages in using astro on bombing raids that must be mentioned. Firstly, taking the sextant readings, doing the calculations and plotting the position lines took not less than twenty minutes in good conditions. If there was cloud obscuring the stars, or avoiding action had to be taken, it could be longer. Therefore, by the time that information was available from the astro fix, that point was already, even at only 210 knots, at least 70 miles astern. Good astro navigators could bring their aircraft within five or eight miles of a predetermined point but they were always working with information that was dramatically, if not dangerously, out of date. In 1940 and 1941 when raids were often individual efforts, being within five or eight miles of the target rarely provided the opportunity for either target identification or successful bombing. If bombs were dropped at the estimated time of arrival they were wasted.

Astro, secondly, was also unpopular with pilots and other crew members, especially over enemy territory, because it required that the aircraft be flown strictly straight and level. Most Bomber Command crews believed they survived because their pilot was a 'weaver'. He changed both heading and height of the aircraft not only irregularly but also abruptly. Astro was not encouraged and thus, an additional check which could have helped to indicate an aircraft's progress, was forfeited.

In December 1940, after the war had been in progress for sixteen months, Air Marshal Peirse, then Commander-in-Chief of Bomber Command, claimed that in the period April to December
1940, no less than three out of every four bombers lost on operational sorties were actually 'lost in and around England, from causes other than enemy action'.

Peirse blamed the losses on the lack of supervision by aircraft captains over insufficiently trained observers. Although the Air Ministry disputed Peirse's summation, the substitute figures they provided — of 97 losses out of a total of 548 possibly being due to navigation mistakes — were surely indicative that the time for reassessment was overdue.

The most common cause of error in air navigation was — and remains — lack of experience. It was a strange environment, it was cold, noisy and there was a reduced oxygen supply, even as low as 7,500 feet. If oxygen masks had to be worn above 10,000 feet they further complicated the navigator's problems. Average navigators did not become good navigators until they appreciated that the success of a particular operation depended on them, the preparations they had made before flight and the observations and judgements they made during flight. All navigators made mistakes, the good navigators learned from them. The good navigators also never stopped learning. Perhaps luck sometimes played a part in successful operations but good navigators appeared to have more good luck than bad navigators. However, a good navigator never relaxed his vigilance because in the air the unexpected happened with regularity. The good navigator did not jump to conclusions. The navigator cannot always be where he wants to be — he is where he is. This may seem trite, but all navigators in training at some stage will have been told by their pilot they are over the land when on the navigation chart they should be over the sea. The immediate response of the navigator, even if not expressed, was 'No, that can't be!' The good navigator accepted the situation and set about determining what parameters had changed. The poor navigators, slower to respond, frequently allowed self doubts to dominate, and while perhaps not becoming totally lost, were increasingly uncertain of their position.

In Bomber Command in the period 1940 until early 1942 it was a learning experience built on unsatisfactory training and inadequate equipment. Some lucky navigators survived but many did not. As the war progressed both training and navigational aids improved. By late 1942 the good navigators on squadrons were becoming known and it was from this group that Pathfinders were selected to lead the main body of the bombing force on operations. As will be shown, Pathfinders became increasingly necessary as the bomber battle developed. Timing and the maintenance of track became essential not only for the success of a raid but also for improving the chances of survival. Stragglers, or those outside the bomber stream, were easy targets. But all this will be covered in a later section with particular reference to the Pathfinder Force.

19 Mackenzie-Wood, op.cit., p.372
THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 2
Rejecting Inconvenient Facts.

THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 1.
Ignoring Wind Effect.

THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 3.
Not knowing the Salute Height.

THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 4.
Stooging on after E.T.A.

TEF EMH
(London : Air Ministry, August 1945 - November 1945)
THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 5.

Failing to check position.

THE SEVEN DEADLY SINS OF NAVIGATORS
No. 6.

Incorrect Drill.

THE SEVEN DEADLY SINS OF NAVIGATORS.
No. 7.

Over-familiarity with the Route.

TEE EMH
(London: Air Ministry, December 1945 - February 1946)
10.  **Pre-War Target Planning**

In September 1939 the guiding principle for Bomber Command was the conservation of both men and machines. Unfortunately, necessity - rather than considered policy options - had determined the actions to be taken. War had been narrowly averted in September 1938 and Air Staff estimates of Luftwaffe bomber strength at that time meant that quantitatively at least, Bomber Command was apparently an inferior force.¹ At the end of September 1938 the Mobilisation Committee in Great Britain estimated that 42 bomber squadrons would be available for operations. This total included, however, no less than 32 medium bomber units - thirteen Battle, sixteen Blenheim, three Wellesley and only ten of what were then regarded as heavy bombers. When these heavy bombers are identified as five Whitley and five Harrow squadrons, the paucity of offensive bombers available to planners can be more fully appreciated. Armstrong Whitworth Whitleys entered R.A.F. service in 1937 and, because of their low speed, operated purely in a night role. From the outbreak of war they were employed mainly on leaflet dropping raids or security patrols over the East Frisian Islands and the seaplane base at Sylt. Whitleys also carried out the first bombing raid against targets in Italy but this effort required a refuelling in the Channel Islands. Although they remained on operations with Bomber Command until April 1942, essentially they were a stop-gap measure. Handley Page Harrows, an early example of the first monoplane bombers (although high-wing), were also first issued to the R.A.F. in 1937 but were never used operationally. Originally the Harrow was designed as a transport aircraft and its pre-war conversion to bombing duties was a consequence of expansion needs and the fact that modern bombers were in desperately short supply.

But even then this is not the full story because, although it had not yet been translated into a policy directive, the Air Staff's intention was to operate the bomber force at only 50 per cent of the first line strength. Necessity was the guide line because there were no reserves of aircraft and spare parts, nor trained crews, even if the aircraft had been available. It is evident that Bomber Command recognised its unreadiness for war because it admitted that 'less than 50% of the crews in the mobilisable squadrons would be fit for operations as judged by ... peacetime standards'.² Any attempt to initiate a widespread bombing campaign would result in a rapid and immediate decline of the meagre strength available. Some authorities go even further. They called Munich a lucky escape and one declared that 'The Royal Air Force was simply not in a position to fight the Luftwaffe in the autumn of 1938'.³

¹  John Terraine, *The Right of the Line*  
   (London: Hodder and Stoughton, 1985), pp.55-7

²  Wernham & Frankland, *op.cit.*, p.235

³  Spaight, *op.cit.*, p.74
As a direct result of the Munich crisis in September 1938, British air policy, with respect to bombing plans, had to be urgently reconsidered. If, as appeared likely, German military attentions were concentrated initially on Eastern Europe, then the plans prepared for either the delivery or the deflection of a 'knock-out' blow had been rendered inoperative. British military and political leaders fully appreciated that the initiation of any strategic bombing offensive which placed enemy civilians at risk invited retaliation at a considerably higher level. This eventuality had to be avoided. Bombing operations would, therefore, have to be conducted only against clearly recognised and identified military targets. Under the terms of these provisos it had been decided in September 1938 by Newall, Chief of the Air Staff, that attacks against the German armed forces could be considered legitimate. At the same time the Air Council insisted that no bombing raids could be carried out against these target systems if they were situated in populated areas. However, Ludlow-Hewitt head of Bomber Command in 1938, having just been made aware that the operational range of the Blenheim bomber was only 700 miles and not 792, realised that 'no more than two German airfields would be within reach of the great majority of the British bombers'. In combination, the shortage of crews and aircraft, inadequate training, lack of reserves, apparent remoteness of suitable targets, fear of German retaliation and British Government restrictions imposed on Bomber Command, were the ultimate determinants of bombing policy. What strengths Bomber Command possessed had to be retained, and neither crews nor aircraft were to be put at risk on possibly futile or unduly hazardous operations. Conservation of the limited force that Bomber Command had available, at least until the Luftwaffe attempted their 'knock-out' strike on the British Isles and peoples, was the guideline. Little wonder that Ludlow-Hewitt, on 14 September 1938, wrote that 'skillfully dropped propaganda, distributed by aircraft, may prove a more potent weapon than bombs'. But we will return later in this section to discuss the question of leaflet-dropping.

For a major portion of the 1930s the raison d'être for the bomber force was its calculated capacity to either deter or deliver a 'knock-out' blow. By 1938 military reassessments had changed the established order. Immediate security for Great Britain could then only be provided by the natural barrier of the North Sea and an expanded Fighter Command supplemented by anti-aircraft guns, searchlights, the Observer Corps, a chain of largely unproven radio direction finding (R.D.F.) stations and a developing ground control organisation. It was logical, subsequent to the Munich Crisis in 1938, that defence preparations concentrated on the production of fighter aircraft. They could be produced more rapidly than bombers, they required fewer resources and they needed, normally, only a pilot for their operation. The Defiant, which also carried an air gunner, after

a Wernham & Frankland, op.cit., p.232

b Ibid., p.231
suffering heavy losses, was rapidly removed from front-line day operations. Any strategic bomber offensive was, essentially, a long term consideration and time was the major requirement in order that sufficient and capable bombers could be produced and crews fully trained for their operation. In the meantime the small and largely unprepared offensive bomber force was to attempt to improve its efficiency. Retaliation by the British bomber force, should it prove necessary, was only to be contemplated under conditions which promised good chances for an effective response. Admittedly, this appeared a somewhat meagre return from an investment in Bomber Command which had cost so much and for which such high hopes had been entertained. But at least it was slightly more impressive than the role British bombers would have played had the Germans attacked strictly military objectives in a western offensive operation. In that situation Bomber Command had few permissible targets within range so its activities would largely have been limited to leaflet dropping. The only major targets that could have been attacked were units of the German fleet, the naval port of Wilhelmshaven, and the Kiel Canal.

Since 1945 much criticism has been levelled not only at individual leaders in the R.A.F. but also Government measures taken in the 1930s, for the failure to provide an effective bomber force in 1939. Many of the points made are perfectly valid. Of course the bomber aircraft in 1939 were operationally inadequate for the tasks with which they were confronted. But at least the larger machines that would form the backbone of Bomber Command throughout the war were in the planning and construction phases. Of course insufficient specialised training had been provided for bomber crews. Partially training individuals as air gunners, wireless operators, navigators and bomb aimers may have made economic sense in times of recession but it was totally unacceptable when war came. It was only when the individual needs, responsibilities and problems were fully appreciated that the enormity of the gap between pre-war training and operational readiness was fully comprehended. Of course it had been satisfactory in peace-time to pluck an armourer or a wireless operator from their ground duties to operate a gun or a wireless occasionally in an aircraft. Pre-war, the major failure was to be unaware that the efficient operation of a bomber aircraft depended on good equipment, thorough training and close co-operation among a crew not burdened with extraneous responsibilities.

Numerous and frequent Air Ministry expansion plans also proved detrimental to the efficiency of bomber squadrons in the years and months leading up to September 1939. Such was the haste to establish new squadrons that aircraft lacking much vital equipment were often accepted in squadrons. All too infrequently gun turrets, bombsights, bomb carriers or blind flying equipment were lacking. Some Battles had the blind flying instrumentation installed but lacked the engine-driven pumps necessary for their
operation. One squadron flying Blenheims in October 1937 was due to be re-equipped with Hampdens in June 1938. Only the personal intervention of Ludlow-Hewitt prevented that squadron from being non-operational for over twelve months because of vital equipment deficiencies. Bomber Command expansion meant that squadron efficiency, rather than being increased, was actually reduced because of the time taken to master new equipment. Training suffered. In April 1937 there were only 84 pilots in Bomber Command qualified for night flying and only thirteen of these were above the lowly rank of Flying Officer. This meant that either very junior officers filled important squadron positions or they were staffed by inadequately trained officers.

Perhaps however, there is a more fundamental reason to explain the inability of Bomber Command, even as late as 1944, to deliver a 'knock-out' blow to either the German military or German industry. On occasions heavy blows had been struck and Hamburg, in late July and early August 1943, is a good example. No comparable success was achieved even in the prolonged Battle of Berlin from November 1943 until March 1944. During this period 380 Lancasters were lost in action and a further 43 crashed on two nights of bad weather in England. Over the same period 117 Halifaxes and six Stirlings were also lost in attacks on the German capital. Because of their relatively poor performance the Stirlings and two marks of Halifax were withdrawn from front line service during the battle. While losses for Bomber Command mounted, the effectiveness of their attacks waned. Perhaps the failure of Bomber Command lay not with popular notions of inadequate training, poor equipment, low performance aircraft or low crew morale, but rather with the consequence of a flawed strategic theory. Make no mistake, by early 1944 Bomber Command was a highly trained and fully equipped force. Yet, in the winter of 1943-44 over Berlin, and again over Nuremberg on the night of 30/31 March 1944, Bomber Command suffered severe defeats at the hands of the German night fighters. Success for any strategic bombing offensive demanded, apparently, air supremacy and it was clear by events that this had not been achieved. By itself the bomber did not appear to possess the potential to be a war winning weapon. Perhaps the claims for its potential had been over estimated. These are considerations that will be more fully discussed as the story of Bomber Command and the development of the Pathfinder Force evolves.

6 Wernham & Frankland, op.cit., p.236


8 Ibid., p.54

9 Ibid., p.56
Operational planning for the employment of Bomber Command in the event of a war with Germany began as early as 1933 or 1934 when the first productive discussions on the necessity for rearmament took place. Admittedly they were only broad generalisations at that point because no all-embracing war plan involving the three services had been considered. Indeed, considerable uncertainty as to either Germany's political aims or its potential military, economic and industrial strengths made detailed planning virtually impossible. In October 1936 the Joint Planning Committee (one representative from each of the Services), responsible for the preparation of inter-service war plans, drew up a 'worst-case' scenario. In this eventuality the Low Countries would have been occupied by Germany whose Air Force would then be in a position to launch, from close range, heavy and sustained bombing attacks against British shipping, ports and communications. These assessments were the manifestation of the 'knock-out' blow concept which, by 1936, had come to dominate British defence policy planning. To counter this threat it was essential that any British bomber offensive had to have as its primary task the reduction of the power of the German Air Force. Secondly, it was desirable that even if the German occupation of Belgium and Holland could not be prevented, it should at least be made as difficult and costly as possible. But these were only defensive measures. It was also necessary to have an offensive plan. In broad terms this required that Bomber Command had the capacity to initiate a strategic bombing offensive against German industrial, transport, naval and communication targets, powerful enough to destroy her capacity to make war.

Fear of a 'knock-out' blow has been mentioned previously in this work but it will bear repetition. Official estimates of casualties to be expected in the event of German bombing raids directed against British cities were horrendous. Air Ministry forecasts of '400 tons of bombs every twenty-four hours over a limited period of perhaps thirty to forty days [would cause] casualties of the order of 20,000 ... in London within the first twenty-four hours ... Within a week ... casualties in the order of 150,000'. Small wonder that the priority in defence planning was accorded those measures designed to defeat any German air offensive launched against Great Britain. Second in order of priority were the plans to render aid to victims of German aggression. Finally, came the proposals for providing an effective counter offensive aimed at the defeat of Germany. Victory over Germany was a long term consideration. It could only be contemplated after the initial attacks had been contained, forces had been expanded, and an extended strategic bombing offensive carried out. In this situation it was clear that Bomber Command would have a pre-eminent role to play.

10 Neville Jones, The Beginnings of Strategic Air Power, pp.107-8

11 Wernham & Frankland, op.cit., p.147
Costly military campaigns, fought along 1914-1918 lines, were to be avoided. But how best to employ Bomber Command to achieve the aim?

A major difficulty experienced by the Air Staff in drawing up plans for the use of the bombing force in war was the vulnerability to air attack not only of London, in particular, and Great Britain in general, but also many parts of her Empire. In the past naval threats had been countered by the availability of the Royal Navy. Air threats to far flung outposts were less readily met. Effective air defence systems were not provided for even the most strategically or economically vital cornerstones of the British Empire. The fall of Singapore in 1942 would provide the final proof of the omission. But the inherent dangers had previously been exposed during the Italo-Abyssinian crisis in 1935. It was during this war that the need was recognised for restrictions on what targets could be attacked from the air. In the event of the direct involvement of British forces in the struggle, Malta offered an easy target for Italian bombers. There was also concern expressed in Britain over the independent nature of the British bomber force. A suggestion in 1935 that R.A.F. bomber squadrons based in Southern France could launch attacks against industrial targets in Northern Italy, indicated an Air Staff preparedness to take initiatives without due regard for either Army or Royal Navy problems. During this same crisis it was also noted that the limited range of British bombers required that they could only be operated effectively against either Italy or Germany in the event of war, provided advanced bases were made available in France. Because this meant that France could anticipate bombing retaliation it was therefore reasonable that French participation in the planning of such attacks would be demanded. Such co-operation would place the independence of the British bomber force and the Air Staff at risk. Direct involvement on the Continent always inferred some loss of sovereignty and to this the Air Staff had always been opposed. Now the argument was turned against themselves. 17

In 1936 three possibilities were identified as offering the British bombing force the best prospects for success in the opening phase of another war with Germany. In order, they were an attack on the morale of the German people to reduce their capacity for war; the destruction of a particular element of German industry which would significantly reduce her ability to wage war and, finally, an all-out assault on the German Air Force, its bases, communications and maintenance facilities. 13

Unfortunately no German city offered the prospect of the early reduction of morale as the consequence of a bombing assault. London did. It was particularly vulnerable if German

17 Smith, British Air Strategy between the Wars, pp.281-5
13 Wernham & Frankland, op.cit., p.149
forces had occupied the Low Countries. Berlin, however, was beyond the reach of most R.A.F. bombers at this time especially if they were forced to operate from bases in the United Kingdom. It was still a distant target even if the French were willing to agree to provide bases in their country. Targets at extreme range meant that bomb loads (light as they already were) would need to be further reduced by the necessity to carry increased fuel loads. Agreement with the French was highly unlikely because their Government feared for the safety of its own peoples, cities and industry.

An attack on a particular sector of German industry was also annulled because of the failure to identify a significantly vital and vulnerable target, the elimination of which, would inhibit German capacity for war. Even the Ruhr, where a large proportion of industry was concentrated, offered no suitable target in the short term. Simply because the first two possible targets had been rejected and despite the problems offered, airfields and the German Air Force maintenance organisation were accepted as the only viable options for British bombers in the event of an early conflict with Germany.

It was argued, however, that a bombing assault directed against the Luftwaffe was a purely defensive measure, and that offensive actions should commence at the first opportunity. Such attacks would mark the beginning of a new phase of the war but tangible results were not short term prospects. Despite the concentration in the Ruhr and the Saar regions many elements of German industry were widely dispersed. To be effective, attacks against such targets would have to be both persistent and of considerable weight. Such concentration required a large force of heavy bombers. They were not available at this time but fortunately, at least by the late 1930s, they were on the drawing boards and production jigs in the Avro, Handley Page and Shorts' design rooms and factories. Although broad strategic aims had been identified they were based on vague generalisations. Arguments over the equipment required and the tactics necessary to launch an effective bombing offensive had still not been decided. Already, too many of the decisions that had been made were based neither on practical experience nor scientific study. At core was the accepted Trenchard belief that the road to victory would be prepared by the bombers. The need to defeat the enemy air force remained recognised.

In the autumn of 1937 Sir Thomas Inskip, the newly-created Minister for the Co-ordination of Defence, called for an enquiry into the rearmament programmes under consideration. His aim, allowing for both needs and costs, was to establish a broad basis on which each of the Services could determine their part in an all-embracing strategic policy. For the R.A.F., successive expansion programmes were produced to either achieve a parity

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with, or meet the threat of, the German Air Force. Now, in 1937, all three Services were called upon to prepare detailed plans for their response to two possible German initiatives. Firstly, what could be done in the event of a German attack on France through the Low Countries thus circumventing the Maginot Line defences? Secondly, what responses could be made in the face of an all-out air assault on Great Britain? Approval was given by the Air Ministry in October 1937 for the release of a document listing, at that time, thirteen operational possibilities. Called the Western Air Plans and covering a wide range of options they were identified by the abbreviation 'W.A.' followed by a number from one to thirteen. Some of these plans had sub-sections and there were later additions. By September 1939 they totalled sixteen in all.

Only after the list had been compiled in 1937-8 did detailed planning and the collection of intelligence data and administrative information on possible targets commence. But even then only three plans were considered in detail. A Plans Section in Bomber Command was not established until November 1937 and this fact combined with staff shortages and lack of detailed information meant that immediate consideration could only be given to those plans deemed the most likely to be implemented. Those which received the early attention of the Planners were W.A. 1 (the concentration on the German Air Force), W.A. 4 (to delay an advance of the German Army) and W.A.5 (for a diverse assault on German industry). Detailed plans however, were only drawn up in face of the pessimism expressed by the head of Bomber Command. Ludlow-Hewitt, in a letter to the Air Ministry on 19 March 1938, forecast that if his bombers were totally committed to an attack on Germany then 'his medium bomber force would be eliminated in three and a half weeks and the so-called heavy bombers in seven and a half'.

It had been intended that detailed operational planning would be completed by 1 April 1938 for the three initial plans but lack of staff, insufficient intelligence data and inadequate administrative organisation, saw a deferral until 1 June 1938. Another major cause of delay was that Ludlow-Hewitt, having considered the plans under review and the tasks required of his bombers, wanted to relocate his squadrons. Their range and security he saw were the specific problems. With the likelihood that the neutrality of the Low Countries would mean their airspace could not be infringed, aircraft such as the short-range Blenheims and Battles had to be positioned as close as possible to their potential targets. Ideally, the Whitleys with their longer range should have moved to bases in Yorkshire, Harrows and Wellingsons to the East Midlands and Hampdens to Lincolnshire. But these moves coupled with the desirability of concentrating

15 Wernham & Frankland, op.cit., pp.179-180 (see Page 8a)
16 Webster & Frankland, op.cit., Vol.1, p.95
the bomber squadrons of a particular group near the group headquarters, proved administratively impossible. There was also the prospect of basing squadrons on the Continent, or at least carrying out refuelling there, but because staff conversations even between potential allies had been banned by the British Government, these remained hypothetical possibilities. Finally, consideration had to be given to the possible vulnerability to attack of the forward bases. Relocation and reorganisation was not finally approved until 28 April 1938.

Three plans, as we have seen, had been prepared. Western Air Plan 4, which provided for attacks aimed at either deterring or delaying an advance by the German Army, was the first to be rejected. Air Staff concern was based primarily on the possible loss of independence for the bomber force. Their fear was that the independent bombing force could become over-involved in an army support role. In effect the Air Staff rejected the notion that a German Army advance could be halted by bombing. As well, the alternative road and rail routes available to an advancing German Army and the wide dispersal of their supply depots, gave increased credence to the ineffectiveness to be expected from attacks launched against such targets.

Western Air Plan 1 was viewed in no better light. German airfields were spread over a wide area, aircraft could be rapidly dispersed and there was no central holding pool for reserves. Factories involved in either the construction or repair of aircraft and components offered better targets but even successful attacks provided only long-term gains. Again, range was a critical and decisive factor. Dutch and Belgian neutrality would mean that R.A.F. bombers faced a 200 mile North Sea passage. Accurate navigation would be required to ensure that the attacking force then crossed the coast between the Dutch and Danish borders before proceeding to their targets. Blenheim and Battles, with their reduced range and poor defensive armament, were particularly ill-suited to such forays. As well, the Whitleys and Harrows in 1938, which had the range to meet these requirements, lacked the speed necessary to operate in daylight. Utilisation of Bomber Command's limited resources in an effective counter offensive was ruled out with the rejection of Western Air Plan 1 and Western Air Plan 4.

Prior to the Munich Crisis in September 1938 there remained one possibility for the employment of the bomber force in an offensive role. This was for attacks, not directly against German Army, Naval or Air units, but indirectly at the industrial centres and transportation systems (road, rail and water) on which the military relied. Although no particular target had been identified by the Joint Planning Committee in 1936 as constituting a critical element in any specific production process, by 1938 the Ruhr complex was known to be crucial to

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27 Wernham & Frankland, op.cit., pp.182-3
German industry. From the area came 75 per cent of Germany's coal and iron, over 60 per cent of the heavy engineering capacity and the major portion of her chemical production. If the implementation of Western Air Plan 5(a) and (b) resulted in the destruction of the dams supplying power to the Ruhr, closure of the elaborate canal system on which heavy industrial traffic depended, and the ruination of the power and coking plants, then it was believed that the German war effort would be drastically reduced within three months.\footnote{18}

Bomber Command's enthusiasm for the Ruhr plan was based largely on the fact that targets were only 150 miles from the North Sea coast and no more than 50 miles from either the Dutch or Belgian frontiers. Despite the known prevalence of considerable industrial haze and the frequent occurrence of fog, it was accepted that their location would not prove difficult. In this assessment the planners were not wrong. The Ruhr area was easily identified. But where they were to prove wildly inaccurate was that particular targets within the Ruhr complex remained hidden to R.A.F. bomb aimers' eyes all too frequently until late 1942.

Enthusiasm for Western Air Plan 5 had waned, however, when it was calculated that no less than 3,000 sorties would be required to ensure destruction of the twenty six coking plants and nineteen power stations on which Ruhr industry depended.\footnote{19} At this stage Western Air Plan 5 became a long term plan. Bomber Command's strike force in the immediate future was incapable of either mounting that degree of effort or of sustaining the expected casualties. Neither the Blenheims nor the Battles were capable of carrying the larger bombs required for the task. Indeed, the 1,000 and 2,000 pound bombs that were essential, had not yet been produced. Whitleys and Harrows possessed both the range and the bomb-carrying capacity but were too slow for day operations and lacked the ability to find their targets by night. Wellingsons and Hampdens, the most efficient of the then so-called heavy bombers, were adequate for the task but even in early 1939 there were only two operational squadrons equipped with these aircraft. It was becoming evident that conservation of the bomber force was a necessary and important element of policy.

Only hindsight has shown on what insubstantial foundations the Air Staff had based their plans for the execution of Western Air Plan 5. Navigational difficulties were overlooked, problems of target location were ignored, and estimations of bombing accuracy and effectiveness were wildly optimistic. Even the bombs required for the tasks had still to be produced and their effectiveness, or otherwise, fully assessed. Too much reliance

\footnote{18 Wernham & Frankland, \textit{op.cit.}, p.190}
\footnote{19 \textit{Ibid.}, p.191}
was based on mathematical theory; too little on practical experience. If one aircraft dropped one bomb it was assumed it would hit the target and create a certain amount of damage. Therefore, it followed, three aircraft dropping three bombs would create three times the amount of damage. All too often the future would show that targets were only located with difficulty and too few bombs were dropped with accuracy. Damage created by those bombs striking the target was, on most occasions, considerably less than anticipated.

Implementation of Western Air Plan 5 also implied a willingness by the Air Staff to adopt total war tactics. In such a situation German civilians would be killed. But British politicians were unwilling to be identified as the initiators of what would amount to unrestricted warfare. Cabinet approval for the execution of Western Air Plan 5 was therefore only a remote possibility. No doubt Western Air Plan 5 as a retaliatory measure, in response to German aggression, would have received approval. However, the generally accepted belief was that in the event of a military campaign in the west, German forces would employ only restricted warfare and not put civilians at unnecessary risk. In such a situation Western Air Plan 5 would not be sanctioned. Equally, should Germany drive eastward and merely conduct a holding operation in the west, approval for the implementation of Western Air Plan 5 was most unlikely.

It was these factors, in combination with the desire to conserve the bomber force, that caused the Air Staff to concentrate their target studies to those of a specifically military nature. Especially was this true after the Munich crisis. Notions of an independent strategic air offensive were thus deferred. But even within this deferral were growing the seeds of the idea that perhaps Bomber Command could become the weapon for total victory rather than simply the shield to avert defeat. Thus, during the last year of peace up to September 1939, concentration was given to those Western Air Plans which provided virtually no risks to German civilians. Targets which fitted this description were considered 'legal'. Those failing to provide security for German civilians were regarded as 'illegal'.

There is no use however in seeking dictionary definitions for the terms 'legal' and 'illegal' as they applied to bombing considerations. Some argued that legal guidelines meant practically everything could be considered a legitimate target. Oliver Stewart, in 1936, wrote that 'There can be no doubt that a town in any industrial civilisation, is a military objective; it provides the sinews of war; it houses those who direct the war ... It should be frankly and openly admitted by serious authorities, as well as by sensational writers to the press, that the aerial bombardment of open towns will probably, almost certainly, be a feature of any future war'.

On the other hand, if expediency was the main consideration, virtually nothing could be attacked. Thus it was that words and meanings became transposed. The British Government, when forced to agree to attacks on targets of necessity, called them legal. In the British description of German air attacks on cities in the United Kingdom, they were designated as illegal. Even retaliatory bombing was considered by some to be within the undefined laws of aerial warfare because 'A belligerent who sets the rules at defiance cannot complain if his opponent follows suit. The later is justified ... in resorting to reprisals, and unfortunately reprisals are themselves the subject of no formally agreed rules'.

Some however attempted to differentiate between retaliatory bombing and reprisals. Oliver Stewart, quoting H.A. Jones, averred 'that reprisals are violations of the laws of warfare undertaken in answer to similar violations, whereas retaliatory bombing is undertaken within the laws of warfare'. Civilians under a hail of either retaliatory or reprisal bombs normally do not accept that those are suitable conditions for semantic arguments.

Because there were, and are, no prescribed laws for air warfare, 'legal' does not possess a simple meaning in this circumstance. If particular codes of air warfare, such as those prepared by the Commission of Jurists at The Hague in 1922-23, had been ratified, then the situation would have been different. In that case an act committed under the banner of defined legality was lawful. However, when considering the word in relation to British bombing policy during the Second World War, it depended upon whether or not a specific act or acts were within the prescribed guidelines. These were defined on 22 August 1939 as 'objectives of a military nature as agreed with the French'. The ramifications of the expression 'military nature' are of course endless but we have already pursued the matter sufficiently. Suffice to say that because expediency and not pseudo legality determined the limits, the term 'legal' in this case conformed, not with reason, but rather more with custom.

Neville Chamberlain, the British Prime Minister, in a speech in the House of Commons on 21 June 1938, laid down the guidelines

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23 Wernham & Frankland, op.cit., p.261
24 Ibid., p.249
for the employment of Bomber Command in the event of war. In this address he quoted international law as prohibiting bombing attacks aimed at civilians. Targets that could be attacked from the air must be legitimate military targets and be clearly identifiable. Finally, in any attacks on these targets, care was to be taken that civilians in the neighbourhood were not put at risk. Air Staff planners heeded the injunction. Despite the difficulties of categorisation they attempted to list targets as either 'definitely illegitimate' or 'unquestionably legitimate'. In a third list were those targets whose legitimacy remained indeterminate. At the same time the Air Staff accepted that 'the policy governing the choice of targets is a matter for decision by the Government'.

The acceptance of a restricted bombing policy had several consequences. On the debit side the deterrent value of the bombing force had been emasculated. Also, if through either territorial acquisition or increasing self sufficiency German economic and industrial strength grew, the failure to restrict that growth by bombing meant a relative reduction of British power. Finally on the debit side, by accepting a limited bombing option which thereby reduced the attacks that could be launched against German air power, Britain's capacity to avoid a knock-out had also been undermined.

On the credit side however, restricted bombing by the R.A.F. surely implied a reduced threat from the Luftwaffe. In the event, the Luftwaffe did not launch an unrestricted bombing campaign against Great Britain until late in August 1940 when the first bombs since 1918 fell on London. This does not necessarily imply the acceptance, by Germany, of any perceived threats posed by Bomber Command. Hitler, in the summer of 1940, rejected his strategic advisers' call for saturation bombing of London and threatened a court martial for disobedience. This measure had little to do with fear of British bombers but considerably more with the retention of a hope that a peace could still be made with Britain and thus provide the opportunities for Germany to concentrate on her designs for Eastern Europe. Possibly Hitler sought, also, to retain some international support but again, in respect of the United States, it was not because of fear. He knew nothing of the country and its racial mixture and lack of authoritarian discipline 'predisposed him to regard it as another decadent bourgeois democracy'. One of Hitler's most serious mistakes, however, was his gross underestimation of latent American strength.

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25 Wernham & Frankland, *op.cit.*, p.255

26 Ibid., p.255


Adherence by the Air Staff to a policy of restricted bombing did not necessarily imply defeatism. While it was accepted in 1939 that Bomber Command lacked both the capacity to deliver a knock-out blow and the ability to avoid attack through deterrence, planning on legal and illegal Western Air targets continued. But now conservation of resources and ultimate expansion were the aims. Heavy bombers were in the offing and in the meantime it appeared to make no sense to provoke a German assault which could be neither prevented nor against which Bomber Command could effectively retaliate. Bomber Command in 1939 was a force lacking both an offensive and a defensive capacity. Military necessity may have demanded attacks on targets which put German civilians at risk, so preparations for such an eventuality were made. Closest attention however was paid to the preparation of plans for use by the bomber force, in the event of war, which did nothing to increase the risks of a German air assault on Britain. But the actions of the planning staff were guided more by necessity than any debateable question of legality or otherwise.

Thus it was that two sets of plans were drawn up for use by Bomber Command in war. In the first group of legal plans, actions against the German navy predominated. At the same time it was understood that ultimately a wider range of targets would have to be attacked. This would come about either by German provocation or the need to initiate actions designed to bring about her defeat. Unfortunately the preparation of plans for restricted bombing induced a certain malaise in Bomber Command. Was there any necessity to risk a limited force in actions which, even if successful, promised, apparently, only meagre returns? Why not defer actions until telling blows could be delivered?

The greatest restraints placed on the planners in the R.A.F. were not those imposed by the need to consider the legality or otherwise of the possible targets. The limiting factor was the small number of effective bombers in the front line squadrons. More were arriving all the time and soon, it was hoped, they would be bigger, heavier, faster and able to carry a greater load of bombs. Unfortunately all that was somewhere in the indeterminate future. The present, in 1938 and 1939, meant a very small number of aircraft, of reduced range and limited bomb carrying capacity flown by crews not all of whom were even fully acquainted with their aircraft. On 30 November 1938 Ludlow-Hewitt stressed that in target planning "two hundred miles was the "absolute limit" for "sustained attacks", though he thought that "sporadic" attacks might be made at greater range". So much for his confidence in the first of the truly heavy bombers,

29 Wernham & Frankland, op.cit., p.257
30 Ibid., p.276
the Stirling, the prototype of which would make its maiden flight on 14 May 1939.\textsuperscript{31}

As was mentioned earlier, Britain faced three significant threats in the event of war with Germany. These were a knock-out blow from the German Air Force; the repositioning of German forces subsequent to their successful invasion of the Low Countries, or the disruption of the sea trade on which Britain depended. Only the third threat offered prospects for Bomber Command to be used effectively and still comply with the restraints of a restricted bombing campaign. In the event of either the threat of a knock-out blow by the Luftwaffe, or a German invasion of France and the Low Countries, then the use of unrestricted plans would have to be urgently reconsidered. In such circumstances German civilians would be at risk. These restricted plans, it had been decided, would be held in abeyance until either Germany had initiated total war, or it was believed Bomber Command possessed the strength to conduct a potentially war-winning strategic offensive. With other options not available the Air Staff were forced to examine what could be done to prevent disruption of Britain's sea trade.

Admiralty Plans Division advised the Air Ministry of the three possibilities they considered would be to the best advantage of Britain and the Royal Navy. In order of priority they were: an attack on German naval units at Kiel and Wilhelmshaven; destruction of the lock entrances at both ends of the Kiel Canal; and attacks on naval bases at Kiel, Cuxhaven, Wilhelmshaven or Bremerhaven.\textsuperscript{32}

Western Air Plan 7A, the plan for an attack on Wilhelmshaven, was greeted coolly by Bomber Command. Their concern was that success for such an enterprise required both surprise and concentration. Surprise was only possible, they argued, if the attackers made their approach from the North Sea and had made no previous landfall on the German coast. The possibility that the Germans may have possessed a rudimentary radar (which they did) did not come into the tactical considerations. It was also desirable that the bombers arrived at first light which meant a night crossing of the North Sea and would consequently require navigation of a high order. Under these conditions, it was believed, concentration would be impossible because bomber crews had not been trained in night formation flying. Another possibility raised was that the warships might be underway when the bombers arrived and again, the aircrews were untrained in both ship recognition and attacking moving targets.

\textsuperscript{31} Windrow (ed.), \textit{op.cit.}, Vol.6, p.309

\textsuperscript{32} Wernham & Frankland, \textit{op.cit.}, p.278
Bombing raids against the Kiel Canal linking the Baltic and the North Sea appeared, at first sight, to offer better prospects of success. Several possibilities were presented for Western Air Plan 9. These included the destruction of the lock gates at Kiel and Brunsbuttel, breaking down an area of the stop banks, blocking the canal by sinking shipping in transit, or the wrecking of the plants which provided the electricity for the hydraulic systems on which the canal depended. Only the destruction of the lock gates appeared to offer long term benefits but Bomber Command planners were not enthusiastic. They stressed the difficult nature of the targets. To achieve accuracy low level attacks were essential. Ideally, torpedo carrying aircraft were required. Unfortunately, there were no aircraft with both a torpedo carrying capability and the necessary range for such an attack. The Bristol Blenheim, although ostensibly possessing a low-level capability, lacked the endurance necessary to carry out such attacks on these targets. In mid-1939 plans for the implementation of Western Air Plan 9 were shelved. It was calculated that to achieve destruction would require bombs of at least 1,000 pounds. They had not been tested at this time and would not be available, together with the aircraft to carry them, until the end of 1939.

Finally, there was the desire of the Admiralty for attacks to be launched on German naval bases under Western Air Plan 7. This plan never reached a detailed stage of planning. The scattered nature of the targets, the fact that Kiel was outside Blenheim range, plus the bombing restrictions, appeared to provide few prospects for significant success. Legally, and technically, if any of the suggested naval bases were to be attacked, then Bomber Command considered Wilhelmshaven offered the best prospects. Indicative of the carelessness shown by those responsible for collating target intelligence for this plan is that in a minute of 12 October 1939 Wilhelmshaven was corrupted to Wilhelmsburg.

Planning the employment of Bomber Command at war was not simply a question of determining particular avenues to be followed in specific circumstances. As the weaker air power it was necessary that the R.A.F. reacted to enemy moves. It had little scope to initiate actions either unilaterally or in conjunction with allies. On 23 August 1939 Newall, wrote that 'A simple solution on the lines of a short directive saying put this or that plan into effect forthwith' ... 'might not be possible. Britain did not hold the initiative] ... 'so that our plans must to some extent be dependent on the initial actions of the enemy. It would be manifestly unwise to expend a high proportion of our best aircraft and crews at the very beginning when there are so many unknown factors in air warfare of which we have to gain experience. This would be all the more undesirable during a phase when for political reasons, we are

Wernham & Frankland, op.cit., p.288
confined to a course of action which is neither economical nor fully effective'. Bomber Command went to war in 1939 with few prepared plans for positive action. The recognised limitations of the force and the consequent need for conservation combined with Government imposed bombing restrictions provided limited scope for effective actions. All that could be attempted were limited attacks on German naval vessels, even more restricted raids on German airfields or purely reconnaissance flights. That more positive actions may be required, or demanded, was recognised, but that was still in the indeterminate future.

However, there was one other possible avenue of employment for Bomber Command in September 1939 which has not yet been discussed and which largely occupied the force in the early months of the war and, indeed, was an extra activity throughout the period of hostilities. This was the distribution of propaganda from the air under Western Air Plan 14. Originally, the list of Western Air Plans only included thirteen major headings. By 1939 the number of plans considered had increased to sixteen. These additions were:

- Western Air 14 Plans for dropping propaganda leaflets
- Western Air 15 Operations against enemy shipping by 'M' Mine (Magnetic)
- Western Air 16 Buoyancy mine attacks on the German Canal System

It is perhaps significant that Western Air 14, despite being the most unwarlike of all the plans, would appear to have absorbed a high proportion of Air Staff time. Does this mean that the consideration given to other so-called 'legal' plans was only paying lip-service to offensive or defensive operations? Was it accepted that no useful military successes could be gained by the use of the bombing force?

Mention has previously been made of Ludlow-Hewitt's suggestion, in 1938, that propaganda could possibly bring about greater successes than bombs. Perhaps it was an expression of despair. It must also be remarked that the leader of the bomber force had very little confidence in the ability of his Command to carry out any of the Western Air Plans with the possible exception of those included in Western Air Plan 5. But even in this case, while admitting the advantage to be gained by creating significant damage to German industry, there is no evidence that he accepted it could be done by the R.A.F. bomber force in being. Ludlow-Hewitt was aware of the deficiencies in his aircraft, air gunners, navigators, bombing accuracy, night flying ability and the operational readiness of his crews. Was his proposal meant

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Wernham & Frankland, *op.cit.*, p.320
seriously? Did he really believe that German morale could be lowered by what A.P. Herbert in Punch later termed 'bomphlets'? Or was he simply seeking ways to use his bombers in minimum risk operations and at the same time reduce the threat of German reprisals? Was it a response to the need for force conservation plus the fact that there were no other viable options?

Support for Ludlow-Hewitt's proposal was provided by Group Captain Slessor, the Deputy Director of Plans. Both agreed that the Ruhr was an attractive target and offered significant returns. But it was also a restricted objective, at least until Germany initiated a bombing programme which put British civilians at risk. However, even in that situation, Slessor advocated that notices be dropped in Germany giving advance warning of bombing attacks. International support, particularly opinion in the United States, was too valuable to be put at risk.

Air Vice-Marshal Peirse, the D.C.A.S. was less enthusiastic over the question of leaflets. He doubted their efficacy and questioned the need for their distribution. Was it to retain the support of wavering neutral governments? Surely it wasn't with the hope that it would deter the German Air Force? Peirse saw leaflet raids as providing opportunities for significant losses while returning insubstantial profits. He also believed that any threats made in leaflets were ineffective unless the power which they stated could be applied, had been previously demonstrated. Finally, he suggested that significant civilian unrest could result if the only riposte to German iron bombs was limited to paper threats.35

In general, the Air Staff supported the use of aircraft to drop leaflets provided the activity was not to the detriment of other feasible operations. They accepted that propaganda could be an effective weapon and saw leaflet dropping as an enterprise providing fewer risks than attacks on defended targets. Leaflet raids would be wide-ranging, conducted at night, and from the maximum altitude the distributing aircraft could attain in the prevailing conditions. Target identification was not strictly necessary because the wider the leaflet spread the greater the potential for success. Three types of leaflets were considered. Firstly, those providing wide ranging propaganda and dropped prior to any bombing offensive. Secondly, as suggested by Slessor, bombing warning notices could be dropped. This measure, the Air Staff believed, would retain not only the goodwill of the Americans but also that of the anti-Nazi element believed to exist in Germany.36 Warnings, it was hoped, would cause unrest, if not panic, among German citizens in general and the labour force in particular, thereby reducing industrial output. The final option was to drop leaflets in conjunction with bombs. This 'incidental' dropping as it was called, was to continue for the duration of the war.

35 Wernham & Frankland, op.cit., p.289
36 Ibid., p.290
Distribution of propaganda from the air was not a new concept. It had been used extensively by both sides during the First World War. Later, it was employed effectively in R.A.F. policing operations in Aden, Iraq, Mesopotamia, Kurdistan, India and the Sudan, during the 1920s and 1930s. Issuing these early bombing warning notices had not always met with general approval. Some preferred displays of 'real bombing ... [where] ... a full sized village ... can be practically wiped out and a third of its inhabitants killed or injured by four or five machines' 37 Illiteracy in the 1920s among dissident tribesman was one of the factors which mitigated the effectiveness of leaflets. In 1932 the Air Ministry claimed, in response to a challenge, that it was 'the invariable practice for tribes to be warned that a village is liable to be bombed'. 38 It was not the exact truth.

Few preparations however, even by September 1938, had been made for either the drafting, production and binding of leaflets, or the selection of areas where they were to be dispersed. The first test drops were carried out at Mildenhall on 25 September 1938 and Bomber Command was then able to advise the Air Ministry on the packaging they required for the leaflet bundles. Normally rectangular in shape, they were held in bundles by string around the longer sides of the rectangle and a rubber band over the shorter. Prior to release via the flare chute the string was removed and the rubber band held the leaflets together sufficiently until the bundle cleared the aircraft. Test drops were satisfactory.

Then, without prior warning, Ludlow-Hewitt on 28 September 1938 appeared to become lukewarm in his support for the leaflet project for which he had been a prime mover. At this stage he appeared to discover that only the Whitley had the range necessary if leaflets were to be dropped over Berlin. Even worse, the Harrow would require refuelling in France if it was sent distributing 'nickels' (as the leaflets came to be called), over the Ruhr. Perhaps another consideration was the possible risk that R.A.F. aircrews ran by being involved in the spreading of propaganda. In the First World War two Allied airmen, Lieutenants Wookey and Schulz, after being captured and court-martialled, were sentenced to death for the war crime of distributing inflammatory messages. Although the death sentence was commuted to ten years' imprisonment and then further commuted to normal prisoner-of-war incarceration, the threat remained. 39


38 Ibid., p.155

How would the Germans react in similar circumstances in another war? Foreign Office legal advisers considered that, depending on the nature of the propaganda, Germany could provide sufficient grounds certainly to protest against, if not to commit to trial, any airmen captured while dropping leaflets. Ludlow-Hewitt took another tack. He re-emphasised the need for conservation of his forces. With aircraft and crews in short supply should they be chanced on such enterprises? It was almost an acceptance of the position originally adopted by Peirse. As a compromise, Ludlow-Hewitt suggested that consideration be given to dropping leaflets from free-flying balloons. In point of fact a balloon unit was established, which in October and November 1939 distributed approximately one and a half million leaflets. But in late September 1938 the main thrust was aircraft delivery. Too many influential people and diverse groups had become involved for the issue to be side-tracked. From the Archbishop of Canterbury to the Air Staff, Board of Education, Stationery Office, Ministry of Information designate and the Foreign Office - all had made a contribution and were generally supportive.

Subsequent to the Munich Crisis in 1938 leaflet plans, which had previously been somewhat ill-considered, became more rationalised. Only two types of leaflets were contemplated - those dropped to provide a warning of forthcoming bombing and others which threatened reprisals. It was understood that Bombing Warning leaflets would require wide distribution so that actual targets were not compromised. They could provide two benefits. Civilian casualties, it was hoped, would be reduced and industrial output disrupted. By now, although it was only 10 October 1938, the legality of Western Air Plan 14 was unquestioned.

The authority quoted was Article 21 of the Draft Hague Rules of Air Warfare (never ratified by any of the major nations) which stated that 'The use of aircraft for the purpose of disseminating propaganda shall not be treated as an illegitimate means of warfare. Members of the crews of such aircraft must not be deprived of their rights as prisoners of war on the charge that they have committed such an act'. Why Ludlow-Hewitt had previously overlooked or ignored this paragraph is not known. He had posed a particular question. Were the risks involved in leaflet dropping, in aircraft and crews, likely to reap a sufficient reward? The planners simply continued with the project. They did not respond to his question and, at the same time, they ignored his objections.

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40 Wernham & Frankland, op.cit., Appendix G4,
41 Ibid., p.293
42 Ibid., Appendix G4, p.2
43 Ibid., p.294
Propaganda can be defined as 'The presentation of facts, arguments, half truths, or even falsehoods, with selective emphasis designed to implant in human minds impressions desired by the purveyors of propaganda'. After Munich, interest in propaganda in Great Britain increased. Agitation grew for the establishment of a Ministry of Information. Centralisation was essential if confusion was to be prevented. Bomber Command was to be charged with the delivery of pamphlets and so the Air Ministry was concerned that suitable material was prepared. Out of date material, or patently incorrect claims, could possibly do more harm than good and should be avoided. This particular facet of the leaflet question was a bone of contention throughout the war. The 'Harris Leaflet', purporting to originate from the C-in-C Bomber Command, was a good example. It contained misleading information, was threatening in tone and, although the unrest was rapidly subdued, criticised in both Parliament and the British press.

Shortly after Germany's annexation of Austria in 1938, a group of three men, Reginald Leeper, Robert Bruce Lockhart and Major Dallas Brooks, were appointed by the Government to consider ways of conducting political warfare in the event of future hostilities. They worked from an office in Electra House, the headquarters of the international Cable and Wireless network, and were known as the 'E.H.' team. In 1939 the Franco-British Propaganda Committee was formed and one member from the 'E.H.' team was attached to this group. Its function was to decide upon distribution methods and contents of propaganda leaflets to be directed at both Germany and Italy. Under directions from the Committee, and prior to the outbreak of war, 'E.H.' began the production of material.

In September 1939 'E.H.' was renamed the Political Intelligence Department - part of the Foreign Office. Later, in September 1941, it was merged with the established Political Warfare Executive (P.W.E.) which, since the beginning of the war, had been involved in the analysis of enemy propaganda and the distribution of material culled from foreign press and radio sources. The Ministry of Information, established at the outbreak of war, had no control over P.W.E. policies. Ostensibly, the Foreign Office was responsible for the text of pamphlets but with the P.W.E. being virtually exempt from either public criticism or parliamentary restraints, its authority was tenuous.

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45 Longmate, op.cit., p.142
46 Hinsley, op.cit., Vol.1, p.90
47 Auckland, op.cit., pp.240-1
With leaflets produced in such numbers (twelve to fourteen million were dropped in the first week of war), and destined for the widest possible distribution, it is surprising the degree of secrecy that was attached to their contents - as far as British or Allied eyes were concerned. E.H. 273, the first leaflet dropped over Germany and headed 'Warning', was received, shortly after delivery, by the Press Association in London from sources in Amsterdam. Representatives from the Press Association then called upon the Ministry of Information for corroboration and the authorised translation. One American journalist, believed to be John Gunther, who wanted the text to cable to his paper was refused, for the sublime reason that 'it might fall into enemy hands'.

Naturally the press were enraged. They made their own translation of the leaflet and published it in their papers. At this stage the Ministry of Information relented and provided their own version for publication. Despite assurances from the House of Commons that the original refusal had been a misunderstanding, the reluctance to release material continued. Copies of subsequent leaflets distributed to Government departments were marked in red ink 'Not to be shown to the Press'. Even the Keeper of Books at the British Museum was advised, in November 1939, that leaflets he received should 'not for the time being be made available to the public'.

For various reasons, as we have seen, leaflet distribution became an important element of Bomber Command's function from the first day of the war. Indeed, there is no valid reason why it should have been neglected. Every avenue had to be explored. The results that were expected from such an exercise however, displayed a degree of optimism bordering on the dangerous. Ludlow-Hewitt's suggestion that paper might be more effective than bombs, was a delusion. At the same time it has to be accepted that he was a victim of circumstances. His bomber force was ineffective and he knew it. Perhaps he accepted leaflets as a panacea and not necessarily because of any particular intrinsic value. Where mistakes were made was to over-emphasise their possible effects. This obscured the primary role of Bomber Command which was to inflict material damage on the enemy. The effects of leaflet raids, or the 'confetti war' as it was often called, will be considered in the Part 2 of this work.

48 Photo Copies of actual leaflets and translations on pp.166 - 170
49 Auckland, op.cit., p.243
50 Ibid., p.244
LIST OF WESTERN AIR PLANS 1937-1938

W.A.1 - ATTACK ON GERMAN AIR FORCE AND ITS MAINTENANCE ORGANISATION AND ALLIED INDUSTRIES

W.A.2 - RECONNAISSANCE IN HOME WATERS AND THE EASTERN ATLANTIC IN CO-OPERATION WITH THE NAVY

W.A.3 - CO-OPERATION WITH THE NAVY IN CONVOY PROTECTION IN HOME WATERS AND THE EASTERN ATLANTIC

W.A.4 - ATTACK ON CONCENTRATION AREAS, LINES OF COMMUNICATIONS ETC., OF THE GERMAN ARMY

W.A.5 - ATTACK ON GERMAN MANUFACTURING RESOURCES:
(A) IN THE RUHR
(B) INLAND WATERWAYS TRAFFIC BETWEEN THE RUHR AND BALTIC AND NORTH SEA PORTS
(C) OUTSIDE THE RUHR

W.A.6 - STORES, PARTICULARLY OF OIL

W.A.7 - COUNTER-OFFENSIVE IN CO-OPERATION WITH THE NAVY IN DEFENCE OF SEA BORNE TRADE

W.A.8 - NIGHT ATTACKS

W.A.9 - ATTACK ON KIEL CANAL, ETC.

W.A.10 - DESTRUCTION OF GERMAN SHIPPING AND ITS FACILITIES ESPECIALLY IN BALTIC PORTS

W.A.11 - DESTRUCTION OF FORESTS AND CROPS

W.A.12 - ATTACKS ON GERMAN FLEET OR PARTS OF IT, AT SEA OR IN HARBOUR

W.A.13 - ATTACKS ON GERMAN ADMINISTRATIVE, ETC. HEADQUARTERS ESPECIALLY IN BERLIN
Warnung

Großbritannien an das Deutsche Volk.

Deutsche,
Mit kühl erwogenem Vorsatz hat die Reichsregierung Großbritannien Krieg auferzwungen. Wohl rüstete sie, daß die Folgen ihrer Handlung die Menschheit in ein größeres Unheil stürzen, als 1914 es tat. Im April gab der Reichskanzler euch und der Welt die Versicherung seiner friedlichen Absichten; sie erwies sich als ebenso verloren wie seine im September des Vorjahres im Empfangsausfall verkündeten Worte: „Wir haben keine weiteren territorialen Forderungen in Europa zu stellen.“


Allen Bemühungen Deutschlands — solange sie Ändern gerecht blieben — hätte man in friedlicher Verhandlung Rechnung getragen.

R.N.Z.A.F. Museum
!!! Warnung !!!

President Roosevelt hat euch sowohl Frieden mit Euren als auch die Aussicht auf materielle Wohlfahrt angeboten. An Stelle dessen hat eure Regierung euch zu dem Massenmord, dem Ende und den Entbehrungen eines Krieges verurteilt, den zu gewinnen sie nicht einmal erhoffen können.


Ihr, das deutsche Volk, habt das Recht, auf Frieden zu bestehen jetzt und zu jeder Zeit. Auch wir wünschen den Frieden und sind bereit, ihr mit jeder aufrichtig friedlich gesinnten deutschen Regierung abzuschließen.

R.N.Z.A.F. Museum
WARNING

German men and women: The Government of the Reich have, with cold deliberation forced war upon Great Britain. They have done so knowing that it must involve mankind in a calamity worse than that of 1914. The assurance of peaceful intentions the Führer gave to you and to the world in April have proved as worthless as his words at the Sportpalast last September, when he said: "We have no more territorial claims to make in Europe."

Never has Government ordered subjects to their death with less excuse. This war is utterly unnecessary. Germany was in no way threatened or deprived of justice. Was she not allowed to re-enter the Rhineland, to achieve the Anschluss and to take back the Sudeten Germans in peace? Neither we nor any other nation would have sought to limit her advance so long as she did not violate independent non-German peoples.

Every German ambition — just to others — might have been satisfied through friendly negotiation.

— Page 2 —

President Roosevelt offered you both peace with honour and the prospect of prosperity. Instead, your rulers have condemned you to the massacre, misery and privations of a war they cannot ever hope to win.

It is not us, but you they have deceived. For years their iron censorship has kept from you truths that even uncivilized peoples know. It has imprisoned your minds in, as it were, a concentration camp. Otherwise they would not have dared to misrepresent the combination of peaceful peoples to secure peace as hostile encirclement. We had no enmity against you, the German people.

This censorship has also concealed from you that you have not the means to sustain protracted warfare. Despite crushing taxation, you are on the verge of bankruptcy. Our resources and those of our Allies, in men, arms and supplies are immense. We are too strong to break by blows and we could wear you down inexorably.

You, the German people, can, if you will, insist on peace at any time. We also desire peace and are prepared to conclude it with any peace-loving government in Germany.

EH 273

English Translation of the 'Warning' Leaflet

This, the first leaflet to be dropped by the R.A.F., was distributed on the night of 3/4 Sept. 1939
Die Blätter fallen
Münchner Neueste Nachrichten
1941 wird das Jahr des Endfieges werden
Der Vaterlandsergegen ist Blätter an die Erde rutscht, das Jahr der Macht

In Russland decken gefallene Blätter gefallene Soldaten
In das Jahr des Endfieges 1941

Schnee deckt die Blätter, die gefallene Soldaten decken
AUTUMN LEAVES

EH 527

This leaflet, photographed actual size, was first dropped over Germany on the night of 30 November/1 December 1941.

The leaves fall.
The promised final victory fails to arrive.

In Russia fallen leaves cover the fallen soldiers.
Snow covers both fallen leaves and the fallen soldiers.

Leaflet provided by
PART TWO

WAR AND THE PATHFINDER FORCE
At 11.15 a.m. on 3 September 1939 Neville Chamberlain, the Prime Minister, addressed the British peoples. Speaking on the wireless, in sombre tones, he said, 'You can imagine what a bitter blow it is to me that all my long struggle to win peace has failed. Yet I cannot believe that there is anything more or anything different that I could have done, and that would have been more successful.' He continued that that same morning the British Ambassador in Berlin had handed the German Government a note seeking an assurance that the German forces attacking Poland would cease their assault and withdraw behind their original borders. No such assurance had been received at the 11.00 a.m. deadline. 'Consequently,' said Chamberlain, 'this country is now at war with Germany.'

At 11.27 a.m. only fifteen minutes after the Prime Minister had commenced his melancholy address, the moaning wail of London's air raid sirens summoned her citizens to the air raid shelters. Was this to be the apocalypse? Was this the feared knock-out blow? It was neither. A small French aircraft on route from Paris to Croydon was the culprit. Either it had failed to file a flight plan, or the plan had not been received by the appropriate British authorities, so it was treated as potentially hostile until identified. The fears that it had engendered were, however, very real.

War had been declared. Bomber Command had prepared for war and very shortly it would have to face the first major trial. In little more than twenty-four hours fourteen trained airmen would be dead, three others would be prisoners of war and seven R.A.F. aircraft would have been destroyed. They, airmen and aircraft, were to be the first casualties of many in a long and costly campaign.

Bomber Command in September 1939, as we have seen, was ill-prepared for war. This state of ill-preparedness applied not only to the technical preparations that had been made in training, equipment and aircraft, but also to the theoretical aspects of a strategic air offensive. How was the bomber force to be employed now that war had been declared? How effective would it be? What were the long-term objectives of a strategic air offensive? In 1939 there were no firm answers to these questions because strategic bombing was only a concept. To its supporters it appeared to offer a means of avoiding the slaughter of trench warfare while at the same time carrying the war to the enemy. Theories on the effective employment of a strategic bombing force had emerged during the First World War but that war ended before they could be subjected to practical tests. Thus the doctrine of

Top  Marshal of the R.A.F.
    Sir Charles Portal

Bottom Air Chief Marshal
    Sir Edgar Ludlow-Hewitt

Top  Air Chief Marshal
    Sir Richard Peirse

Bottom Air Vice-Marshall
    Sir Ralph Cochrane

Maurice Harvey, The Allied Bomber War 1939-1945
(Tunbridge Wells: Spellmount, 1992), pp. 51 & 143
E.B. Panter, The R.A.F. in the Bombing Offensive against Germany
(London: Air Ministry, no date), Vol. 2, Map 1a
the strategic bomber offensive, conceived in the First World War and subsequently nourished by inadequate air exercises and insufficient scientific examination in the era of appeasement, was largely the off-spring of the union of imagination and hope.

Until 1938 Bomber Command had a dual role. Primarily, its function was to act as a deterrent to potential aggressors. However, should deterrence fail, the strategic doctrine on which the force was based was its intended capacity to deliver a knock-out blow. This was in accordance with the accepted theory that the bomber would always get through. Strategic thinking changed in 1938 when it was realised that the force in being was incapable of performing its planned tasks. It lacked the capacity to deliver a knock-out blow. On the other hand, it now became crystal clear that London, the hub of Empire, was vulnerable. British rearmament was therefore redirected towards strengthening the fighter defences. Therein lies the dichotomy. If British fighter aircraft could be expected to defeat German bombers, surely the reverse should be true? Why was it not appreciated that a strategic air offensive, launched by Bomber Command prior to the defeat of the Luftwaffe fighter force, invited disaster? Western Air Plans produced prior to the outbreak of war failed to accept, as the first priority, the need to defeat the German Air Force. They failed to recognise that air supremacy was a pre-requisite to the fullest exercise of air power. It was a lesson to be dearly learned.

Subconsciously perhaps, strategic planners had accepted the concept of a *guerre de course* - the avoidance of the enemy's main strength. Any proposal to achieve air supremacy before a strategic bombing offensive could be launched was ignored. In earlier wars, France - being the weaker naval power - had employed a *guerre de course* strategy on several occasions against Britain, but although successes were obtained, final victory was not achieved. In the First World War the German U-Boat offensive was another example. But while the U-Boats came close to achieving victory, in the end, they also suffered defeat. It became clear, certainly in Mahan's view, that the fullest exercise of naval power required supremacy at sea - total command of the oceans. The doctrine accepted by the Air Ministry and Bomber Command when planning the strategic bombing offensive, ignored the requirement of air supremacy. Darkness, evasion and the vastness of the skies were to be the shields for British bombers. It is one thing to go to war with adequate strategic concepts but inadequate equipment and training. Those deficiencies are rectifiable. Bomber Command had to go to war

A.T. Mahan, *The Influence of Sea Power Upon History 1660 - 1783*  
(London: Methuen & Co. Ltd., 1965)
in 1939 with a flawed strategy, inferior equipment and unsound training—surely a recipe inviting disaster. Perhaps, in the final analysis, only two elements (discounting courage) provided victory for the Allied cause: German blunders and the fact that time proved to be on the Allied side.

Marshal of the Royal Air Force The Viscount Trenchard, in a paper written after the end of the Second World War, defined what he saw as the four great principles of air power. In order, they were to secure and maintain mastery of the air; by strategic bombing to destroy the enemy's means of production and his communications; to ensure one's own commanders could operate without enemy interference, and, finally, to prevent the enemy from making further war preparations either by repositioning his forces or building up his supplies. He quoted Field Marshal Von Rundstedt who, in an order written on 20 June 1944, admitted 'The enemy's complete mastery of the Air'. This may have been true over the battlefields at that time but it was certainly not true earlier in 1943 and 1944 in the night skies over Berlin or Nuremberg. If lessons are to be learned from war they must not be confined only to those taught in the last stages of a conflict. Perhaps Bomber Command attempted to operate for too long in spite of Luftwaffe opposition when the better option may have been to first seek its neutralisation. General H.H. Arnold, Commanding General of the United States Army Air Forces (U.S.A.A.F.), in a letter written to Sir Charles Portal, the then Chief of the Air Staff, on 14 October 1943, was under no illusion. He regretted the lack of alertness, in the Allied High Command, to changes in the overall course of the Air war. Bluntly, he wrote, 'Our failure to decisively cripple both sources of German air power and the G.A.F. itself is causing you and me real concern... we are not employing our forces in adequate numbers against the German Air Force in being, as well as its facilities and sources...'

Bomber Command in 1939 was well aware of the uniqueness of a strategic bomber offensive. Time was the critical element for Britain. Time was needed not only to prepare the defences to attempt to counter the expected onslaught, but also to gather the forces necessary to assume the offensive. In the final assessment wars are only won by offensive action, and in 1939, Bomber Command appeared the only service arm possessing the potential to gain that necessary time. First, however, there was the urgent need to test the pre-determined

The Viscount Trenchard, The Principles of Air Power in War

Ibid., p.24

Noble Frankland, The Planning of the Bombing Offensive and its Contribution to German Collapse
(London: Air Ministry, 1951), p.222, (underlining in the original)
strategies, tactics, men and machines. Aircraft had been both economical and successful in colonial policing operations but a strategic bombing offensive, directed against another highly industrialised society, raised many pertinent questions. It was an experiment - the trial of a new way of making war. Unfortunately, as would early be revealed, the Air Staff had a force of bombers unable to defend themselves in daylight and incapable of night operations.

Bomber Command had prepared for war ignoring the problems of navigation and target location, unaware of the inaccuracies of bomb aiming and uncertain whether their weapon was a rapier or a bludgeon. Such negligence was to raise grave doubts, over an extended period, that the necessary time could be won and would bring Bomber Command itself and the national war effort, to the brink of disaster.

Bomber Command also went to war in 1939 aware of the need for conservation of both aircraft and crews. Expansion of the force, it was appreciated, was a long term consideration. Lost aircraft could be replaced but crew experience was something that could only be gained by minimising losses. The crews of the Whitleys, Hampdens, Blenheims and Wellingtons had to be regarded as the pool from which experienced leaders would be drawn when the new heavy bombers, ordered in 1936, entered front-line service. It was a situation which required careful and continual surveillance because possible casualties had always to be balanced against operational necessities. Preservation of crews and aircraft was acceptable provided it was only a battle that was lost. To keep Bomber Command intact but lose the war was unthinkable. Risk taking is an integral part of war but at the same time Bomber Command was not, in 1939, nor indeed throughout the war, to be in a position when its leaders could afford to be profligate with either crews or aircraft.

During the months prior to September 1939 and throughout the period of the 'phony' war which ended in May 1940, interminable Anglo-French talks took place, at many different levels, concerning the employment of Bomber Command in war. Only rarely did they reach agreement. Both sides believed that ultimately the Wehrmacht would launch an assault in the west. British staff officers argued that the best employment for the then so-called heavy bombers was in a strategic role. They wanted them used to attack either industrial targets in the Ruhr or oil refineries within range, as envisaged in the major Western Air Plans. Whitleys, Wellingtons and Hampdens were not considered suitable for direct support operations. On the other hand the French wanted both the medium and heavy bombers to be employed in a tactical role attacking communications, troop concentrations and military depots. France's view, a short term one, was coloured by the fear of Luftwaffe reprisals. Her perceived vulnerability exerted a powerful influence. Contrariwise, the long term view
adopted by Britain was that strategic bombing would apply economic pressures on Germany that might quickly prove decisive. Both sides were in full agreement on two questions. Firstly, Germany had to be permitted to make the pace. France and Great Britain must, of necessity, await German initiatives. Secondly, neither the R.A.F. nor the French Armée de l'Air would initiate an unrestricted bombing campaign. Any targets attacked would be strictly military objectives and German civilians would not be put at risk.

Acceptance of a restricted bombing programme fitted in well with Britain's unclearly defined, strategic plans. Politics, the desirability of reaching an agreement with France plus the anxiety not to antagonise world opinion by killing civilians were but one side of a complicated equation. Necessity and the force of circumstances were the other.

Bomber Command in 1939, thanks to a late start and slow progress in rearmament programmes, was a small, ill-equipped and inadequately trained force. Numerically it was inferior to the Luftwaffe. Technically, its measure was unknown. In combination the need for conservation and the restrictions on what targets could or could not be bombed meant that even those targets which appeared to offer the greatest potential for satisfactory returns, could not be attacked. German industrial, chemical and engineering facilities in the Ruhr, and natural and synthetic oil refineries were, at least in the meantime, sacrosanct. As a consequence, the only targets for Bomber Command at the outbreak of war that were politically acceptable and strategically profitable, appeared to be German naval vessels in Wilhelmshaven and neighbouring waters.

On 31 August 1939 returns of Bomber Command strength indicated a total of 55 squadrons and 920 aircraft. But these were misleading figures. By 3 September 1939 only 25 squadrons and 352 aircraft were operationally available. Ten Fairey Battle squadrons totalling 160 aircraft had been transferred to France, to operate under Army orders, although still nominally a part of Bomber Command. Two Blenheim squadrons, while they did not move to France until late September, were marked as a reserve for Army requirements. No less than seventeen squadrons lacking equipment, training or personnel, were removed from the first line to fulfil either a training or reserve role. Finally, there was one squadron still to complete its operational training.

Yet even 25 squadrons and 352 aircraft did not represent the full picture. Air Chief Marshal Sir Edgar Ludlow-Hewitt, Air Officer Commanding-in-Chief Bomber Command, appreciated that bombers concentrated on a limited number of aerodromes presented fine targets for an aggressive enemy. His order for their dispersal (necessary as it was) further reduced the readiness of his Command for war. Communications in wartime
are always a problem and 1939 was no exception. Moving squadrons from their regular bases caused a considerable upheaval that created control, organisational and supply problems. Dispersal of Bomber Command at the outbreak of war, while designed to increase safety, considerably reduced efficiency.

Amidst all the movement, apprehension and uncertainty, two decisions concerning Bomber Command were made, virtually from the beginning of hostilities, which remained constant. The first was that Bomber Command was an offensive weapon. Despite numerous and frequent diversions occasioned by German initiatives, this belief persisted, although it could not always be applied. It was believed that if the Luftwaffe could be thrown on to the defensive certain benefits would result. Perhaps the threat of a knock-out blow would be reduced; or the German Army would not receive the support that it had had in Poland. Unfortunately there was also a misconception involved as far as some British strategists were concerned. They presumed that if the Luftwaffe could be put on the defensive it would not have to be defeated: it would become the hunted rather than the hunter. But as well as possible advantages to be gained by being the aggressor, Bomber Command still had some problems to solve. Could the bombers operate by day with acceptable losses? If they were forced to operate by night, for which they were untrained, could they still find, and strike, their targets?

It was quickly learned that day bombing of German targets defended by modern fighters, radar and anti-aircraft guns, created a loss rate, which if persisted in, would rapidly bring Bomber Command to its knees. The first raid of the war on 4 September 1939 against naval units based at Wilhelmshaven set the pattern. Seven R.A.F. bombers from a total force of twenty nine were lost. Then, on 14 December 1939, a formation of twelve Wellingtons, on reconnaissance in the Schillig Roads north of Wilhelmshaven, were intercepted by German fighters and five of the formation were shot down. Finally, on 18 December 1939, twelve Wellingtons from a force of only twenty two (two had earlier aborted), were destroyed off Wilhelmshaven. In none of the cases had the German coast been crossed. It was becoming clear that day operations by self-defending bomber formations was not a feasible proposition. Whatever the problems and difficulties, bombing it seemed, would have to be done under cover of darkness.

This brings us then to the second decision by Bomber Command which remained constant. Bomber Command, after having been forced unwillingly but necessarily into a night role, was unable by itself, to reverse the situation. It attempted to

* Middlebrook & Everitt, op.cit., p.22
* Ibid., pp.26-7
do so occasionally, in the future, with usually disastrous results. Only late in the war, when total air supremacy had been secured thanks primarily to American efforts, was it able to resume its planned pre-war role.

There was one other factor over which Allied planners had little control. Only time would provide the larger four engined aircraft to replace the heavy bombers of 1939 many of which, even then, were at least obsolescent. Bomber Command ceded the initiative to the Luftwaffe in the hope that time to expand and re-equip could be bought. Time, it was accepted, was on the Allies' side. This assessment, based on the belief that Germany's economic and industrial strengths had peaked, implied that a long war would be to Britain's and France's advantage. Time was to prove, however, that there was considerable slack in the German economy. Nevertheless, the strategic aim for the employment of Bomber Command remained constant. Internal collapse in Germany, as the consequence of a strategic bombing offensive against vulnerable elements in the economic infrastructure and the morale of the people, remained the aim. The fact that German strengths had been grossly underestimated simply increased the time scale. Bomber Command, it was hoped, was a long term investment which ultimately would provide good returns.

Two factors were of critical importance in the decision to switch Bomber Command from their pre-war planned role of a day bombing force to one which sought the safety of darkness. Firstly, Ludlow-Hewitt finally accepted that the self defending formation theory had failed. Initially, the heavy losses experienced at Wilhelmshaven and later over the Schillig Roads had been credited to accurate German anti-aircraft fire. It was obvious however, that the losses on 18 December 1939 were entirely due to the aggressive tactics of German fighter pilots compounded by lack of protection for the bomber aircraft's fuel tanks. This particular raid also shattered another pre-war belief - that beam attacks by enemy fighters would not be attempted. It had been assumed that the high relative speeds of bombers and fighters would necessitate such large deflection angles as to make the tactics unprofitable. Luftwaffe fighter pilots had learned quickly, however, and exploited to the full the lack of defences of British bombers when attacked from either beam.

Acceptance of the collapse of pre-war policy decisions was not without argument. Only three options had been considered for the employment of the bomber force before the war: high-speed aircraft, provision of fighter escorts or self-defending formations. Neither of the first two options, unfortunately, were practical propositions when first considered. Rearguard actions were fought to sustain the credibility of the only available tactic.

Naturally, the losses experienced on 18 December 1939 attracted the attention of Ludlow-Hewitt. But these were early days in the air war and rather than admit to the failure of pre-war planning, modifications to the bombers - the fitting of an upper-located gun turret - came under consideration. Ludlow-Hewitt spread the blame. One suggestion, widely supported, was that the German fighters encountered had been flown by specialist crews transferred to the Wilhelmshaven area to bolster the defences. Ludlow-Hewitt then returned to his bête-noir - the lack of proficiency of the air gunners in Bomber Command. Remember, on 17 July 1939 he had written, 'the gunners have no real confidence in their ability to use this equipment [their guns] efficiently in war, and Captains and crews have, I fear, little confidence in the ability of the gunners'. Yet, somewhat incongruously, on 18 December 1939 the approved tactics for Bomber Command were day raids by self-defending bomber formations.

Finally, Ludlow-Hewitt suggested that poor formation flying had played a significant part in the heavy losses experienced. At the same time he overlooked the fact that although formation flying may have been practised within a squadron, mixed squadrons had not taken part in any such exercises. Good formation flying is heavily reliant upon efficient leadership and having knowledge of, and confidence in, the pilot who is tucking his wing under your own. Ludlow-Hewitt appreciated that good formation flying was not achieved naturally; it was the product of hard work. He instructed Air Vice-Marsh J.E.A. Baldwin, who commanded 3 Group (flying Wellingtons), that he (Baldwin) was to personally brief his unit and flight commanders on the 'vital importance of good formation flying'. Air Vice-Marsh A.T. Harris, Air Officer Commanding 5 Group, equipped with Hampdens, agreed with Ludlow-Hewitt. On 2 January 1940 he told his Commander-in-Chief that 'so long as three bombers were in company in daylight the pilots "considered themselves capable of taking on anything"'.

But already the warning signs were out that a major change in tactics, from day to night bombing, was inevitable. On 19 December 1939, the Air Ministry ordered Bomber Command to cease reconnaissances in strength in the Heligoland Bight estuaries. Then on the same day that Harris had expressed his confidence in the security of good formation flying, two Wellingtons from a group of three, were shot down in the North Sea. Despite the optimism implicit in his demand for improved formation flying, Ludlow-Hewitt, in late January 1940, was using the December losses as sufficient reason for a

11 Webster & Frankland, op. cit., Vol.1, p.115
12 Ibid., p.198
13 Ibid., p.200
reconsideration of Western Air 5, the plan for the attack on German industry in the Ruhr. He argued that his small force could create little significant damage and that 'In view therefore of the risks involved and ... the doubt of achieving success, I suggest the urgent necessity to reconsider the whole question and ... to study the possibility of devising some other means of employing the bomber striking force'.

Ludlow-Hewitt's reassessment of tactics was not necessarily due entirely to negative reasons. Doubtless he had been encouraged, not least by the low loss rate experienced, by 4 Group Whitleys in their nightly forays spreading propaganda leaflets over the German mainland. This brings us then to the second critical factor in the decision to switch from a day to a night role for the bomber force.

From the first night of the war Whitleys had ranged widely in comparative safety through the night skies over Germany. Crews reported few searchlights and no other opposition. They operated at high altitudes for those days but although generally unaffected by enemy counter measures, suffered considerably because of inadequate cabin and turret heating and the lack of electrically heated flying clothing. Weather was their major problem with icing a particular hazard. Whitleys, in common with most aircraft at that time, had no de-icing equipment and 'Kilfrost', smeared over the leading edges before take-off, was an inadequate solution for the severe conditions encountered. Ice formation on the mainplanes was a frequent reason for aircraft and crew losses. But if aircraft carrying leaflets could operate with virtual immunity from the defences at night, why should it be any different for those carrying bombs? When bombing restrictions were lifted and targets inside Germany could be attacked, a strategic bombing offensive could only be maintained provided casualties were kept to a minimum. Neglecting the other problems that night operations would create, it still appeared a viable alternative. Air Vice-Marshal A. Coningham, head of 4 Group, the leaflet raiders, although appearing somewhat ambivalent, perhaps provided the clinching argument. Earlier, on 9 December 1939, he had reported to Bomber Command Headquarters of the difficulties of night operations with regard to weather conditions and the lack of illumination, either natural or artificial. 'I foresee' he wrote, 'a never-ending struggle to circumvent the law that we cannot see in the dark.' Yet just over ten weeks later, on 19 February 1940, Coningham was considerably more optimistic. In another letter to his headquarters, his

14 Webster & Frankland, *op.cit.*, Vol.1, p.139

15 Rupert Cooling, 'First Deliveries' in *Royal Air Force Yearbook*, 1986, p.18

16 Orange, *op.cit.*, p.64
opinion was that 'the accuracy of night bombing will differ little from daylight bombing'.\(^{17}\) It would not be his last change of mind.

However, the die was soon cast. Portal had replaced Ludlow-Hewitt as head of Bomber Command on 3 April 1940 and he received his first Directive from the Directorate of Plans ten days later. It considered two hypotheses. Both envisaged situations in which bombing restrictions would be lifted. Firstly, if the Low Countries were not invaded but approval was given for unrestricted air action, then Western Air 8 was to be implemented. This plan aimed 'primarily by means of night operations to produce an immediate dislocation of German war industry'.\(^{18}\) Secondly, it considered the situation should Germany invade either Holland or Belgium, or both. In this situation attacks would be carried out immediately against targets in the Ruhr, troop concentrations, communications and oil-plants. Although all could be identified as military objectives, German civilians would be at risk. The Directive was explicit in one area. Heavy bomber operations were 'to be confined mainly to night action in order to conserve our force'.\(^{19}\)

Bombing policy had been determined for particular circumstances. What had not been considered were the methods whereby the policy could be implemented. In point of fact it was not even certain that it could be implemented. Some of the problems involved in night operations had been revealed but answers to them were still awaited. Yet more problems lay dormant. What was or was not operationally possible cannot be resolved simply by the issuance of policy directives. Before we examine in more detail the implications of a night offensive, this may be a suitable place to discuss the efficacy or otherwise, of propaganda leaflets.

Leaflets, or 'nickels' as they were code named, vividly illustrate the distorted view, largely held in Britain, of the state and morale of the German people. Ludlow-Hewitt had said that leaflets may 'prove a more potent weapon than bombs'.\(^{20}\) Whether or not nickels were effective is highly questionable. Where they rendered a considerable disservice to the British war effort lay in their perpetuation of the myth of the fragility of the morale of the German people. As early as September 1939 doubts as to their usefulness were being expressed. Perhaps those responsible for them were also somewhat ambivalent because leaflet raids had to be called 'special reconnaissances'. Later in the war leaflets were only dropped in conjunction with other mission requirements.

\(^{17}\) Webster & Frankland, op.cit., Vol.1, p.212

\(^{18}\) Ibid., Vol.4, Appendix 8(i), p.109

\(^{19}\) Ibid., p.110

\(^{20}\) Ibid., Vol.1, p.235
These 'incidental' leaflet raids provided a cover for patrols of German airfields, target selection investigations, weather sorties and crew training.

Harris's blunt views on the usefulness of leaflets are well known. In considerably more subdued language he has his supporters. H.W. Koch of the University of York is perhaps his latest. He explained that from 1938 to 1945 the Internal Security Service, Sicherheitsdienst (S.D.), of the National Central Security Office, Reichssicherheitshauptamt (R.S.H.A.), conducted regular public opinion surveys in Germany. They were a measure of the German peoples' feelings and eagerly read by Hitler. Their report of 29 April 1940, not denied by Koch, was that 'The effect of the leaflets is now as before very minimal. The population describes them as downright ridiculous'.

Hans Drisel, an authority on leaflets in the Second World War, expressed the same opinion. While admitting that the public were supposed to hand in all leaflets recovered to the local Nazi party office and were not supposed to discuss their contents, he still considered them to be 'rather useless'. Some, he said had been very well prepared and he particularly mentioned Nachrichten für die Truppe dropped later in the war by the American Air Force. Somewhat surprisingly he claimed that leaflets dropped by the Luftwaffe on the Russian front lines, as late as Autumn 1944, provoked a rash of surrenders.

Perhaps, after all, there was some validity in attempting to keep secret, from British eyes at least, the contents of many of the leaflets. Their representation of the fragility and instability of the control exercised over the German population by the Nazi political system increasingly lost its validity as the war continued. Both the portrayal of Hitler as an unpopular leader and the perception that the German people lacked the moral strength to suffer aerial bombing, were shown to be false claims. As we have seen, however, the secrecy problem was clumsily handled. So important was the leaflet campaign viewed in some quarters that the Air Ministry was sufficiently diverted, at one stage to consider the development of an aircraft, solely for spreading propaganda from the air.

The continuing attack on morale whether by leaflets or later bombs was both a waste of resources and a misapplication of the force available. For some however it became almost an obsession. Morale was still attacked, late in the war, with minimal results, while targets such as oil or communications, which could have possibly shortened the conflict, were ignored. Frequently, these targets were neglected in defiance of clearly defined operational directives.


\[22\] Letter to the Author, 1 May 1990
When considering the area bombing offensive in the Second World War one particular question must be considered - was the bombing indiscriminate? No doubt it is possible to differentiate between area and indiscriminate bombing but generally arguments are centred on connotative differences. Area bombing was not indiscriminate in the sense that bombs were dropped in a confused or promiscuous manner. Nevertheless it was indiscriminate in that bombs were dropped which were not identified as being aimed specifically at military targets. Such bombing has been called the 'gambler's throw'. It converted a war of limited military and political goals into a crusade conducted with passion. Spaith had argued in his book for specified and accepted rules for the conduct of a strategic bombing offensive. It was his opinion, supported by a reviewer of his work, that 'attacks on non-military objects never pay, for mere brutality in war does not cow, but enrages, and so strengthens the spirit of the afflicted'.

When claims for the usefulness of leaflets are considered they must be related to those made for the success of precision and area bombing up to August 1941 when the Butt Report was received. Both were exaggerated. On 26 March 1940 the Chiefs of Staff considered that 'there are some grounds for the belief that our propaganda in Germany is having useful results and this should be continued and intensified'. In point of fact neither bombing nor leaflet dropping was doing much harm to either the German war effort or German morale at that stage of the war.

There was, however, one positive feature arising from the pursuit of Western Air 14 - British aircrews were gaining experience in operating over Germany at night in all weathers. Peace time training had not prepared them for the difficulties they were now experiencing. Darkness, extreme weather conditions and the development of German night defences were all recognised as potential problem areas. Unfortunately, navigation was not, at this early stage, seen as a cause for concern. Roaming about without a road map, somewhere over Germany, somehow became equated with being able to locate a particular area and then bomb a specific target in that area. One pilot, late back to base after a leaflet raid, explained his lateness as being due to having 'to push'em under the doors'. What would only many months later be

24 C.F. S-G., Review of 'Air Power and the Cities' in _Aeroplane_: 10 September 1930, p.602
25 Pander, _op.cit._, Vol.2, p.53
revealed, was that most bomber crews failed to locate not only
the specific target they were briefed to attack, but also even
the city wherein that target was situated.

Many now consider that the strategic bomber offensive
against Germany did not commence until at least late in 1942.
Air Chief Marshal Sir Norman Bottomley has been even more
explicit. His contention was that it did not begin until
January 1943. Indeed, he went even further. In an address in
1948 he argued that the real strategic bomber offensive 'was
not [even] properly conceived - until January 1943'. The
inference was that the Casablanca Conference at that time
determined future Allied strategies. As, successively, A.9.C.
5 Group, D.C.A.S., and finally Assistant Chief of the Air
Staff (Operations) from May 1942, his views must carry
considerable weight. However, he allowed for disagreement
because he also admitted that 'effective bombing attacks were
delivered on the enemy before January 1943'. But in this
context just as one swallow does not necessarily make a summer
neither does one, nor even several effective bombing attacks,
eventually constitute a successful strategic bombing
offensive.

Judged purely on the basis of damage created to both
Germany's capacity to wage war and the morale of her people,
measured against crew and aircraft losses, there is some
justification for his claim. On the other hand acceptance of
his argument required that even the 1,000-bomber raid on
Cologne in March 1942 is ignored. When the definition of a
strategic air offensive is taken as being 'a means of direct
attack on the enemy state with the object of depriving it of
the means or the will to continue the war' then an earlier
date must surely be chosen. It is suggested that perhaps 15
May 1940 may be more suitable. On that date the War Cabinet
authorised Bomber Command for the first time to attack
military industrial targets on the German mainland east of the
Rhine River. Operationally, the bomber force may have been
generally ineffective until January 1943 but effectiveness or
otherwise does not necessarily determine the opening of the
strategic bomber offensive.

Perhaps the commencement date for the strategic bomber
offensive is an irrelevancy. What cannot be denied is that
Bomber Command was directly involved in war operations from
the first day of hostilities. It was to be a long learning
experience. Very early it was discovered that the tactics of
self-defending formations operating in daylight were fatally
flawed. British bombers were incapable of defending

27 Air Chief Marshal Sir Norman Bottomley, 'The Strategic
Bomber Offensive against Germany' in

28 Ibid., p.225

29 Webster & Frankland, op.cit., Vol.1, p.6
themselves against German fighters by day. Final proof, if it was still required after earlier disasters, was provided on 12 April 1940 when six Hampdens and three Wellingsons were lost from a force of sixty attacking enemy shipping in the Stavanger area following the German invasion of Denmark and Norway. 30 Heavy bombers would, from now, only appear in a night role for the next four years apart from a few costly exceptions. Leaflet raids had shown that darkness appeared to offer the bombers virtual immunity. Very little scientific effort, on either the British or German side, had been made to provide an effective defence system against night raiders. Equally, however, Bomber Command was totally unprepared and ill-equipped to meet the challenges raised by night operations. Navigation and target location were to prove ongoing problems.

For inexplicable reasons night bomb-aiming was not seen as providing significant difficulties. Why this should be so is difficult to understand because it was totally contrary to pre-war assessments. Before the war it had been generally accepted that day bombing errors even from high levels would not be greater than an average three hundred yards. On the other hand grave doubts had been expressed about the accuracy of night bombing. It was not believed that 'appreciable results' could be attained in such circumstances against precision targets. 31 Yet in February 1940, Coningham was able to advise his headquarters that 'the accuracy of night bombing will differ little from daylight bombing'. 32 Portal, in December 1940, confirmed Coningham's optimism. He assured a Chiefs of Staff meeting that at least fifty per cent of a night bombing force would not only find their targets but also hit them 'even if they were as small and unilluminated as oil plants'. 33

These optimistic claims for the accuracy of night precision bombing, weighed against the certainty of prohibitive losses for any continuation of a day bombing offensive, determined the tactics to be employed by Bomber Command. By a mysterious, transmutative process, the average 300 yard day bombing error became also the expected night error in moonlight conditions. In point of fact no practical or extensive bombing trials had been conducted prior to the beginning of the war. Results of simulated night attacks on unlit targets were simply described as 'disappointing'. 34

30 Middlebrook & Everitt, op.cit., p.31
31 Webster & Frankland, op.cit., Vol.1, p.100
32 Ibid., p.212
33 Ibid., p.216
34 Ibid., note 2, p.228
This hardly equated with the accepted 300 yard average night error. Hopes, born of necessity, had become the accepted tenets. Precision bombing it was agreed, was thus possible by night. Indeed, the evidence to contradict this fallacy was extremely meagre. Crew reports after bombing raids almost always spoke of targets being readily identified and hit, with explosions and fires visible from great distances. Photographic reconnaissance (P.R.) aircraft were only being developed at this stage of the war and aircraft cameras, which ultimately provided the final proof of the failure of the precision night bombing offensive, were in short supply.

Photography, as early as 1936, had been recognised as having a significant part to play in a bomber offensive. Firstly, it was an aid to crews to assist in target recognition. Secondly, damage assessments could be obtained from post-bombing photographs. Finally, photographs taken in the moments after bombs were released, showed which crews were actually locating their briefed targets. Unfortunately the call for cameras to be a part of the basic equipment for bomber aircraft remained largely unanswered even after the outbreak of war. It was not until May 1940 that the first night photograph of a European target was obtained.

By January 1941 it had been planned that each squadron in Bomber Command would have four cameras. Thus, with 42 operational squadrons, there should have been available no less than 168 cameras. In fact there were only twenty-two. Photographic interpretation was also only at the embryonic stage. If the right answers were not provided by the photographs available then it was the photographs that were rejected. As an example, between 5 and 16 June 1940 fifteen photographs taken by Wellington crews were processed and analysed. Three were considered successful while twelve were 'not of much account' even though it was admitted that this was because of the 'failure of [the] pilot to find targets'.

Until November 1940, when the first Spitfire P.R. flight was formed, post-bombing day photographs taken by Blenheims of 2 Group were not only small in number but also of a scale which made their interpretation difficult. Evidence they provided for bombing failures was largely ignored.

Another reason for persevering in the belief of the usefulness of night precision bombing was the virtually unqualified acceptance of the work of civilian advisers called in to assist Bomber Command planners. The oil expert, Mr. D.A.C. Dewdney provides a good example. He regretted the few photographs, of small scale, that were available to assess the damage done to German oil targets. At the same time he

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Webster & Frankland, op.cit., Vol.1, p.222
suggested that appearances could be deceptive. Perhaps greater damage had been created than was apparent on the few unsatisfactory photographs available. Using as his basis the 300 yard bombing error, together with the destructive capacity of a 500 pound bomb over a twenty five yard radius, he calculated the number of bombs required to be dropped to achieve the 75 per cent destruction of particular targets of varying sizes. By comparing these figures with the number of bombs dropped on some oil targets he was able to report to Portal that the results of the oil offensive, at least until September 1940, were 'satisfactory'. The totally unsatisfactory nature of his report can be more fully grasped when one reads further. Dewdney argued that 'However little damage appears in a photograph, an objective must have suffered damage in proportion to the weight of bombs dropped over it'.

Dewdney's calculations were fundamentally flawed because they were largely based on misapprehensions. Webster and Frankland even suggest that it was he who originated the perception of the 300 yard night bombing error. Even after ignoring the high proportion of bombs which failed to explode, it was still simply not possible to relate damage created to the number of bombs dropped. Too many bombs were falling not yards but miles from their targets. But evidence was being accumulated of gross bombing errors that would bring about radical changes in the tactical employment of the bomber force.

On the night of 7/8 November 1940 a mixed force of Wellingtons, Hampdens and Blenheims were briefed to bomb the Krupp works at Essen in the Ruhr. The Wellington attacks lasted from 2010 hours until 2236 and crews reported that flames were seen reaching considerable heights and that the fires were still visible even at 60 miles after leaving the target area. Hampdens commenced their bombing at 2126 but reported that no fires were visible on arrival in the target area. Their attacks ended at 0035 but at the debriefings only one crew reported a fire on arrival at the target. Blenheim crews, supposedly over Essen between 2315 and 2345, also had little to report. Only one photograph was mentioned - it had been taken by a Wellington crew and simply showed a patch of woods. It was the considered opinion of 3 Group that this fact as 'not operationally important'. But what report had the crew taking the photograph made at their debriefing? Had they claimed to have attacked the Krupp factories? Did they report explosions or fires? Or had they been unable to locate their target? Despite the fact

37 Webster & Frankland, op.cit., Vol.1, p.223
38 Ibid., p.223
39 Ibid., note 2, p.228
40 Ibid., p.225
that fires could die down rapidly, it should have been clear
that not all the aircraft had been operating in the briefed
target area.

Doubts were growing that precision bombing at night was
achieving any significant results. Despite aircrew claims of
vast explosions and enormous fires, and in the face of reports
from 'normally reliable neutral sources' of great damage being
created in Germany, the realisation was becoming apparent that
night precision bombing was a failure. Widespread attacks by
small numbers of bombers were creating neither vast material
damage nor visible morale collapse. A new Bombing Directive,
issued on 30 October 1940, marked the first stage of the
transition from precision to area bombing. Concentration on a
specific target area rather than widespread disruption was now
to be the aim. Instead of a few aircraft bombing widely
dispersed oil installations or railway marshalling yards, all
would now be required to converge on selected targets within a
particular city. Oil and communications targets retained
their priority with enemy morale a secondary consideration.
Heavy industrial damage and the chaos and fear created by near
misses were the catalysts, it was believed, to adversely
affect morale. Air Marshal Sir Richard Peirse, head of Bomber
Command from early October 1940, was instructed that his force
was to carry out 'regular concentrated attacks ... on
objectives in large towns and centres of industry, with the
primary aim of causing very heavy material destruction which
will demonstrate to the enemy the power and severity of air
bombardment and the hardship and dislocation which will result
from it'.

The Directive also included instructions that would later
be an important part of Pathfinder tactics. Aircraft first
over the selected target, flown by the most experienced crews,
were to carry a high proportion of incendiary bombs in order
that fires could be created that would act as guiding beacons
for later arrivals. Perhaps the Directive went too far when
it suggested that 'Successive sorties should then focus their
attacks to a large extent on the fires'. All too often the
fires started, even by experienced crews, were not necessarily
in the target areas. Increasingly, as the bomber war
developed, the fires were deliberately lit by German
authorities to entice bomber crews to waste their bombs. It
was a ruse at which the Germans became increasingly adept.
Despite the problems created by anti-aircraft fire, searchlights, possible enemy night fighters and the weather,
crews should still have been encouraged to attempt to identify
their target. Simply bombing existing fires merely widened
the bomb spread. Until the appropriate fire to be aimed at
could be identified by a pilot in authority over the target,
too many bombs were being wasted by crews anxious to vacate
the danger area.

41 Webster & Frankland, op.cit., Vol.4, Appendix 6, p.129
42 Ibid., p.129
Under the terms of the Bombing Directive issued on 20 October 1940 the parameters of the bombing war had been extended. Approval had now been given for raids to be launched against German industrial centres preferably located in the larger cities. These attacks, against non-specific objectives and designed to inflict both industrial and morale damage, were code-named 'Abigail'. At this stage of the war the German cities had all been allocated female code names. 'Abigail-Rachel', ordered for 16/17 December 1940, was to be the first attack on a major German city without a specific target having been defined. Mannheim was to be the sufferer. 'Fire-raisers', flown by experienced crews, led the attack with concentration of destruction the aim. Concentration in time was to be a later tactical refinement as the German defences improved. Bombing was to continue until as late an hour as would allow all the bombers to return to their bases under cover of darkness. 'Abigail-Rachel', planned partly as a reprisal for recent heavy Luftwaffe raids on Coventry and Southampton, marked the opening of a new phase of the bomber war. 'Area bombing' as it was called by the R.A.F., or 'terror bombing' as it was identified in Germany, had begun.

It must be remembered, however, that no carefully planned strategic bombing offensive had, as yet, been possible. Employment of the bomber force had been simply 'knee-jerk' reactions to particular situations and perceived German threats. When no more pressing problems had been identified then the planners in Bomber Command redirected their attentions to oil targets. They retained their priority certainly until March 1941, to reappear later in the war. Bomber Command's efforts were counter punches; responses to German initiatives. Bombing restrictions early in the war, followed by the need to reduce the Luftwaffe threat while retaining international goodwill, had severely limited the targets available. Plans had been made for attacks on German industry when these restrictions were lifted, but the lifting coincided with the German assault on France and the Low Countries. At that stage Bomber Command's role became tactical - they were called upon to help in the effort to slow down the Blitzkrieg by bombing road and rail communications, bridges and enemy airfields. Their strategic plan to reduce the German threat by attacks on oil and industry in the Ruhr were thwarted by army calls for more direct assistance. When finally the War Cabinet, on 15 May 1940, approved the bombing of targets which would place German civilians at risk, tactical bombing had precedence over strategic.

During the Battle of Britain, in the summer and autumn of 1940, Bomber Command's operations were largely dictated by two immediate concerns. Firstly, there was the need to reduce the threat that the Luftwaffe posed to Britain. This required that the German aircraft industry including aluminium producing factories, airframe and engine plants and equipment depots, became priority targets. Secondly, Bomber Command had to contend with the possibility of a sea-borne German landing
in Britain. This necessitated attacks on potential invasion ports on the Channel Coast, German shipping in Norwegian ports and heavy German naval units based at Kiel. In addition, three squadrons of an already meagre bombing force were now fully occupied in mine-laying, or 'Gardening' as it was called, in German-dominated seaways.49

Early in the war Bomber Command had been required to provide standing patrols over German seaplane bases to prevent their use for minelaying operations. In April 1940 Britain's response to the magnetic mine, the 'M' mines, were dropped by parachute from Hampden aircraft outside German ports and along frequently used sea routes. Minelaying, ostensibly, was the responsibility of Coastal Command but in accordance with the particular Directive then in force, Bomber Command provided the crews and aircraft. Although the 'Gardening' operations required precise navigation they were frequently carried out by crews in their final stages at Operational Training Units. 'Gardening' was always a subsidiary operation but when resources are scarce distractions are very noticeable. It was also on-going. More mines ('vegetables') were laid by Bomber Command than by the combined efforts of Coastal Command and the Fleet Air Arm.44

Bomber Command was never its own master throughout the whole duration of the Second World War. This of course was more particularly true during the first three years. It was always subject to the needs of the other services, politicians or propagandists. In March 1941 for the first, but not last time, the threat posed by German U-Boats, surface raiders and long-range aircraft, necessitated Bomber Command's intervention. German submarines were threatening to sever Britain's vital supply lines. German domination of Europe had provided Grand Admiral Dönitz, Führer der U-Boote, with unique opportunities for his force's operations. Their successes were alarming. Under the terms of the Bombing Directive of 9 March 1941, the Battle of the Atlantic assumed for Bomber Command the priority previously held by oil targets.

Yet, despite the foregoing, Bomber Command did in fact enjoy greater independence than any other arms in all the Services. It may not have attained the total freedom of action that Harris desired but to many it appeared virtually autonomous. Harris had later to subordinate himself and his Command to General Eisenhower's requirements for the invasion of Europe but when this control was relinquished, on 25 September 1944, he immediately reasserted his independence. Portal, with final victory in sight, was anxious that Bomber Command could be shown to have made a significant contribution. The Bombing Directive of 25 September 1944

49 Panter, op.cit., Vol.2, p.114
44 Ibid., p.175
issued to Harris was explicit and required that primarily, his force was to attack targets involved in the petroleum industry with special emphasis on petrol. Harris ignored successively (and successfully) the appeals, directions and even the entreaties of Portal, his superior, to adhere to the requirements of that September Directive. It was a revival of the old argument - precision versus area bombing. However the difference in late 1944 was that Bomber Command than possessed the capacity to launch accurate precision attacks. Yet between October and December 1944 only 14 per cent of Bomber Command's sorties were directed against oil targets while 58 per cent were still area attacks. Although he was out-ranked, Harris was strong-willed, possessed very considerable prestige and had, until late in the war, the ready-ear and support of Churchill. For Portal, Harris proved to be the immovable object. We will return to the controversy later in this narrative.

On 6 March 1941 Churchill as Minister of Defence (a post unknown during either the First World War or in the inter-war years) issued a directive acknowledging that the Battle of the Atlantic had begun. Germany's aim, he believed, was to strangle Britain's food supplies and cut the sea link with the United States. Churchill was explicit. 'We must' he wrote, 'take the offensive against the U-boat and the Focke-Wulf wherever we can and whenever we can. The U-boat at sea must be hunted, the U-boat in the building yard or in dock must be bombed. The Focke-Wulf and other bombers employed against our shipping must be attacked in the air and in their nests'. Some of his words were quoted in the Directive issued to Bomber Command on 9 March 1941. This Directive, apart from minor deletions of targets at extreme range and the addition of targets in Cologne and Stuttgart which supplied submarine components, remained in force until early July 1941.

Perhaps the diversion of Bomber Command from its oil targets saved it the embarrassment of having to admit to failure. However the involvement in the Battle of the Atlantic entailed more than a change of target co-ordinates. Aircraft, aircrew and ground crews were all involved. Coastal Command was immediately allocated a squadron of Wellingsons while other aircraft such as Whitleys, which could have gone to the Bomber Command expansion programme, instead went to Coastal Command.

45 Hastings, op.cit., p.330
47 Webster & Frankland, op.cit., Vol.4, Appendix 8, p.135
Bomber Command was a force for the future. Its operations were planned with conservation and ultimate expansion always in mind. But consider the crew position in Bomber Command at the beginning of March 1941 compared with what it had been in September 1940. On 1 September 1940 the establishment, that is the planned number of crews for which there were aircraft, equipment and accommodation, was 760. In fact on that date there were 580 operationally fit crews. Six months later, while the establishment had increased to 860 crews, there were only 489 operationally fit crews available.\footnote{Wider employment and non-expanding resources had, in fact, resulted in significant contraction.}

Portal, in July 1940, as head of Bomber Command, had objected to the use of his bomber force in purely defensive roles. He saw it as an offensive weapon. He believed it to be capable of dislocating German heavy industry, lowering enemy morale and disturbing the German peoples' belief in the National Socialist system. In doing so he overlooked not only the inadequate size of Bomber Command but also its operational limitations. Neither had there, to this stage, been an adequate assessment of actual bombing results. However, in the main, his objections had been largely ignored until both the air and invasion threats had been reduced, or removed, either by other concerns or the approach of winter. Portal's promotion to C.A.S. in October 1940 ensured that offensive operations, in the form of area attacks against selected German cities, finally began. Events in Norway, the Battle of France, the Battle of Britain, rapidly changing situations and as quickly changed orders from the Air Staff, all may have been reminders to Portal to adopt a more 'hands-off' approach to the operations of Bomber Command during his tenure as C.A.S.\footnote{Perhaps his enthusiasm for offensive operations did, in the long term, cloud his judgement. His later failure to adequately curb or control Harris, who appeared to want to run a 'one-man' war, may in any final analysis, count against him.}

At this stage it is pertinent to consider, in broader terms, the state that Bomber Command had reached by June 1941. Basically it was still a force for the future. Neither the planned expansion nor the major re-equipment with larger four-engined heavy bombers had as yet taken place. Stirlings, Manchesters, Halifaxes and American Fortresses had been added to the bomber force, but only in very limited numbers. Their successes, were still largely in the future. Crews continued to claim significant accuracy for their bombing but evidence was accumulating that targets whose destruction had been claimed were, in fact, still in production. Neither had there

\footnote{Panter, \textit{op.cit.}, Vol.2, p.147}

been, apart from the recent 'fire-raising' efforts, any significant change in operational tactics or techniques. There was also the growing realisation that pre-war expectations of damage, both material and moral, to be expected from particular sizes and numbers of bombs, had been grossly exaggerated. Finally, Bomber Command navigators were still trying to find their way to often distant targets with the same inadequate aids and techniques they had used since September 1939.

On the wider strategic scene, after June 1941, Britain's lonesome struggle against Germany had ended. Russia was now involved and although the final outcome was still very much in doubt, in the meantime, the German army and airforce were fully occupied on their Eastern Front. This expansion of the war would also entail disadvantages in the long term, but at least for a time, Bomber Command could now appear in a supporting, rather than a leading, role.

As was (and still is) usual, there were always teething problems when new aircraft were introduced into service. Especially was this true under war-time conditions when time is a vital consideration. The first Stirling squadron had been formed in August 1940 but it did not carry out an operational sortie until February 1941. Initially the Stirling had been fitted with non-supercharged Hercules engines which meant the aircraft could not operate above 10,000 feet. By January 1941 a later mark of Hercules engine had been fitted and, although operating altitudes were still considered to be undesirably low, the small numbers of aircraft available to Bomber Command meant that they had to be used. Stirlings also had problems with their tail wheel assembly but this was solved, not entirely satisfactorily, by imposing a maximum operating weight limitation.

Avro Manchesters entered squadron service in November 1940 and were first used on operations late in February 1941. They provide the classic example of an aircraft allocated to operational squadrons before either engines or airframe had been fully proven. The urgent need was for another heavy bomber to supplement the Wellingsons and Whites to increase the bomb tonnages dropped on German targets. The hope was that any modifications required, identified under combat conditions, would simply be refinements and would not require the aircraft to be taken from the front-line for them to be completed. In essence the Manchester was a stop-gap measure.51

50 F.C. Roberts, The R.A.F. in the Bombing Offensive against Germany
   (London: Air Ministry, no date), Vol.3, p.4

51 Francis K. Mason, The Avro Lancaster
Contrary to popular belief the Lancaster did not, phoenix-like, arise from the ashes of the Manchester. They were conceived in tandem. Aware that designers in both Handley Page and Shorts were preparing aircraft with greater weight lifting and range performance than the Manchester, Roy Chadwick, as early as 1938, was considering the possibility of fitting four engines to the Avro Type 679. Thus the aircraft subsequently called the Lancaster was being considered at least two years before the Manchester was accepted by the R.A.F. Manchester flew their last operations in June 1942 after cures had not been found for their proneness to engine failure and subsequent fire.

Halifax squadrons, formed in November 1940, commenced operations in March 1941 but were not fully effective until June of the same year. A tail wheel problem followed by hydraulic troubles and cabin over-heating, all caused delays to their becoming fully operational.

At this point mention must be made of the Boeing Flying Fortress - the B-17 in various configurations - which entered front-line service for Bomber Command on 8 July 1941. The version used initially in Bomber Command was identified by the Americans as the B-17C but was known in the R.A.F. as the Fortress I. Derivation of the name Flying Fortress is often ascribed to its supposed invulnerability but, in fact, the aircraft was originally designed as a defensive weapon - a form of highly mobile, long-range artillery. Acceptance by the American military tacticians of the theories of Douhet - the practicability of daylight, precision bombing - entailed the change from a defensive to an offensive role. Results achieved by the Fortress I in R.A.F. hands, however, were less than satisfactory and it was removed from operations after 25 September 1941. Later versions of the Flying Fortress, the Fortress IIA or B-17E, also entered R.A.F. service but only in Coastal Command squadrons and they helped to close the 'gap' in mid-Atlantic which hitherto had provided rich and easy pickings for German U-boats. Finally, in February 1944, the Fortress III, or B-17G, joined Bomber Command in 100 Group and was widely and successfully employed on electronic countermeasure activities.

By 25 September 1941 the Fortress I had carried out only 51 operational sorties less than half of which were claimed to be effective, and had dropped less than 50 tons of bombs. It also had entered front-line service with too little known about its performance when operating at maximum altitude. Bombing accuracy was reliant on the human element above 20,000 feet because the much vaunted Sperry automatic bomb-sight was not designed for operation above that altitude. Its armament

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Mason, op.cit., p.57

Thetford, op.cit., pp.106-9

Roberts, op.cit., p.18
Avro Manchester

Boeing Flying Fortress

R.N.Z.A.F. Museum
Wigram
was heavy, manually-operated machine guns and conditions for
the beam gunners, exposed to outside air temperatures of minus
50 degrees Centigrade, were appalling. These shortcomings,
coupled with the fact that its engines were prone to failure
when operating at maximum altitude, and that the air/mix
oxygen system could render crew members anoxic at altitudes
approaching 40,000 feet, meant that the Fortress was
considered unsatisfactory.

The failure of the Fortress I in R.A.F. hands naturally
was of considerable concern to the American authorities
because heavy bombers had been accorded a high priority in
their military build-up and their doctrines were based on the
efficacy of daylight, precision bombing operations. They
believed that the aircraft had been foisted on an unwilling
R.A.F. by the British Government for political advantage.
They also considered that crew training in the R.A.F. had been
inadequate, particularly with regard to the Norden bomb sight,
and that operational limitations had been grossly exceeded by
R.A.F. crews in respect of operating weights and altitudes.
For their part the R.A.F. authorities noted the mechanical
failures, limited defensive armament, lack of success, and
casualties. The R.A.F. experience did not radically alter
American opinion but it did mean that the B-17E, when it
commenced operations in the European theatre, was a better and
more efficient aircraft than it otherwise would have been.

In June 1941 Bomber Command was still basically a 33
squadron, medium bomber force. There were only two Halifax,
two Stirling and three Manchester squadrons operational plus
one Fortress squadron, non-operational. They were the total
of the new so-called heavy bomber force. Consequently it
could only be considered a force of limited capability.

For operations between June and August 1941 when
reasonable weather conditions could be anticipated – although
the hours of darkness were reduced – the numbers of heavy and
medium bombers actually available with crews for operations
averaged just under 400. This figure of course compared very
unfavourably with the establishment for 700 bombers with
crews. There were many valid reasons. Heavy bombers with
trained crews remained in short supply. Then, not all the
crews on squadrons were fit for operations. Leave, sickness,
ferny pilot duties, and the need for squadron training,
reduced the numbers available for operations. On average,
only 60 per cent of the establishment of crews on a squadron
were available for operations at a particular time. It was
impossible to increase the establishment because this required

Roberts, op. cit., p.17

W.F. Craven & J.L. Cate (eds.), The Army Air Forces in
World War II
(Chicago: University of Chicago Press, 1964), Vol.1,
pp. 600 - 604

Roberts, op. cit., p.2
an increased output from the training units already working at full capacity. There was also the problem of aircraft serviceability which only averaged 65 per cent. Interchange of surplus crews from one squadron to surplus aircraft on another, was operationally and administratively impossible, so that the initial establishment of 700 was, in fact, a distortion.

There were other worries. Because O.T.U. courses had been reduced, squadrons were having to provide a considerable proportion of their flying hours for advanced training to bring freshmen crews up to operational standard. Also, despite the fact that German night fighters did not as yet provide a significant threat, losses on operations were already exceeding the calculated wastage rate on which the training programmes were based. Squadron experience and with it, efficiency, was being diluted. Finally, each month, no less than 30 medium bomber and 30 light bomber crews were required as reinforcements for squadrons based in the Middle East.  

By June 1941 the war had been in progress for 21 months. Progress on the actual provision of navigation aids to assist the bomber crews to reach the approximate area of their targets had been nil. Fortunately, research and development was taking place at the Telecommunications Research Establishment.

On 6 October 1939 Air Commodore Bottomley, then Senior Air Staff Officer at Bomber Command Headquarters, addressed a paper to Ludlow-Hewitt. His recommendation was that Bomber Command crews would be 'well advised to concentrate on astro-navigation and D/F positioning as the main aid (sic) to night bombing or rather position finding at night'.  

The Navigation Officer at Bomber Command Headquarters, Wing Commander Ivelaw-Chapman, pointed out that using astro and radio position lines would at best only 'give a pilot ... his target area'.  

Bomber crews at the beginning of the war were thus heavily reliant on an aid, astro, with which they were barely trained and in which they lacked confidence or, radio aids, which were notoriously unreliable at night and subject to interference either by weather or a technically competent enemy.

Despite these apparent handicaps, Harris, as a Group Commander, on 1 July 1940, was able to confidently report to Bomber Command that 'the standard of navigation achieved has improved considerably as crews have gained experience, and the

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Roberts *op. cit.*, pp.27-8


Ibid., p.210
majority of aircraft can be expected to arrive within a few miles of their objective on D.R. and W/T'. Another Group Commander, Coningham, was no less sanguine. 'Navigation,' he reported, 'has reached a high standard, and with the assistance of loop bearings, crews are enabled to navigate accurately to the neighbourhood of their targets.'

By 29 December 1940 Coningham had somewhat changed his stance. Pre-empting the establishment of the Pathfinder Force, he praised the German bombing achievements using specially selected crews and fire raising tactics. Bomber Command, he suggested, 'could do equally well, and better, if we pick our best units and specialise on similar lines'. But now he rejected D/F as a reliable aid to navigation. Astro, he also now conceded, could only be used by a limited number of crews, weather permitting. Indicative perhaps of his awareness that the Germans had made use of radio beams in their most successful attacks, he concluded that, 'something more definite is required'. Earlier in 1940 he had suggested that timed runs from an identified landmark to an obscured target would result in bombing 'as accurate as if the target itself were visible'. Exercises to test the theory had not supported his suggestion. Off-set bombing - as a variation of this tactic came to be called - would later be used but not with either startling or consistent success.

Operationally, in fact, the method had been tried in June 1940. More than twelve Whitleys crossed the North Sea from Spurn Head guided by the fires burning in Rotterdam. From Rotterdam the group was to do a time and distance run of approximately 35 miles to a reported German troop concentration. At the end of the run each aircraft was to drop a flare and fire a red Very light. Despite the fact that the experiment had started at an excellent pin point, was conducted in good flying conditions and had encountered no opposition, no aircraft of the formation could report having sighted any other aircraft’s flares or Very lights.

On the following night, using only four aircraft and with the aircraft compasses having been re-swung and the air speed indicators recalibrated, the experiment was repeated. This time it was successful. Four flares and four Very lights were

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61 Webster & Frankland, op.cit., Vol.1, p.217
62 Ibid., p.217
63 Ibid., p.227
64 Ibid., p.227
65 Ibid., p.209
seen and the target finally identified. It was clear that the system could only be employed by the best crews and required precise flying. Even then the tactic only brought crews to the target area. This was satisfactory for area bombing but less than satisfactory for attacks on precision targets.

Group Captain T.G. Mahaddie's assessment of his bomber operations in 1940 (he had been involved as a sergeant - pilot in the time and distance trial), was that they had been 'a complete and utter waste of time... I am quite certain we never got anywhere near anything that looked like a target'.

His views are very relevant because he had completed two operational tours with Bomber Command - one in the P.P.F. on Stirlings - before being posted to P.P.F. Headquarters as the recruitment officer. In typical Mahaddie fashion he describes himself as 'Bennett's horse-thief'.

Navigational inaccuracies were the root cause of poor bombing results. Yet the navigators were not necessarily at fault. They did the best they could with no aids and under difficult conditions. As late as June 1941 navigation over the European Continent was by D.R. supplemented when possible by pinpoints. It also must be remembered that at this stage of the war bombing aircraft did not carry a specialist bomb aimer. When the ground became visible the navigator was advised. He moved to a position in the aircraft where he would then try to relate what he could see on the ground with what was shown on a topographical map. Later, on the four engined aircraft with specialist bomb aimers, they kept a continuous watch for pinpoints and relayed them to the navigator.

Bombers, in 1941, operated on routes and at timings determined by the individual crews. With weather frequently preventing either pinpoints being obtained or targets identified, many bomb releases were made purely on the estimated time of arrival (E.T.A.) at the target. Accepting the cumulative error of D.R. navigation as being 30 miles per hour flown since the last fix or pinpoint, then bombers after two hours were only somewhere within a 60 mile circle of their planned target. Errors in war-time D.R. with the requirement for weaving, evasion, changes of altitude and airspeed, and the fact that the pilot was not always able to concentrate totally on his instruments, could well have meant that the 30 mile per hour DR error figure was somewhat conservative. It should have occasioned no surprise that most bombs (after cameras had been fitted) were unplantable. Vast numbers simply helped plough up the German countryside. Proof of the navigational difficulties were the large numbers of bombers attempting, after raids, to return to their bases.

67 Mahaddie, op. cit., p.38
68 Ibid., p.96
69 Anderson, op.cit., p.243
While perhaps not ready to admit they were lost, all too frequently they were very much unaware of their exact position.

By June 1941, despite the lack of significant success for the bombing campaign, many valuable lessons had been learned. Perhaps the first was that targets could only be attacked if the bombers could proceed to them and return to base under cover of darkness. This meant that targets at extreme range could not be attacked during the short summer nights. As a corollary, this meant that consideration had to be given as to whether or not a target, although appearing tactically or strategically desirable, should be attacked, bearing in mind that it could be given long months to effect repairs. The best targets were those which could be bombed whenever it was considered necessary without the dictates imposed by the season.

There was also now an appreciation of the need for concentration of the bombing effort. Reduction in the time that the bombers would spend in any particular target area would be a later refinement of tactics. Too many targets had been attacked in the earlier months by too small a bomber force. Until considerably greater expansion of Bomber Command had taken place target selection had to be more carefully made from a narrower range of targets. Economic and industrial considerations had to be taken into greater account, as well as the purely military requirements. It was also desirable that targets that were attacked were in built-up areas so that bombs that either fell short or over-shot the target, still had both a material and morale effect. If the targets chosen were ones requiring some form of precision attack on moonlight nights then they had to be of sufficient, identifiable size so that the possibility of creating significant damage existed. Pinpoint targets were not, as yet, a viable proposition. Finally, target selections had to be made with alternatives in mind for those frequent occasions when weather conditions prevented attacks on the primary.\(^70\)

All that was needed, some now believed, in order that the German war potential could be destroyed, was expansion of the bomber force, improved aids to navigation and an elite force capable of leading their less experienced brethren to the target area and defining for them the targets they were to attack.\(^71\)

Expansion and the re-equipment of the bomber force had, by June 1941, become both the short and long term aims. The immediate aim was to attain an 85 squadron bomber force by December 1941. Known as Target Force 'A' it was to comprise 75 medium and heavy bomber squadrons, each of sixteen aircraft


\(^71\) Panter, op.cit., Vol.2, pp.149-150
plus reserves, and ten light bomber squadrons. By mid-1942 it was planned that Target Force 'C', consisting of 100 medium and heavy squadrons of which half would be heavy bombers, would be available for operations.

These comparatively modest expansionary plans were overwhelmed, in June 1941, by the figures contained in a document, the 'Future Strategy Paper'. Produced on the insistence of Churchill, this futuristic paper envisaged a force, Target Force 'E', of no less than 4000 heavy bombers by the spring of 1943. This review was not, of course, a blueprint for how such an expansion was to take place. Its importance at this juncture of the war was that it confirmed the pre-eminent position held by Bomber Command in Britain's armed services. It re-emphasised the fact that a preliminary and extended bombing offensive was considered the prerequisite to any actions aimed at Germany's collapse. Bomber force expansion plans were not to be prejudiced by the attempted build up of other forces whose actions were dependent upon a successful bombing campaign.

After wastage - losses in action and accidents - had been allowed for, to meet the requirements of Target Force 'E' meant that no less than 22,000 heavy and medium bombers would have to be obtained between July 1941 and July 1943. American production it was expected would only provide for 5,500 aircraft in this period which left a deficit of 16,500. Ministry of Aircraft production estimates for bombers in the two year period were for 11,000 aircraft. This optimistic figure required that the 'tail of the production curve be lifted'. By this subterfuge the initial production shortfalls were added to later programmes so that as time passed the tail became not only considerably higher but also impossibly longer. Shortages of tools, labour and raw materials in British factories, conjoined with bomb damage created by German bombers, aircraft engine shortages and production bottlenecks, always meant that the 16,500 figure was never within reach. America's entry into the war in December 1941 reduced by 40 per cent the numbers of aircraft being built for use by the R.A.F. Even in 1941, between April and July, when 642 American bombers had been expected, only 69 had been received.

Target Force 'E' was an unattainable concept. Its failure had important consequences. When difficulties were experienced contingency plans were adopted to maintain

\[72\] Roberts, op.cit., p.51

\[73\] M.M. Postan, British War Production (London: H.M.S.O., 1952), p.124

\[74\] Ibid., p.242

\[75\] Gwyer & Butler, op.cit., p.29
productivity as high as possible. This meant that the production of those aircraft which required larger amounts of scarce materials and increased man-hours in construction, was diluted. Instead of Stirlings, Halifaxes, Manchesters and later Lancasters, Bomber Command would receive increased numbers of Wellingsons, already identified as at least obsolescent. Inadequate production figures for heavy bombers in particular, coupled with the Butt Report of 18 August 1941, may well have been the vital ingredients involved in raising doubts in the minds of those responsible for the war's higher strategy. Was a new direction and emphasis required?

Acceptance, albeit reluctant, of the Butt Report marked yet another significant development in the bomber war. Although few were yet prepared to admit it, the oil offensive had failed simply because bombs had not hit their targets. Photographic evidence, admittedly insubstantial through lack of aircraft cameras, had been rejected in favour of crew reports based on optimistic assessments made under stressful conditions. Crew evidence was accepted because it was what the bombing enthusiasts had not only hoped for but also expected. Reports of the destruction of oil installations were simply confirmation of an achievement for which few doubts had been entertained.

Failure of the oil offensive can be blamed on two elements. Firstly, Bomber Command lacked the strength and the equipment to achieve the aim. Secondly, the weather factor, while not necessarily providing extreme conditions for operations, nevertheless provided situations of cloud, thunderstorms, icing, poor visibility and unforecast winds for which crews had neither been trained nor had had time to gain the experience necessary to be able to cope. Poor weather training, in rushed conditions by day, did not provide the expertise necessary to handle European winter flying conditions by night. Additionally, perhaps the assumptions made, that oil was a super-critical element in the German economy and that it could be destroyed by bombing, were both at fault. The clinching argument for ending the first oil offensive was provided when it was finally accepted that night bombing errors were in no way related to any 300 yard average. Mathematical calculations of damage done, using this figure as the basis, were rendered useless.

In retrospect, two photographs can be identified as providing justification for ending not only the oil offensive but also the attempts to carry out precision bombing by night at this stage of the war. Both were taken on 24 December 1940 and clearly showed that the two oil plants at Gelsenkirchen were working and that, apparently, they were undamaged. The photographic interpretation report was damning. It said that 'there was no sign of any important repairs having been carried out and few bomb craters could be seen in the vicinity. It was obvious that the majority of the
crews of the 196 aircraft which claimed to have attacked these targets had been mistaken and that the greater part of the 260 tons of bombs, excluding incendiaries, which they had reported as having fallen on them, had not done so, and, on the contrary, had missed by an immeasurable distance. But photographic reconnaissance and photos taken at bomb fall, had as yet still to establish their full authority.

The photographs of Schelven and Gelsenkirchen were of course taken during the day by a Photographic Reconnaissance Unit (P.R.U.) Spitfire. They clearly showed the actual condition of the plants but they did not reveal why the plants were undamaged, apart from the obvious fact that the bombs had missed. What was needed were photographs taken at the time of bomb fall to compare the position at which the navigator believed his aircraft to be, with his actual position. Such analysis would be of little practical value if bombing errors were only a matter of hundreds of yards. Should the errors be in the order of miles however, the photographs would be of considerable worth. Mr. D.M.B. Butt of the War Cabinet secretariat was, in August 1941, invited to carry out an investigation of recently taken bombing photographs.

Issued on 18 August 1941, the Butt Report was an assessment of approximately 650 photographs taken during night bombing operations from 2 June 1941 until 25 July 1941. Twenty eight targets were considered, on forty-eight different nights and in one hundred separate raids. Butt assumed that the target area was a circle, radius five miles and centred on the actual target. Of the 633 photographs examined, 113 or 18 per cent were measurably outside the target area, 194 or 31 per cent were within the target area, while the remaining 326 or 51 per cent were unplottable. On the basis that his photographic interpreters (who worked at Bomber Command) were competent, it was assumed that the unplottable group were also located outside the target area.

The reality of the situation revealed by the Butt Report, bad as it was, was even worse than these figures may have at first indicated. Apparently 31 per cent of the aircraft had been within the target area when their bombs were released. It must be recalled, however, that only 66 per cent of aircraft despatched on a raid actually claimed to have attacked their targets. This meant that during the short period under review, when 6,103 bombers had been despatched and when 4,065 had claimed to have identified and attacked their targets, only approximately 1,200 had in fact done so.

76 Webster & Frankland, op.cit., Vol.1, p.228
77 Frankland, The Planning of the Bombing Offensive and Its Contribution to German Collapse, p.61
78 Ibid., p.61
79 Ibid., p.62
These 1,200 aircraft then spread their bombs somewhere within a 75 square mile circle.

There were other further depressing implications emanating from the Butt Report. Target location, weather and enemy defences all played significant parts in whether or not the bomber reached its briefed area. Targets situated on or near the coast, such as the French Channel ports or Hamburg, were the easiest to locate. Butt estimated that at least two thirds of the bombers claiming to have attacked were, in this situation, within five miles. Over the Ruhr, where cloud, industrial haze and improving defences thwarted the bombers, the proportion of bombers within the target area reduced to one-tenth. The absence or presence of moonlight, provided the ground could be seen, also made a difference. In no moon conditions only one-fifteenth of the aircraft claiming to have attacked were within the five mile circle. When a full moon was available two-fifths of the bombers were within the target areas. Again, it must be stressed that these proportions are only applicable to those aircrew actually claiming to have bombed their particular target.

Butt, naturally, while accepting his report was not necessarily infallible, was prepared to justify his assessments. His claims were less acceptable to Bomber Command leaders in general and the upper echelons of the R.A.F. in particular. Portal, while he considered the figures could be 'wide of the mark', agreed with Lord Cherwell who had informed Churchill that 'however inaccurate the figures may be, they are sufficiently striking to emphasise the supreme importance of improving our navigational methods'. Peirse found the figures hard to believe. 'I don't think at this rate,' he wrote, 'we could have hoped to produce the damage which is known to have been achieved'. His use of the word 'known' is interesting. It leaves no room for discussion. Who or what were his sources? It was patently obvious that they were grossly in error. Air Vice-Marshal Saundby, (S.A.S.O.) at Bomber Command Headquarters stressed the unfavourable weather experienced during June and July and suggested that a ten per cent sample was an inadequate basis on which to judge overall performance.

Saundby's suggestion to explain the poor results, that squadron commanders gave the limited number of cameras available to their most inexperienced crews, was later refuted by Harris. In his despatch written at the end of the war he discussed the analysis of 147 raids between August 1941 and

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80 Webster & Frankland, op.cit., Vol.1, p.178
81 Ibid., p.180
82 Ibid., p.179
83 Ibid., p.179
March 1942. 'On the average' he wrote, '68 per cent of the
sorties despatched claimed to have attacked the primary
target, of which it was estimated that 30 per cent had
actually dropped their bombs within 3 miles of the aiming
point ... this figure ... is based ... on ... night
photographs and, as ... few cameras were available ... there
was strong tendency for the squadrons to allocate these to
their best crews'.

Butt's analysis had confirmed the correctness of the
decision to abandon night precision bombing. It also
attracted the serious attention of the planners to the
compelling need for accurate aids to navigation if bombing was
to be successful. Another important consequence was that the
long overdue Operational Research Section (O.R.S.) of Bomber
Command was finally established. Its task was to study bomber
operations and attempt to improve the efficiency of the
command 'in terms of bombs on the target per aircraft lost'.

Harris was well aware of the value of the O.R.S. 'Without
the O.R.S.' he wrote, 'many problems would have remained
insoluble, and others would have been solved only after trials
and errors extravagant not only in terms of time and effort
but also in lives of our aircrew'. Even with the O.R.S.
the lives of aircrew members of Bomber Command were not noted
for their longevity.

Bomber Command ended 1941 on a very low note indeed.
Heavy losses in widespread raids during August had occasioned
concern in the War Cabinet. On 29 August 1941 Churchill wrote
to the C.A.S. requesting 'Action this Day'. There were two
worries - heavy losses and the non-expansion of the bomber
force. 'The losses in our bombers have been very heavy this
month', he wrote 'and Bomber Command is not expanding as was
hoped. While I greatly admire the bravery of the pilots, I
do not want them pressed too hard. Easier targets giving a
high damage return compared with casualties may more often be
selected'.

Conservation was again the watchword. Confirmation of
the need was provided by the heavy bomber losses on 7/8
November 1941 when, in widespread raids on Berlin, Mannheim
and the Ruhr, 37 aircraft from a force of 400 were lost. The
Bombing Directive of 13 November 1941 was explicit. Bombers
were not to be exposed either to 'unfavourable weather' or
'extreme hazard'. Continuing, the Directive said that the

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Sir Arthur T. Harris, *Despatch on War Operations*
23rd February 1942 to 8 May, 1945
(London: Air Ministry, October 1945), p.75

Air Ministry, *The Origins & Development of Operational
Research in the Royal Air Force*, p.44

Ibid., p.43

Churchill, *The Grand Alliance*, p.635
War Cabinet 'have stressed the necessity for conserving our resources in order to build a strong force to be available by the spring of next year'. So 1941 ended as it had begun for Bomber Command with most night operations being directed against German heavy naval units in Brest Harbour. There had been an advance in technology however, and during these raids in December 1941 a beam called 'Trinity', a fore-runner of Oboe, was used, although without spectacular success. According to Alfred Price 'it might have used a Lorenz beam for direction and it employed normal radar techniques to measure range'.

As the winter of 1941/42 approached it was time for further reassessment of Bomber Command's achievements and prospects. What had been the positive results of the bombing experiments? There were few claims that could be made that were able to stand up to close scrutiny. German oil production had been largely unimpeded and with the resources now available from captured territories, the target was largely irrelevant. German transportation systems, despite the number of attacks delivered against them, experienced few even short term interruptions. Repairs were quickly completed and alternative routings were normally available. Civilians in Britain may have been greatly encouraged by the claims of bombing successes but there was no acceptable evidence that German morale had declined. With America now involved in the war, expansion plans for Bomber Command had received another set-back. Would Bomber Command continue to receive the same degree of support from the War Cabinet that it had previously enjoyed? Could it show that it still had a positive contribution to make in the defeat of Germany? Or was it to be allowed to run down, to only play a minor part?

Naturally the Air Staff were in no doubt. Bomber Command with a larger force of heavy bombers and improved navigational aids would lead the way to victory by shattering German morale with concentrated area attacks on her major cities. Others were less certain. Alternative means of attacking Germany had now presented themselves. Extension of the war, however, also brought problems in addition to the slowing down of Bomber Command's expansion. Assistance to Russia and reinforcements to both the Middle and the Far East all demanded attention. But where once the only possible response to the question as to how the war could be won was, by bombing, other possibilities were now presented.

Evidence of growing political and public concern as to the employment of Bomber Command can also be adduced. Sir Stafford Cripps, newly appointed Lord Privy Seal in the revised Cabinet, voiced these anxieties on 25 February 1942 in a speech in the House of Commons. 'Members have questioned whether', he said, 'in the existing circumstances, the continued devotion of a considerable part of our effort to the

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Webster & Frankland, op.cit., Vol. 4, p.142

Alfred Price, Letter to the Author, 1 July 1991
building up of this bombing force is the best use we can make of our resources ... the Government are fully aware of the other uses to which our resources could be put, and the moment they arrive at a decision that the circumstances warrant a change, a change in policy will be made.\textsuperscript{90}

Naval critics were also in evidence. On 20 March 1942, Sir Dudley Pound (the First Sea Lord) questioned the bombing of Germany. 'Are we sure that this is the best way of using our increasing strength in this arm? Is it right to employ a very large proportion of our heavy bombers doing to Germany this year little more than they did to us last year with such inconclusive results?'\textsuperscript{91} Air Staff and Bomber Command opposition to diversions from what they saw as their appropriate role, bombing German cities, caused Terraine to write that 'it is at times difficult to decide whether it is more correct to say that Bomber Command was irrelevant to the war, or that the war was irrelevant to Bomber Command'.\textsuperscript{92}

Largely, however, the words of Cripps and Pound were rear-guard actions although controversy regarding the employment of Bomber Command was never completely extinguished. A memorandum, in January 1942 issued by the American and British Chief of Staff after the Washington Conference, had identified Germany as the principal enemy. Germany's defeat was the primary aim and her war effort was to be eroded by strategic bombing. Bomber Command received its new Bombing Directive on 14 February 1942. However, the fact that it was sanctioned by Churchill should not be misconstrued. Approval for the Directive to be issued did not necessarily imply that the Government was committed to any specific bombing policy.\textsuperscript{93}

For their part the Air Staff were in no doubt. They believed that the conservation period had ended. Churchill had implied as much when, on 14 February 1942, he had declared he was 'entirely in favour of the resumption of full bombing of Germany'.\textsuperscript{94} Sir Archibald Sinclair, Secretary of State for Air, wasted no time in confirming the imminent recommencement of offensive, rather than defensive, bomber operations. Addressing the House of Commons on 4 March 1942 he said that it was intended 'to resume the bomber offensive against Germany on the largest possible scale at the earliest possible moment'.\textsuperscript{95} Lord Cherwell's intervention on 30 March

\textsuperscript{90} Webster & Frankland, \textit{op.cit.}, Vol.1, pp.328-9

\textsuperscript{91} \textit{Ibid.}, p.330, note 1.

\textsuperscript{92} John Terraine, \textit{Business in Great Waters} (London: Leo Cooper, 1989), p.355

\textsuperscript{93} Webster & Frankland, \textit{op.cit.}, Vol.1, p.330, note 2

\textsuperscript{94} \textit{Ibid.}, p.322

\textsuperscript{95} \textit{Ibid.}, p.330
1942 was possibly crucial. In a mathematically based summation he produced figures purporting to show that a specific bombing effort 'would break the spirit of the [German] people'. In Churchill's words Cherwell provided 'a design and theme for bringing the war to a victorious end in a reasonable period'.

To maintain its primacy, Bomber Command in 1942 needed to be able to conclusively demonstrate a new-found effectiveness. Although strategic bombing was no longer solely a British concern, the addition of American aircraft flown by American crews, added a new dimension to the strategic bombing offensive. The Bombing Directive of 14 February 1942 appeared explicit. Bomber Command was told that the 'primary object of your operations should now be focused on the morale of the enemy civil population and in particular, of the industrial workers'. Portal went to some lengths to make clear that the aiming points for industrial targets were not the docks or factories in the cities, but were to be the built up areas.

Despite its apparent clarity the Directive was, in point of fact, somewhat ambiguous. Morale had been identified as the primary target. But the target list also included Schweinfurt where, it was believed, most of Germany’s ball-bearings were manufactured. Did this mean that precision targets, which Schweinfurt was, were to be destroyed by area attacks? Or were precision attacks to be renewed? At one place the Directive spoke of the time in the future when, with the aid of Gee, believed to be both a navigation and a bombing aid, and due to commence its operational career in conjunction with this latest Directive, 'effective attacks on precise targets are possible'. Finally, the inclusion of Lubeck in the target list implied that cities could well be attacked, not because their destruction would necessarily effect either morale or cause industrial dislocation, but simply because they were assessed as being operationally susceptible.

Stage settings had been completed. Bomber Command, released from the shackles imposed by conservation, had a new Bombing Directive. It also had a new aid which, it was believed, would add a new dimension to both navigational and bombing accuracy. Lastly from 22 February 1942 Bomber Command had a new leader. Air Chief Marshal Sir Arthur Harris was now in charge.

96 Webster & Frankland, op.cit., Vol.1, p.332
97 Ibid., pp.335-6
98 Ibid., Vol.4, p.144
99 Ibid., Vol.1, p.324
100 Ibid., Vol.4, p.145
12. **Bomber Command at War:**

1942, The Year of Experimentation

Bomber Command's direction in the Second World War was, until the end of 1941, dominated by two considerations - expansion and conservation. If only two words were permitted to describe developments in the bomber force during 1942 then expansion would have to be reconfirmed but the second word would undeniably be 'experimentation'. Because of the urgent need to provide visible support for the hard-pressed Russian forces an early resumption of the strategic bomber offensive became imperative. Precision bombing had failed and new untried techniques had to be attempted.

Enemy civilian morale became the primary target. Specifically, the morale of the industrial work force was to be reduced by area attacks not aimed at particular factory groupings but at industrial areas in a vast range of selected German cities. Attacks seeking concentration of effort and utilising new tactics and improved bombing methods were to replace widespread raids using minimal force which had created little physical damage and no detectable lowering of German morale. Individualism was to be replaced by collective effort.

In order to achieve the new aim Bomber Command had to be able to visualise itself as a cohesive whole and not merely the sum of its parts. The principle of concentration, it was hoped, would provide not only increased security for the individual bomber crew in the face of improving German defences, but would also enhance the chances for increased destruction. Concentration made its own demands. New leaders, tactics, navigation and bombing aids, and a reassessed bombing philosophy, were all urgent requirements. Bomber Command had to be able to see itself as a force capable of achieving its aim rather than a collection of individuals loosely grouped in squadrons still trying to prove their worth.

Attention in this section will initially focus on decisions made at the Washington Conference in January 1942 and their effects on the strategic bombing offensive. Next, it is necessary to consider the significance of the appointment of Harris, in February 1942, as head of Bomber Command. Bomber Command's raison d'etre had been its planned capacity to deliver a knock-out blow. Increasingly, however, its leaders had raised their doubts concerning the capabilities of the force they commanded. Ludlow-Hewitt, as early as 1937, had criticised the displayed inadequacies in both navigation and air gunnery. After the outbreak of war he called for a reconsideration of the Ruhr Plan because he believed it would fail and that the resulting heavy losses would be disastrous to future expansion plans. He was
replaced, as head of Bomber Command in April 1940, by an interim commander, Air Marshal Sir Charles Portal. Ludlow-Hewitt's pessimism (or was it realism?) was superseded by the Trenchardian - based optimism of Portal. Portal's tenure of office as head of Bomber Command, although it covered the Norwegian intervention and the German Blitzkrieg in France, was short-lived. In October 1940 Portal replaced Air Chief Marshal Sir Cyril Newall (about whose performance criticism had been growing) as Chief of the Air Staff. Peirse became the new leader of Bomber Command. His failure to recognise (or acknowledge) that increasing bomber losses were not being compensated by increased industrial damage or morale decline in Germany - finally revealed in the Butt Report - saw him supplanted by Harris in February 1942.

The appointment of Harris as head of Bomber Command inaugurated a new era for the bomber force. He was aware of its short-comings but he fervently believed in its potential. His task, he assumed, was to show the politicians that the costs in material and lives of an allied invasion of Europe, and an extended land campaign, could be avoided by the proper use of bombers. He sought to provide convincing demonstrations of the importance and capacity of air power.

Effective bombing required navigational aids to bring the aircraft accurately to the target vicinity and then equipment which would enable the selected target to be destroyed - even when it remained concealed by cloud. Therefore, at this juncture, it is convenient to re-examine TR. 1335, or Gee as it was called, which was the first significant navigational aid provided for Bomber Command in the Second World War. High hopes were also held that it would be a useful bombing aid but these aspirations were not fulfilled. Oboe, the first widely employed bombing system that provided accuracy even when the target was hidden, was first used operationally on 20/21 December 1942. Oboe together with H2S, the other significant bombing aid, but not used until January 1943, will both be described at the end of this section.

Bomber Command with a new leader and a new vision of its capabilities required new tactics and the 'Shaker' technique, employed against Essen on 8/9 March 1942, will be the next topic discussed in this section.

New aircraft were also an important addition to Bomber Command's strength in 1942 and the arrival of the Lancaster and the Mosquito play an important role in this narrative.

But there were other matters in 1942 which also demand our attention. The raid on Lübeck on the night of 28/29 March 1942, the Singleton Inquiry, and the importance and significance of the 1000-bomber raids, particularly that on Cologne on 30/31 May 1942, will all have to be considered.
Finally, in this section, we must examine the establishment of the Pathfinder Force (P.F.F.) despite the opposition provided by Harris. Arguments between Air Ministry and the head of Bomber Command had continued during 1942 over whether or not a specialist Target Finding Force was either necessary, or a practical solution of what had been an on-going problem. Photographic evidence had now shown that bombs were not being dropped on the briefed targets in sufficient numbers to create the desired amount of damage. Harris's last hope of resisting the formation of the P.F.F. disappeared when it was accepted that Gee was neither the accurate bombing aid that it was hoped it would be, nor was it expected that it would enjoy a long operational life free from effective German counter-measures. The comparative failure of Gee, despite its usefulness as a short range navigational and homing aid, together with the delayed production of Oboe and H2S, confirmed the urgent need for the establishment of a Target Finding Force. Harris, after virtually being forced to accept the establishment of a specialist force, then refused point blank to call it a Target Finding Force. Illustrative of his petulance, he rejected the name proposed by the Directorate of Bomber Operations and instead chose to call the corps d'élite the Pathfinder Force. Harris's resentment persisted as is evidenced by his own words in his final Despatch on War Operations.¹ He saw himself, a Commander in the field, as having been overruled by junior staff officers in the Air Ministry.² This, however, was a perennial complaint made by Harris and his attitude was made clear in his book Bomber Offensive. He regarded 'Commanders-in-Chief in the field as responsible people who were not to be bothered by the trumpety opinions of young Jacks-in-office who felt that they could blow themselves up with the full authority of the Air Council'.³ Harris ignored the fact that his juniors on the Air Staff could not order him to do anything; they could suggest, or they could attempt to influence his superiors to have him adopt a particular course of action, but only his superiors could command.

America's entry into the war in December 1941, signalled an end to the belief that a bomber offensive offered the only means of achieving victory. American man-power, supported by an enormous industrial base, now provided the prospect that an invasion of Europe could, at some time in the future, be contemplated. The Combined Chiefs of Staff had agreed, in January 1942, that an increasing strategic bombing offensive remained an important element of strategy. Other options however, were now available. In the long term the defeat of

¹ Harris, Despatch on War Operations, pp.10-11
² Ibid., p.11
³ Harris, Bomber Offensive, pp.49-50
German land forces now appeared as a distinct, even if distant, prospect. However in the minds of Harris, and to a lesser and reducing extent Churchill, Bomber Command, supported when possible by American air power, still appeared to offer the only direct means whereby the realities of war could be brought to bear directly and increasingly on the German people. In 1942 it was in fact the only way.

A major decision made at the Washington War Conference (code-named 'Arcadia') in December 1941 and January 1942, was that the defeat of Germany was to be the primary objective. Vital elements in the erosion of German power were the parts to be played by Bomber Command and the heavy bombers of the untried United States Army Air Force (U.S.A.A.F.). First, however, it was necessary to subdue the doubts that had arisen over the efficacy of the strategic bomber offensive. These had been raised by Sir Stafford Cripps on 25 February 1942 in a speech in the House of Commons. Claiming to speak for several Members, he had questioned whether the resources devoted to expanding the bomber force could be justified. One interpretation that could be put on this speech was that the British Government no longer saw Bomber Command's role as a corner-stone of long-term strategy, despite the reaffirmations just made at 'Arcadia'.

Sir Archibald Sinclair was not slow to respond. In a speech in the Commons on 4 March 1942 he spoke of the bomber offensive being resumed 'on the largest possible scale at the earliest possible moment'. His speech tallied with the inference drawn by the Air Staff on the Directive issued to Bomber Command on 14 February 1942. The Directive had appeared straightforward. Gee, the first navigational aid provided to Bomber Command in the Second World War, would, it was hoped, confer a new dimension on the bomber force. Both concentration and accuracy were expected to improve and the offensive was to be resumed 'at full effort'. It was the right time of the year for maximum effectiveness to be obtained from incendiary attacks and the resumption of bombing would greatly encourage the Russians.

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4 Gwyer & Butler, op.cit., Vol.3, Pt.2, p.523
5 Webster & Frankland, op.cit., Vol.1, pp.328-9
6 Ibid., Vol.1, p.330
7 TR. 1335
8 Webster & Frankland, op.cit., Vol.4, p.144
In combination, the renewal of the aerial offensive with further Russian success must, it was hoped, result in the lowering of German morale. 9

The entry of the United States of America into the war was a mixed blessing. In the long-term it helped confirm ultimate victory but in the short-term it provided significant disadvantages. Expansion plans for Bomber Command were thrown into serious disarray. Much reliance had been placed on American industry but President Roosevelt's decree, that it was desirable that whenever possible American aircraft should be flown by American crews, further disturbed growth plans already laid on unstable foundations. Crucially, would America continue to produce long range heavy bombers, to what purpose would they be employed, and would they be used in a day or night role? Cripps' speech, supported by direct observation in Germany from September 1939 until almost the end of 1941, strengthened American opinion, military and political, that a night offensive yielded few either positive or effective results.

Build up of the American strategic bombing force in the United Kingdom for operations against Germany was a protracted operation. Daylight operations had been the doctrine, confirmed during the 1930s, for the employment of the U.S.A.A.F. bombers in the event of war. It was believed that in the B-17 they had an aircraft capable of the task and that the Norden bombsight with which it was equipped would provide the necessary accuracy. Nothing that American observers had seen in either the war in China, or the civil war in Spain during the 1930s, had given any cause to consider it necessary to make doctrinal changes. At the same time it must be noted that as late as July 1937 the B-17 was only considered as 'the best bombardment aircraft in existence, particularly for coastal defence'. 10 This last phrase must be stressed because it is a strong indication that the latest and most powerful American bomber in their Air Force was, at that time, only regarded as an accurate and effective extension of the artillery arm. Even in 1939 U.S.A.A.F. aircraft were forbidden to fly more than 100 miles beyond the American coats.11 Orders were placed by the U.S.A.A.F. for twenty-nine B-17s to be delivered in 1938 and a further eleven in 1939. When, by September 1939, only thirteen B-17s had reached bomber units, for some in the Air Corps this was indicative of a reluctance in some quarters to accept the need for a long-range strategic bomber.12 Strategic bombing, as

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9 Webster & Frankland, op.cit., Vol.4, p.144
10 Craven & Cate (eds.), op.cit., Vol.1, p.68
11 Ibid., Vol.1, p.521
12 Ibid., Vol.1, pp.69-70
distinct from equipping with a long range bomber, was thus a comparatively late change in doctrine for the U.S.A.A.F.

Although it had been decided early in the planning stages that American bombers would operate, experimentally, by day, the first raid did not take place until 17 August 1942. Rouen-Sotteville railway marshalling yard in Northern France was the target and it was bombed by twelve, heavily escorted B-17s, without loss. This attack did not signal the commencement of a combined strategic bombing campaign but it was a first tentative step. R.A.F. leaders were frankly sceptical of the ability of the U.S.A.A.F. to conduct day operations although the Americans remained cautiously enthusiastic. This first raid proved nothing. But if the build up of the Eighth Air Force in England was slow, it must be recognised that there were many conflicting demands. An early invasion of North Africa, Operation Torch, was only one of the actions which required a diversion of effort. There were also those in America who saw Japanese expansionism and militarism in the Pacific area as posing the more immediate threat.\(^\text{13}\)

Churchill supported the American plan for a daylight offensive because he saw it as complementing Bomber Command's efforts. A daylight assault provided continuity.\(^\text{14}\) Portal, on the other hand, recognised potential dangers. He believed that if the Americans suffered severe losses in their day raids their solution would be to increase the size of the force involved. He feared that any ultimate realisation that day penetrations of German air space could not be made without incurring heavy losses, would come too late to permit the force to readily convert from a day to a night role. Over-concentration on day bombing, Portal believed, would mean that if the night offensive were to be joined by the U.S.A.A.F., it could not be achieved before early 1944.\(^\text{15}\) It was even suggested that the Americans should consider building Lancasters because of the fact that neither the B-17 Fortresses, nor the B-24 Liberators, were suited for night operations.

A combined strategic bomber offensive thus, even in August 1942, remained only a concept. But although there may have been differences of opinion over the particular

\(^{13}\) Craven & Cate (eds.), \textit{op.cit.}, Vol.2, p.211

\(^{14}\) Webster & Frankland, \textit{op.cit.}, Vol.1, p.355

\(^{15}\) \textit{Ibid.}, p.357
employment of British and American bombers, both Air Staffs accepted the independent nature of their commands. Bombers were weapons to be employed in direct and hurtful thrusts at the enemy's heart. Strategically, both Air Staffs thought alike - integration of effort was the problem to be resolved.

When Harris became head of Bomber Command on 23 February 1942, although Britain was no longer alone, the overall war outlook was depressing. Japanese forces were dominant in the Pacific while in North Africa, although the front had stabilised along the Gazala Line after yet another allied 'strategic' withdrawal, it had become painfully obvious that the German Army was superior to the British. In the war at sea German U-Boats were again gaining increasing successes in the Atlantic. Russia was staging a counter offensive but, at the same time, was increasing her calls for more aid and the opening of a second front to relieve the German pressure. Resources for the Allies were very thinly spread, demands increasing, and priorities difficult to determine.

Thus, on 23 February 1942, prospects for Bomber Command were not encouraging. Bombers had played a part in forestalling German invasion plans but had achieved little else of significance. Expansion plans had not been realised and suitable aircraft and the crews to fly them were still in critically short supply. In brief, when Harris assumed command at High Wycombe the future of the bomber force was in the balance. Failure of the pre-war theories of self-defending bomber attacks by day, compounded by the shortcomings revealed in the Butt Report, raised the prospect that Bomber Command could be used more in a support role for army and navy operations, rather than operate as an independent offensive force. In other words it would assume a tactical rather than a strategic function.

The Air Staff's solution of the dilemma facing Bomber Command was that precision bombing would be abandoned and replaced by area attacks. The Directive issued to Bomber Command on 14 February 1942 said it all. Full scale operations were to be resumed after the winter lull and eighteen German industrial cities were nominated for attack with the reduction of the morale of the industrial workers the primary objective. Harris's task, on assuming control, was the implementation of this Directive but he recognised the wider implications.

Alan Moorehead, African Trilogy
Bomber Command, Harris realised, was on trial for its very existence. He appreciated that his task was first to confirm the pre-eminence of role for the bomber force. But he also had a broader vision. Strategic bombing, he believed, could be a way to win the war without the need for a land campaign. He accepted his task with an enthusiasm and commitment from which he was rarely diverted either by heavy losses or the influence of higher authority. At the same time he was also well aware that determination shown either by himself or the bomber crews would, by itself, never be sufficient. What was needed were spectacular successes that would focus attention on Bomber Command. Its continuation as a major force demanded bold master-strokes. Harris was a believer in the efficacy of strategic bombing; he was also a master of legerdemain. These attributes, plus the support of Churchill until late in the war, confirmed the continued survival and pre-eminence of Bomber Command.

Harris inherited a command weak in numbers particularly in heavy bombers. Until the end of February 1942 the average number of Manchesters available for operations never exceeded 31, Stirlings never more than 21, and Halifaxes only 23. Bomber Command's needs were many. As well as the heavy bombers promised in numerous expansion programmes, it required better training for the crews, new navigation aids, and new tactics to make better and more effective use of incendiary bombs. Above all it needed fewer distractions from its strategic aim. All of these requirements, except two, were met. Expansion, unfortunately, always fell well short of the concept. Additionally, despite Harris's obduracy, Bomber Command was never able to totally avoid being deflected from what its leader viewed as its raison d'être. A build up of forces in the Far East, the second phase of the Battle of the Atlantic, attacks on U-Boat construction facilities, actions in the Mediterranean, preparations for the invasion of Europe, reduction of the German flying bomb and rocket threat, and provision of support for ground forces in Europe would, in time, all influence Bomber Command's operations.

Harris' arrival at Bomber Command Headquarters in High Wycombe however, coincided with the issue of a positive Bombing Directive, the acceptance for operations of the first significant navigation aid to be introduced to the bomber


18 Terraine, op.cit., p.462

19 Ibid., p.691
force, abandonment of the requirement of a second pilot on the heavy bombers, employment of the 'Shaker' technique (crude forerunner of a Pathfinder tactic), and the operational debut of the Lancaster bomber. It was a significant conjunction. Never one to either underestimate his requirements or understate his case, Harris saw the efficient employment of his Bomber Command as the way to end the war successfully and at minimum cost.

Bomber Command in February 1942 under new, dynamic leadership, with its squadrons gradually being re-equipped with modern heavy bombers, was about to enter a new era. It was also about to be provided with an aid which would dramatically ease the navigation problem. Bomber crews since the beginning of the war had been reliant on imprecise D.R. navigation which, for accuracy, demanded that frequent pin points or fixes be obtained. Then, by comparing the calculated air position with the observed ground position a wind velocity could be calculated to be used to determine a heading to fly to reach a turning point, target, or base. Night and European weather conditions had made pin pointing extremely unreliable. With this new aid, provided the aircraft was within reception range of the ground equipment, an accurate fix could be rapidly obtained regardless of whether or not the ground could be seen, whether it was day or night and virtually uninfluenced by weather conditions. In July 1940 this equipment was code-named 'G' for the grid of position lines it provided in a specific area. Later, for security reasons, it was called 'Gee' and this name was retained. Introduction of Gee marked a significant advance for Bomber Command.

There are three distinct radar systems which can provide precise navigational information to assist bomber crews. Firstly, there are reflection systems. This equipment provides the navigator with a map of the ground immediately below the aircraft and out to a selected range. The higher the range selection the lesser the ground detail displayed. By reference to a bearing and distance from an identified object (lake, river bend, even a particular building) the aircraft position can be determined. With this type of equipment both the transmitter and receiver are carried in the aircraft and its operation is independent of either ground control or ground assistance. Reflections, or echoes as they are called, are returned to the aircraft from the ground, water, or buildings, and are displayed on a cathode ray tube (C.R.T.). H2S, first used operationally in January 1943, was a navigation and bombing aid based on the reflection principle.

20 Webster & Frankland, op. cit., Vol.1, p.341
Secondly, there are responder systems. This equipment consists of a ground located transmitter/receiver beacon. The beacon transmitter is activated on receipt of pulses picked up by its receiver. Aircraft fitted with a transmitter on the same frequency as the ground beacon receiver, and with the aircraft receiver tuned to the frequency of the beacon transmitter, can receive a single position line by interrogating the ground beacon. A pulse is initiated by the aircraft transmitter which is received at the ground beacon. This pulse triggers the ground beacon transmitter and that signal is picked up by the aircraft receiver. An indicator unit in the aircraft measures the time interval between the aircraft pulse transmission and the reception of the pulse at the aircraft initiated by the ground beacon. Thus, knowing the speed at which radio waves travel, a reading of range from the beacon is provided on a calibrated screen. This position line is of course circular and centred on the known position of the beacon being interrogated. Interrogation of a second beacon provides a two position line fix. Naturally, with two intersecting circles, two fixes are obtained but the incorrect one can be discarded by reference to the aircraft's D.R. position. Oboe, a bombing aid of significance, employed a variation of this responder beacon system and this equipment will be more fully discussed later.

Finally, there are hyperbolic radar systems and in this category Gee is the major aid that will be considered. Hyperbolic aids are based on a refinement of the time/distance measuring principle and employ two or more ground stations but do not rely upon triggering transmissions from an aircraft.

The principle of Gee is simply explained. A C.R.T. in the aircraft accurately measured the time difference between the reception of pulses initiated by ground stations working in pairs. The time differences of signals from two pairs of stations are measured simultaneously and then, by referring these readings to an overprinted lattice on a chart, the two position lines provided give a fix of the aircraft's position. An example of a Gee chart and an explanation of its use are contained in the pocket inside the back cover of this work.

A Gee chain usually consisted of a Master Station 'A', and two or more Slave Stations 'B', 'C', and perhaps 'D', established on a carefully measured base line. To ensure that the signal from the Master Station is always received first, and thus overcome the ambiguity arising if both signals were received simultaneously, the Master and each Slave station operate as synchronised pairs. A pulse is sent out by the Master Station and that pulse, as well as being received by an aircraft, initiated an electronic timer at the Slave. This timer could be set to operate at any time in terms of microseconds (a millionth of a second) relative to the master. After the pre-set time had elapsed the Slave emitted a pulse.
Perhaps it is as well to be aware of the accuracy required in the Gee equipment in order to ensure it has a practical navigational application. Radio waves travel at 186,000 statute miles per second. Therefore if a Master and a Slave Station are 93 statute miles apart the pulse from the Master will take $\frac{93}{186,000}$ seconds to reach the Slave. This time interval is normally measured in microseconds (u-secs) - in this example 500. That is $\frac{1}{2000}$ of $\frac{1,000,000}{1} = 500$ u-secs. Precise synchronisation prevented gross errors because an error of one-fifth of a second would give a position line error of 37,200 miles.

Fortunately for navigators they did not have to concern themselves with the electronic wizardry encompassed by Gee. Its operation was easily managed and it rapidly provided an accurate fix. Experienced operators would take approximately one minute to obtain a fix. Gee operated on Very High Frequencies (V.H.F.) so reception was a function of altitude. At 20,000 feet useable signals could be received at up to 400 miles from the Gee transmitters. To receive a position line the aircraft had to be within range of a Master and a Slave, while to secure a fix, within range of a Master and two Slaves of a particular Gee chain.

Accuracy deteriorated at maximum range because of the shallow intersection made by the position lines and the ellipse of probability around such a fix was approximately eight miles long by three miles wide. Closer to the stations, where the position lines crossed more nearly at right angles, accuracy was in the order of hundreds of yards. Introduction of Gee to Bomber Command marked a significant advance in the improvement of navigation but it was not the complete answer because of its comparatively reduced range - it covered the Ruhr - and its susceptibility to enemy jamming. Jones has an interesting section in his book$^{22}$ on the efforts made to deceive the Germans regarding the operation of Gee.

The limited availability of Gee equipment and a shortage of crews trained in its use provided a dilemma for the Air Staff. Late in 1940, when Gee was still being developed, it had been decided that the first sets would be issued to a selected squadron so that it could lead the main component of the bomber force to their target by accurate 'fire-raising'. This idea was dropped in July 1941 when, despite stringent security admonitions, a Gee-equipped Wellington was lost in a trial over Hanover. Operational tests in the United Kingdom had shown that Gee was going to be a vital aid to accurate

$^{22}$ R.V. Jones, op.cit., pp.217-222
navigation. But for some in Bomber Command these experiments had not been sufficient. The major question remained unanswered. Would Gee provide accurate positional information over Germany? Without prior consultation someone, still unidentified, either in Bomber Command Headquarters or on 115 Squadron (responsible for the testing), started operations over the German mainland. On 11/12 August 1941 two Gee-equipped aircraft operated successfully over the Ruhr without incident. The following night two more trial-fitted aircraft were sent to lead attacks on Hanover as embryo pathfinders. One of these aircraft was lost. It had sent no distress message and no one saw it go down. Had it fallen into German hands? Although Gee-equipped trials aircraft were fitted with ten detonators for crew-initiated destruction of the secret aid, there was no immediate way of determining whether or not priceless information had been delivered into enemy hands. Destruction tests had been carried out on individual pieces of the Gee equipment but there had been none on the complete aircraft installation. As an emergency measure, on 18 August 1941, the C.A.S. ordered that all testing of Gee - operational, technical and training - was to cease immediately. However, it would appear that even if the wreckage of the missing bomber had been found, the presence of a new navigational aid was not, on that occasion, noted by the German examining team.

Proof of this surmise is provided by the fact that when Gee was again used operationally in March 1942 the equipment was not jammed. During the first month of operation 20 Gee-equipped aircraft were lost but the first mention of Gee in captured German documents was not made until 26 May 1942. By that stage the German intelligence officer reporting on the equipment knew not only the operating principles but also the purpose. He believed that it was being used 'not so much to find pinpoint targets as to improve dead-reckoning navigation'.

An additional worry had been the mounting numbers of aircrew, with knowledge of the new equipment, who had become prisoners of war. However, the admonition that 'careless talk costs lives', prominently displayed in crew and operations rooms, would not appear to have fallen on deaf ears for there is no evidence that the Gee secrets had been revealed prematurely. Termination of testing in August 1941 and the desynchronisation of transmitters would appear to have thwarted the German scientists, at least until Gee had become operationally effective.

23 Air Ministry, *Signals Vol.3 Aircraft Radio*, pp.143-4

24 Price, *op.cit.*, p.103
Production delays for the new heavy bombers, rather than a shortage of Gee sets, meant a further postponement of the introduction of the new navigational aid. It was estimated that Gee would only have a six months' operational life free from enemy interference. In order that the new aid could make a significant impact it was decided to delay its introduction until sufficient aircraft had been equipped and crews adequately trained in its operation. In late January 1942 it was estimated that there would be 94 Gee-equipped aircraft with trained crews available for operations by 15 February 1942. This was accepted as providing a sufficient force for employing the new tactic of 'fire-raising'. Target date for the first operational use of Gee was therefore set at 15 February 1942.

Because of the navigational and bombing advances which were anticipated by Bomber Command from the use of Gee, new tactics were being considered. Bombing raids, it was planned, would be led by Gee-equipped aircraft and the first aircraft over the target would drop flares to assist in target location. Once found, the target would continue to be illuminated by flares until fires could be started in the target area by other aircraft in the leading groups laden with incendiary bombs. Main Force aircraft, their target now marked by fires, would then start arriving and would aim their high explosive bombs at the fires. This technique, called 'Shaker', was widely practised during 1942 on raids led by Gee-fitted formations.

Two exercises (code-named Crackers I and II) had been held to test the system. A target on the Isle of Man was the scene of the first experiment but it was marred by the failure of one of the ground transmitters and exceptionally strong upper winds. Fortunately the second exercise, on a railway station at Brynhir in North Wales, was more successful although only from a navigational and timing point of view. Release point photographs, after bomb runs on Gee, gave no encouragement to any belief that the equipment would provide a sufficiently accurate blind-bombing device.

Despite the target date of 15 February 1942 Gee was not used operationally until 8/9 March 1942 when Essen was the selected target. Although the results of this first raid could only, at best, be described as disappointing, the raid was important for two particular reasons. Firstly, Bomber Command was at last able to operate as a reasonably cohesive force with a basic tactical plan which, over the next three years, would be radically redefined by Pathfinder crews. Secondly, Bomber Command, because it now possessed an accurate navigation aid, could apply the principle of concentration of effort in a specified and reduced time frame.
There were several reasons why this first 'Shaker' raid on Essen (and seven others in March and April 1942) were comparative failures. Essen, considering the importance of the trial, had been a poor selection of target. Firstly, it was virtually at the edge of Gee coverage. Secondly, crews lacked experience in using the equipment when the accuracy of the system was reduced by the narrow angle of intersection of the Gee position lines. Additionally, although more crews, thanks to Gee, got within the vicinity of their target, final target identification by the Advance Party had to be done visually. This, in the Ruhr area, was never easy. Weather, industrial haze, the close proximity of other cities of similar size plus a lack of significant geographical features all combined to make visual target identification somewhat problematical.

Tactically there were also problems. Timing was the crucial element. From the initial time on target — called Zero hour — to Zero + 15 minutes, flare dropping aircraft were scheduled to arrive in waves at exactly three minute intervals. Their task was to illuminate the target. From Zero +2 to Zero + 15, aircraft loaded with incendiaries were to visually bomb by the light provided by the flares. They were called the 'fire-raisers'. At Zero + 15 the first wave of the Main Force were to arrive to drop their high explosive bombs on the fires. Further waves of the Main Force, loaded with high explosives, were planned to arrive at 15 minute intervals.\(^{25}\)

On this and other early raids employing these new flare-dropping tactics, flare dispersal was a significant problem. The main difficulty was to maintain them in the right place for long enough for the 'fire-raisers' to achieve accuracy. Later arrivals in the target area too often had scattered fires from which to make their target selection. Decoy fires and aircraft forced to jettison their bomb loads, or aircraft shot down prior to incendiary release and making a significant fire point, all contributed to the confusion in the bomb aimers' minds.

There was another problem. At this stage of the war the navigator was also the bomb-aimer. After some hours in his screened alcove concentrating on his Gee set and interminable calculations, he would, when in the target area, make his way, only with difficulty, to the bomb aiming position. His task then was to visually identify his position and having done that direct the aircraft on the bombing run. Orientation for

\(^{25}\) Andrew, *op.cit.*, Vol.4, p.54
the navigators was a considerable problem. For some hours he had worked with the Gee set, a Gee lattice chart and a plotting chart. Now he had to use a topographical map with a mass of detail and attempt to sight the target while ignoring the wrongly placed flares, decoy fires, searchlights and distracting anti-aircraft fire. At the crucial stage of the attack the equipment capable of determining the aircraft's position, the Gee set, was unattended. Accurate bombing required the closest co-operation between pilot, navigator and bomb-aimer — unfortunately at this stage of the war only two thirds of the desirable team were available.

During the years leading up to the Second World War very little consideration was given to either specific crew responsibilities or the potential difficulties in carrying out those functions. Normally the bombers had carried two pilots supplemented, when necessary, by volunteer gunners or wireless operators recruited on a daily basis from ground tradesmen. Pilots were thus responsible for flying the aircraft, navigation and bombing. No transition was required from being either the pilot or the pilot doing the navigation when it became necessary for bomb aiming because bombing and navigation were both purely visual operations. Even after bombers developed enclosed cockpits and the navigator no longer necessarily had a continuous view outside, potential problems were not recognised. But the movement from the navigation to the bomb aiming position created problems which were only solved by the appointment of navigation-trained bomb aimers.

Strangely, even these lessons from the Second World War were not long remembered. Similar problems reappeared in the 1960s. Canberra aircraft in the R.A.F., depending on the mark, sometimes employed two-man crews of pilot and navigator. The main navigational aid was still Gee and part of the Operational Conversion Unit course was high level navigation exercises followed by a first run attack (F.R.A.) on bombing targets at Holbeach and Wainfleet near the Wash on the east cost of England. This exercise required the navigator to unstrap from his ejector seat and oxygen supply, crawl under the flying controls into the nose of the aircraft, reconnect his oxygen, set up the bombing computer, select the bombs, visually identify his position (day or night) from 40,000 feet and then attempt to track into the target. With the Canberra covering seven or eight miles per minute and the changeover having to start at least ten minutes before bomb release time, this move started when the aircraft was still at least 70 or 80 miles from the target. Until the navigator could visually identify his position no accurate positional information was available to the crew. Such a situation provided considerable scope for either bombing errors or an abortive F.R.A.
Although it has been said that even Gee-led attacks on the Ruhr generally produced only disappointing results, this statement requires qualification. Prior to the introduction of Gee operations against targets in the Ruhr were only approved when the moon was available to assist in target recognition. During March and April 1942 the possession of an accurate navigation aid, even though only a portion of the bomber force was so equipped, enabled more than fifty per cent of the attacks to be conducted in no moon conditions. Target identification still remained a problem but, at the same time, industrial damage was being created, even if not always in the planned area. Bombing photographs showed the advantages gained from the possession of Gee. Whereas in the nine months prior to the introduction of Gee only twenty per cent of aircraft actually attacked a built-up area (not necessarily the target), now the percentage had increased to thirty.26

Gee as a blind-bombing aid was a disappointment. Experimental raids were made on defended German targets using the equipment but even the limited evidence available showed errors three times worse than had been found in trials held in the United Kingdom. While the results may have been better than those obtained from purely visual attacks in poor weather, they were not as good as those secured in Gee-led attacks, with visual target identification, in either medium or good weather. Although Gee did not meet the requirements of a blind-bombing aid, navigationally it was a significant advance.

Gee enabled the navigator of a bomber to accurately and speedily determine the position of his aircraft by day or night without the need for any air/ground communication and regardless of the weather. Another advantage was that the aircraft equipment was only a receiver so no possible homing transmissions were radiated while using the aid.

Navigation during the climb phase of any raid, before the advent of a quick fixing aid, had always presented problems for the bomber navigator. As an aircraft climbs it passes through layers of air where different wind velocities are experienced. But the rate of climb of a heavily laden bomber was not a constant figure - as the altitude increased the rate of climb decreased. Thus, increasing time intervals were spent under the influence of variable wind velocities. The first activity for a navigator on reaching cruising level was to obtain a pinpoint, or fix, so that the air plot could be restarted and wind velocities found at the operating altitude.

26 Roberts, op. cit., p. 56
Before Gee was available, if a fix or pinpoint could not be obtained at the top of climb, the errors in the navigator's D.R. position, induced by inaccurate climbing winds or flying techniques, remained unknown. In such a situation the initial winds found at cruising level included possible unknown errors until a fix or pinpoint was obtained. With Gee, an accurate fix at top of climb was generally available unless the climb had been particularly slow and the aircraft had reached an area subject to enemy jamming.

Despite the inherent range limitations of Gee, related to the frequencies employed, the equipment was of very considerable value even when attacks were delivered against targets at long range. For almost the first 400 miles of the flight accurate fixes were obtainable and therefore accurate wind velocities could be calculated. These enabled the navigators to compare actual with forecast winds and thus make a better assessment of the winds likely to be encountered on the later sections of the flight. Possession of Gee reduced the time that navigators were totally dependent on D.R.

Gee also provided Bomber Command planners with the potential for concentration of attacks both in time and space. With the German air defences improving rapidly it was becoming increasingly desirable to route aircraft around known heavily defended areas. While within coverage Gee provided this facility. Routes to be followed by the bomber force were laid down for the crews rather than being a matter of individual choice. Accurate navigation, thanks to Gee, also enabled an attack to be concentrated in time which increased security for the bombing force while concurrently saturating the defences and overwhelming ground rescue organisations.

Finally, Gee was invaluable on the return to airfields in the United Kingdom. Even after the commencement of enemy jamming fixes could normally be obtained over the North Sea so navigators were able to correct errors that had accumulated and enabled the aircraft to make a safe return to base. Aircrew fatigue, battle damage to aircraft, poor weather conditions with fog, low cloud and reduced visibility had, prior to Gee, frequently made it necessary for crews to land at night at a diversion airfield with which they were not necessarily familiar. All these factors combined to make this last section of a bombing raid a perilous operation. According to Harris, on many occasions during 1940 and 1941, more bombers were lost on their return to base or diversion than had been lost on a particular operation. Gee helped reduce the diversions and losses over friendly territory to insignificant proportions.27

27 Harris, Bomber Offensive, p.96
Unfortunately, the acquisition of what was basically an accurate navigation aid created a euphoria in the minds of some of the Air Staff. Where previously little had appeared to be achievable despite strenuous efforts now, some believed, nothing was impossible. Harris however retained a sense of proportion. He was aware of the problems of weather and improving German defences. He also recognised that Bomber Command expansion would only occur in the long term. Heavy bombers were slowly becoming available but in the early stages of reequipment their introduction actually reduced the numbers of bombers available for operations. Their construction took longer and crews had to be trained to fly them. Conversion from flying a twin-engined Wellington to taking control of a Lancaster or Halifax took time. While these change-overs took place squadrons were not available for operations. The Lancaster flew its first sorties on 10/11 March 1942 but at the same time the Manchester, on which high hopes had rested, was increasingly being considered unsuitable for operations. It was removed from front-line service in June 1942. Harris was also well aware that Gee, on which so many pinned their hopes, would, at any moment, have its operational usefulness dramatically curtailed.

During the latter months of 1941 there was a growing acceptance by members of the Air Staff that the incendiary bomb would prove to be a major weapon in area attacks. Proof of its efficiency had been provided by the Luftwaffe during its attacks on British cities. Planners at Air Ministry believed that the first aircraft in a bombing raid should be a fire-raising force dropping loads of incendiaries. The fires they created would act as beacons for the Main Force following. All aircraft in the initial force were to carry maximum incendiary loads with unused bomb space being given to high explosive bombs to discourage German fire fighters and air raid wardens.

Harris in his *Despatch on War Operations*, pp.146-7 provides illuminating numbers. In February 1942 Bomber Command had 37 operational squadrons, 31 of which were Hampden, Whitley or Wellington, while another two were the unsatisfactory Manchester. At the end of 1942 the operational strength of Bomber Command had reduced to only 32 and a half squadrons. But at this stage there were no Whitleys, Hampdens or Manchesters remaining and only six and a half Wellington squadrons. The other squadrons were five Stirling, ten and a half Halifax, ten Lancaster and half a Mosquito. Thus, although aircraft available numbers had reduced, bomb carrying capacity had increased.
For this particular incendiary plan it was initially decided there would be a 45 minute breathing space between dropping the incendiaries and the arrival of the high explosive equipped Main Force. Bomber Command planners, however, considered that such a break could provide the opportunity for fire-fighting organisations to bring the fires under control. Consequently an intermediate force following immediately after the fire-raisers was to drop high explosives in an attempt to disrupt rescue and fire fighting efforts in the target area. Several elements contributed to cause delays before the plan, (code-named 'Unison'), could be tried operationally. Poor weather conditions, diversion of the bombing effort to attacks on German naval units sheltering in Brest, plus the need for conservation, all played their part. There was also the need to overcome the latent opposition of Harris himself. He remained unconvinced at this stage that incendiary bombs could be more destructive to either industry or morale than high explosives. At the same time he accepted that they could assist bombing concentration by providing fires that could act as beacons for later arriving bombers. Nevertheless, in response to instructions to initiate a full scale trial in the next moon period, Harris planned an incendiary attack on Lübeck for the night of 28/29 March 1942.

Lübeck, a city of industrial, commercial and military importance, had been carefully chosen. Situated on the Baltic Coast, at the mouth of the river Trave, it was believed that it would be readily identifiable. Although it was beyond Gee range it had suffered very little from previous bombing raids so its defences were not expected to provide any significant deterrent to the bombers. Most importantly for an incendiary trial, it was a medieval city containing a large number of wooden buildings built on narrow, tortuous streets. Harris is said to have later described it as 'more like a fire-lighter than a human habitation'.

Concentration for the raid on Lübeck was less rigid than would later be considered desirable. However, in general, the plan for the attack resembled the timings achieved in raids made under the 'Shaker' plan. But the two plans must not be confused. Incendiaries in the 'Shaker' plan were for target marking; in the 'Unison' plan they were to create destruction.

For Lübeck it was planned that from Zero Hour to Zero +15, Gee-equipped aircraft were to drop flares to assist in target identification. From Zero +2 to Zero +15 the fire-raising force was to unload its incendiaries. The intermediate force, loaded with high explosive bombs, was to

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be in the target area from Zero +10 to Zero +20. During the final phase of the attack, from Zero +60 to Zero +140, the Main Force bombers were to drop mixed loads of high explosive and incendiary bombs.\textsuperscript{30}

Lübeck provided for the Air Staff proof of the efficacy of incendiary attacks. Harris however remained ambivalent. Even though the proportion of incendiary bombs to high explosive dropped in this raid was less than had been planned for a Unison trial, it was higher than on any other previous raid. Final confirmation for most, of the damaging effects of incendiariaism, was provided by four successive attacks delivered against Rostock commencing 25/24 April, 1942. Main Force aircraft in these raids on three occasions carried bomb loads two thirds of which were incendiary and one third high explosive. Bombing photographs indicated that these raids had been highly successful and this was confirmed by daylight reconnaissance flights.

Harris, neither for the first nor last time, remained obdurate; on this occasion in his opposition to incendiariaism as the means of achieving the aim. Perhaps he considered both Lübeck and Rostock special cases and not able to be repeated on more modern cities where bricks and mortar predominated. Air Commodore Baker, Director of Bomber Operations (D.B. Ops), even inferred that Harris had misinterpreted (deliberately or otherwise) papers sent to him which had defined Air Ministry bombing policy regarding incendiariaism. Baker claimed that Harris only applied the clearly defined policy to trials of the Unison technique against specially selected targets rather than, as intended, targets in general. In May 1942 Harris was still expressing his opposition to incendiariaism. In response to a query from Air Chief Marshal Sir Wilfrid Freeman Vice-Chief of the Air Staff on the proportion of incendiaries carried on the Rostock raid, he stated that he had ‘feared all along that the incendiary properties of Lübeck would tend to disappointed reactions by the bloodthirsty on subsequent occasions on other towns’.\textsuperscript{31}

D.B. Ops next suggested that an expanded scale incendiary attack be delivered against a larger, more industrialised city such as Cologne. Harris's response was that rather than increase the number of incendiaries to be dropped, the aim should be to improve the total weight of attacks. He remained aware, however, that the numerical weakness of the bomber force made this increase virtually impossible. Bomber crews would therefore have to return night after night to the same target to achieve industrial dislocation and morale reduction. Indicative of at least a partial softening of attitude, Harris did concede that perhaps the ideal bomb load could possibly be

\textsuperscript{30} Andrew, \textit{op.cit.}, p.142

\textsuperscript{31} Ibid., p.148
two thirds incendiaries and one third high explosives. D.B. 
Ops, aware of the limited numbers of bombers available, 
declared that the maximum effects of an incendiary attack 
could only be achieved by saturation of the target with 
incendiaries. Against a city as large as Cologne greater 
destruction would be caused in one night by dropping 100,000 
incendiaries than by four successive raids each time dropping 
25,000.

From May 1942 onwards the numbers of incendiary bombs 
carried on raids continued to climb. Operation Millennium, 
the first 'Thousand Plan' attack on Cologne (shortly to be 
discussed), perhaps marked the point from where Harris was 
converted to incendiarism. Bomb loads, generally, were in the 
proportion of two thirds incendiary to one third high 
explosive. Underlining his conversion, Harris, in a letter to 
his Group Commanders in September 1942, rebuked them for 
'deliberately and frequently' varying the incendiary load 
without authorization. 'In future' he wrote, 'these 
proportions were not to be departed from without specific 
orders'. He continued, to show his complete acceptance as to 
the effectiveness of incendiary bombs, 'that blast bombs were 
intended solely for the purpose of creating alarm and 
despacency, the incendiaries being relied upon to do the 
devastation'.

At this juncture it is perhaps pertinent to remember that 
no firm decisions on either the future employment of Allied 
air power or full agreement on future strategies had as yet 
been reached. These would not be determined until January 
1943 at the Casablanca Conference. There was simply the 
general acceptance that Germany's defeat was the priority aim. 
Bomber Command in 1942, however, was making considerable 
efforts to justify the Air Staff's faith in the destructive 
capacity of a strategic bombing offensive. At the same time 
it could not be denied that for much of 1942 critics of the 
strategic bombing offensive were very evident. Demands from 
both the Navy and Army, had they been met in full, would not 
only have reduced the effectiveness of the bombing campaign 
but would also have seriously eroded the independent nature of 
the R.A.F. in general and Bomber Command in particular. The 
excessive nature of the claims for assistance from the other 
Services compromised the R.A.F. position. Unhappily for 
Bomber Command, their results to date had not effectively 
displayed that the bombing policy being pursued could achieve 
the defined aims.

Andrew, op.cit., p.150
Naval concerns in 1942 were dominated by the U-boat threat posed to British sea communications. Naval demands centred on the acquisition of long range aircraft to counter this menace. These aircraft were required not just for patrols in the Atlantic but as well for protection in the Indian Ocean to where the war had now spread. It was also conceivable, in 1942, that German surface units could dominate the sea ways. Additionally, allied shipping losses were reaching such a level that there was an increasing risk that insufficient essential supplies would be landed in British ports. Finally, there was the threat that tanker losses could seriously inhibit the activities of the three Services. 

Foul, in a paper dated 6 March 1942, made the naval position clear. He wrote, 'If we are not to conduct the war at sea at a disadvantage we must have Naval operational control of all aircraft employed on sea operations on lines similar to those now in force with the Coastal Command in Home Waters'.

This amounted to an assault, not simply on Bomber Command, but against the continuation of the R.A.F. itself as a separate Service.

Only four days later on 10 March 1942, General Sir Alan Brooke, the Chief of the Imperial General Staff (C.I.G.S.) launched his attack on the sanctity of the R.A.F. Armies, he claimed, required adequate and appropriate air support. Aircraft allocated such a role could not be operated efficiently, he continued, unless they were under direct Army control. However, he did not go as far as his Naval counterpart. Aircraft and crews, provided they had been fully trained for their Army support role, could be released to the R.A.F. for independent operations when not otherwise required.

With regard to the Admiralty requests, the Air Staff were substantially in agreement that more long range aircraft were necessary. They did not want them, however, to either be provided by Bomber Command or come under fully Naval control. Naturally they opposed any further division of the R.A.F. particularly into three fatally weakened parts.

Perhaps the Army overstated its case when they called for no less than 90 squadrons for support operations. Churchill certainly believed so and he was a powerful ally for the Air Staff. He advised the Chiefs of Staff that 'the requirements of the General Staff for the Army appear to be out of all proportion to existing or prospective resources and, if satisfied, would be destructive of the principle of an independent Air Force'. In any case the Army submission was flaw in that there were no immediate requirements for aircraft to support Continental military operations. Army operations in Europe were only vaguely in the future.

Andrew, op.cit., p.233

Ibid., p.235
On 25 March 1942 the Joint Intelligence Committee (J.I.C.) were asked to estimate the potential effectiveness of strategic bombing on Germany - including its usefulness to Russia - for the summer of 1942. Their report was inconclusive. It could not have been otherwise because their parameters were imponderables. They did not know what weight of attacks could be delivered; the bombing accuracy to be expected; weather influences; need for diversions of the bomber force to assist in other theatres; nor did they know what effect casualty rates would have on operations. They recommended an independent enquiry and this was accepted. Mr Justice Singleton, who had earlier led an enquiry into the strength of the Luftwaffe, was given the task.

On 16 April 1942 Mr Justice Singleton was invited to conduct an enquiry into the prospects in the future of the strategic bombing offensive. His terms of reference clearly demonstrated the difficulties of his undertaking. He was asked to consider 'In the light of our experience of the German bombing of this country and of such information as is available of the results of our bombing of Germany, what results are we likely to achieve from continuing our air attacks on Germany at the greatest possible strength during the next six, twelve and eighteen months respectively'.

Unfortunately, if unequivocal answers were sought they were sought in vain in the Singleton Report published 20 May 1942. Again it could not have been otherwise. His baseline for measurements, the results of German bombing on Britain, was too uneven. Estimates of war production lost in Britain during the Blitz varied enormously - but who was right and who was wrong? What measures could be applied to judge the effect on morale? Should one take a long or short term view when it was already appreciated that the effects of bombing on morale are both local and usually transient? Surely, if the German armies were successful in Russia, then it would be logical for the German people to claim 'we can take it' because victory would be in sight. On the other hand, if Germany was defeated in Russia, then doubtless morale would plummet and a continuation and expansion of the bombing offensive would add to their distress.

The language employed in the Singleton Report was indicative of the fact that it was based on questions to which, in May 1942, there were no definitive answers. The Report was vague almost to the point of being able to be used as illustrative of opposing arguments. But again, it could not have been otherwise. Who was able to confirm that bombing accuracy would improve? What expansion would take place in Bomber Command? Would new tactics or equipment bring increased success? Would the German defences improve or

AIR 8/1015, P.R.O. 5346, 20 May 1942, p.1
Note: Photocopy in Author's possession marked 'C.A.S. Personal Copy'.
In summary Singleton considered that 'there is every reason to hope for good results from a sustained bombing policy. I do not think it ... sufficient to win the war ...[but]... if Germany does not achieve great success on land before the winter it may well turn out to have a decisive effect ... It is impossible to say what its effect will be in twelve or eighteen months ... If Russia can hold Germany on land I doubt whether Germany will stand twelve or eighteen months' continuous, intensified and increasing bombing'.

Far from clarifying the arguments over the employment of Bomber Command in particular and bombing policy in general, the Singleton Report tended rather to aggravate them. Fortunately, it was not a total waste of time. There was one important consequence. The Report showed that bombing policy could not be determined on the basis of opinion merely based on theory. What was required was a positive display of the effectiveness of strategic bombing. Who better than the recently appointed head of Bomber Command, Air Chief Marshal Sir Arthur Harris, to provide a tour de force to convince the cynics, the doubters and the pessimists?

Perhaps, however, the decision to continue with the strategic bombing offensive had already been made. Exactly when it was reached is difficult to determine. By 1942 cancellation of aircraft construction plans dating back to 1936 plus the redeployment of the labour force combined with the R.A.F. expansion plans, would have involved too radical a change of direction. Alternative strategies had been rejected. Factories had tooled-up for the production of four-engined bombers and, as was known from previous experiences with Battle and Whitley aircraft, it was not simply a matter of switching off production. The wheels of industry, once inertia had been overcome, had already proved difficult to bring to a halt. Evidence can also be adduced that Churchill had made up his mind as early as the beginning of April 1942. Possibly the balance had been tipped by the combination of the successful attack on Lubeck and Lord Cherwell’s minute of 30 March 1942. Even though Lord Cherwell had been unable to provide significant new evidence that a bombing campaign would prove decisive, he had the attentive ear of the Prime Minister. His minute to Churchill was based on an analysis of the effects of German attacks on British cities. He had calculated that one ton of German bombs had destroyed 20 to 40 dwellings and turned '100-200 people out of house and home'. British bomber production, it was

AIR 8/1015, P.R.O. 5346, 20 May 1942, pp.5-6
Free-hand underlining in the photocopy.

Webster & Frankland, op.cit., Vol.1, p.331
estimated, would provide no less than 10,000 aircraft between 30 March 1942 and the middle of 1943. With each bomber, on average, carrying out fourteen raids and able, on every occasion, to carry a three ton bomb load, they would drop in their lifetime about 40 tons of bombs per aircraft. In built-up areas Lord Cherwell argued, that would make '4,000 - 8,000 people homeless'. He continued, 'If even half the total load of 10,000 bombers were dropped on the built-up areas of ... 58 German towns the vast majority of their inhabitants (about one-third of the German population) would be turned out of house and home. There seems little doubt that this would break the spirit of the people'.

Churchill's change of mind is evident from the difference in tone between the minute he addressed to the C.A.S. on 27 September 1941 and that to the Secretary of State for Air in April 1942. The former had been a warning declaring that 'It is very disputable whether bombing by itself will be a decisive factor in the present war ... The most we can say is that it will be a heavy and, I trust, a seriously increasing annoyance'. Yet on 11 April 1942 the Prime Minister was able to advise the Secretary of State for Air that 'We are placing great hopes on our bombing offensive against Germany next winter, and we must spare no pains to justify the large proportion of the national effort devoted to it'.

Lord Cherwell's mathematics were easy to understand but surely his reasoning was flawed? There could be no guarantee that because one ton of German bombs had demolished 20 - 40 British houses that one hundred tons of British bombs would destroy between 2,000 and 4,000 German dwellings. Lord Cherwell's arguments were based, also, on several preconditions. What number of bombers would actually be produced as distinct from forecast production figures? Would each bomber continue to survive an average of fourteen sorties? Would loss rates remain the same? Would navigation and bombing aids be produced that would enable the British bombs to be dropped accurately? Was there any guarantee that the bombing effort would not be diverted? Only the passage of time would reveal the answers.

Webster & Frankland, op.cit., Vol.1, p.332
Gilbert, op.cit., p.1205
Frankland, The Planning of the Bombing Offensive and its Contribution to German Collapse, p.80
If Lord Cherwell's minute was decisive perhaps it was only because of faute de mieux. A balance had to be struck. Defeat in the Battle of the Atlantic for Britain meant the war was lost. Defeat for Germany in the Atlantic meant only the loss of a battle but for Britain it provided, despite its importance, simply a defensive success. Total defeat would be staved off but the war still remained to be won. Total victory for Britain required offensive action and this only Bomber Command could provide. Victory for Bomber Command meant the loss of the war for Germany. Bomber Command, with Harris in control, was to be the weapon for offensive and possibly decisive action.

Harris' plan, to show the full potential of a strategic bombing offensive, was a bold initiative. He proposed that no less than 1,000 bombers should be launched in a single attack on a selected German city. Despite the fact that Operation Millennium and the Singleton Report were conceived in parallel, their conjunction confirmed the vagaries of chance. Harris, in February 1942, as the new head of Bomber Command was well aware that the night bomber offensive was at another crisis point. Its failure to achieve significant results had invoked criticism from many quarters. Bomber Command's efforts had been questioned in Parliament, disparaged by some members of the public, and deprecated as a misuse of valuable resources by the other Services. Nor did the immediate future offer the prospect of improved performance. Simply pleading bad weather conditions, shortage of aircraft, need for conservation of the force or diversion of effort, were all totally unacceptable responses. A successful display of the potential of the bomber force had to be provided because its very survival was at stake. Harris was aware he needed to capture both the public's imagination and political support.

For Harris and Bomber Command success with the 'Thousand Plan' offered substantial rewards. It was a plan conceived by Harris. With this in mind, but remaining aware that his book The Bomber Offensive is not a primary source and was written with hindsight in 1947, it is worth quoting his words as to the advantages to be gained from a successful operation. Such a coup de maître Harris believed, meant 'we should have before us a definite and attainable goal, a measure of what could be achieved as soon as our expansion really began. The result of using an adequate bomber force against Germany would be there for all the world to see, and I should be able to press for the aircraft, crews, and equipment we needed with far more effect than by putting forward theoretical arguments, ... Such a demonstration was, ... the only argument .. which was at all likely to prevent our squadrons from being snatched away and our effort diverted to subsidiary targets, or to extract the equipment we so desperately needed, the radar navigational aids and the target indicators, from the torpid departments which withheld them for so long'.

41 Harris, Bomber Offensive, p.109
Possible failure, of course, was the obverse side to the proposition. If such a force could be raised and was committed it would involve placing at risk, not only the total first-line strength plus reserves, but also the major portion of Bomber Command's training organisation in addition to the units borrowed from other Commands. With such a large number of aircraft, of variable performance, concentrated in both space and time, how high was the collision risk? Finally, there were the inherent problems in the recovery of such a large force to their bases, especially if weather conditions deteriorated unexpectedly.

One other important question remained to be answered. Was the 'Thousand Plan' a viable proposition. At this stage of the war the average daily availability of bomber aircraft for operations was only 346 and the largest number previously launched against a single target no more than 228 aircraft. Harris had sought the grand gesture but it was Saundby who confirmed, early in May 1942, that the 'Thousand Plan' was achievable. An attack on such a scale would require all of Bomber Command's aircraft including conversion and training machines and would necessitate using instructors and some pupils for crews. Additionally, those crews on loan to Coastal Command would have to be returned, temporarily, for the operation. By utilising virtually all the aircraft and crews in Bomber Command, even though some were still in the training process, the numbers were available.42

The idea had been born, numbers were confirmed, and the collision and recovery risks calculated and found acceptable, but what made the operation feasible was the possession of Gee. Although by no means all the force would be fitted with the aid it meant that the bombers could be accurately led. It also went some considerable way to determining the target city. Hamburg was considered but was well beyond Gee range while Essen, militarily desirable, was known to be too difficult to locate. Despite Harris's initial predilection for Hamburg, Cologne was the selected target. With Churchill having given his enthusiastic consent for such an operation, it was planned for the moon period at the end of May.

Support for the 'Thousand Plan' was not only widespread but was also immediate. Coastal Command, under Air Marshal Sir Philip Joubert, offered no less than 250 aircraft.43 Flying Training Command offered aircraft and crews while the response from O.T.U. Groups and Conversion Units indicated that even the previously undreamt of number of one thousand bombers would easily be exceeded. Bomber Command itself,


43 Webster & Frankland, op.cit., Vol.1, p.403
given time to prepare for the 'Thousand Plan', was able to produce more aircraft for the operation than had previously been thought possible. This was fortunate because in the event, although 1046 aircraft took part in the attack on Cologne, only four Wellingtons from Training Command were from sources outside Bomber Command.

Coastal Command, under Admiralty instructions, had withdrawn their offer of support. A measure of understanding of their planners' dilemma must be granted. If the raid proved to be an outstanding success they believed they would then have difficulty regaining control of the aircraft they had temporarily loaned. On the other hand, if the attack was a disaster there may be few aircraft to recover. Either way they stood to be significant losers.

Operation Millennium was a success. Of the 1,046 bombers which left their bases in England, 898 claimed to have attacked their target. A total of 540 tons of high explosive bombs and 915 tons of incendiaries were showered on Cologne from 0038 hours until 0310 hours on Sunday 31 May 1942. There were 469 deaths in the city and a further 5,027 people injured. More than 600 acres of the built-up area of Cologne was totally destroyed including about 300 acres in the centre of the city. The leaflets dropped by the R.A.F. later that same day advising the citizens of Cologne that 'Die Offensive der Royal Air Force in ihrer neuen Form hat begonnen' must surely have been somewhat superfluous to requirements.

Considering the many novel features of Operation Millennium, the loss of 40 bombers (figures vary slightly depending on the source), which was only 3.8 per cent of the force, was not unreasonable. Many of the crews involved had been inexperienced, there had been clear skies over Cologne and it was the first time that concentration of a large force had been attempted, so heavier losses, no matter how unwelcome could have been anticipated. Conditions had been good for the German night fighters but over the city itself it was believed only four bombers had fallen victim to their guns.

**, Roberts, op.cit., p.169**

**, Barker, op.cit., p.236**

**, The R.A.F.'s offensive in its new form has begun**

**, Eric Taylor, Operation Millennium**

Another two bombers had collided over the target (confirming the forecast minimal collision risks) while sixteen other bombers fell to anti-aircraft guns. Although, in general, bomber losses had been mounting fractionally, they were lower on this raid than for other raids between June 1941 and March 1942 when, in full moon and clear sky conditions, they had averaged 4.6 per cent.

Several lessons were adduced from this first major operation. While some were valid others, unfortunately, were based on misapprehensions. The first lesson learned from the attack on Cologne was that provided weather conditions were reasonable over the route to the target, that the target itself was readily identifiable, and that a sufficient force had been employed, widespread destruction could be created in German industrial cities.

Another belief arising from this raid, misplaced on this occasion, was that the new generation of four-engine bombers were less susceptible to night-fighter attacks than were the medium bombers they were slowly replacing. A total of 292 Stirlings, Halifaxes and Lancasters took part in the raid and six were reported missing for a loss rate of only 2.05 per cent. For twin-engined aircraft the loss rate was 4.5 per cent. What was not appreciated was that it would be those bombers with the comparatively reduced performance in altitude, speed, or manoeuvrability, that would usually suffer the most severe losses in any particular raid. When the formations were only of four-engined bombers then the Stirlings and Halifaxes usually suffered more than the Lancasters. Even when only Lancasters were committed loss rates did not decline although relative factors were the improvements in the German night-fighter organisation and tactics.

Some survivors of the Cologne raid still believe that there were more than two aircraft lost as a result of mid-air collisions. In a letter to the author of this work, Gwyn Martin, who wrote Up and Under, describing his experiences on 75 (N.Z.) Squadron, gave as his opinion, supported by others, that there was more than one collision. But, as he said, who can confirm the collision of two laden aircraft - the survivors of the explosion?

Eric Taylor, op.cit., p.170

Andrew, op.cit., p.170

Figures calculated by the author from data in Middlebrook & Everitt, op.cit., pp.268-273
Another assumption, accepted as a consequence of the raid on Cologne, was that concentration of the bombing force tended to saturate the defences. Losses on the first two waves had averaged 4.5 per cent but on the third wave, where the greatest concentration was achieved, they fell to 1.9 per cent. Unfortunately statistics did not tell the full story. Throughout the raid, German Fliegerabwehrkanonen ('flak') gunners continued to shoot down an attacking bomber every seven or eight minutes. What should have concerned bomber Command authorities, had they been aware, was that despite the large numbers of aircraft in the target area the German location system was still able to select, follow, and regularly shoot down, individual bombers. So although percentages may have varied significantly loss rates per individual wave were very similar. Flak successes in other words were dependent upon the number of detector and predictor units available and the number of anti-aircraft guns deployed. Employment of increasing numbers of bombers was not, on its own accord, going to reduce the numbers of aircraft being destroyed by gun fire from the ground.

In a disparagement of the efforts of the German night fighter forces the authors of the Official History expressed surprise that, although weather and visibility 'presented the German night fighter pilots with perfect conditions for "cat's eye" interception' and that the 'German night fighter effort was larger than usual' they had been, in the main, generally unsuccessful. Their words were an echo of those in the Narrative History which said 'Taking into account ... enemy night fighter activity was considerably above normal and that conditions favoured attack by 'cats-eye' fighters, a very much higher loss rate ... might have been expected'.

Their criticism was misplaced for two particular reasons. Firstly, the number of German night fighters deployed on the night of Operation Millennium was not significantly higher than usual. Secondly, although the German night fighter defence system had recently been reorganised, it still remained rigidly based on controlled night fighting. Had the British authors merely criticised the controlled system of night fighting when compared with 'free' night fighting, their arguments were valid. Had 'free' night fighting been in vogue on the night of this attack against Cologne then assuredly R.A.F. losses would have increased. The 'tame-sow' and 'wild sow' tactics adopted later in 1943 by the Luftwaffe night fighter force provide ample confirmation. Bomber losses on 30/31 May 1942 due to Luftwaffe fighter activities were consistent with the defensive tactics being employed at that time.

** Webserth & Prankland, op.cit., Vol.1, p.408
** Ibid., Vol.1, p.408
** Andrew, op.cit., p.94
The air defence system employed by the German authorities at the time of the 1,000 bomber raid on Cologne consisted of radar warning and control, a searchlight belt and patrolled boxes. A single fighter patrolled his box and was vectored by ground radar on to targets passing through his area. If no interception was made the target passed rapidly out of the box and was lost on the ground radar. The fighter then returned to orbit the beacon in his box and await instructions from the ground radar. Of the Luftwaffe fighters deployed in their night fighting zones on 30/31 May 1942, some ten per cent had aborted due to either technical defects or combat damage and only twenty-five had been guided by ground radar to an individual bomber passing through their particular defensive box. It was only after the Cologne raid, when so many crews had been held in impotent idleness, that discussions in German aircrew messes were directed towards the possibility of 'free' night fighting. Their day would come but changes were not immediate.

Although 'Thousand Bomber' raids were repeated on 1/2 June 1942 against Essen and again on 25/26 June 1942 on Bremen, such effort could not be maintained. Weather interfered with both these raids and although substantial damage was created it was not necessarily in the target area. The major problem however was that the front line strength of Bomber Command simply did not permit a continuation of these massive attacks. Bringing up crews from the O.T.U.s or conversion units to make up the numbers was not the answer. That would have entailed a significant interference to a training programme already experiencing difficulty in merely maintaining front line strength. Unfortunately, (although not unnaturally), the public perception of the 'Thousand Bomber' raids was that they should be the norm. Therefore, for a considerable period in 1942 the training element of Bomber Command continued to provide aircraft and crews for major raids. Weather conditions largely determined their success or otherwise.

The first three large raids on Cologne, Essen and Bremen were deliberate aberrations. Such enormous efforts in 1942 were, in theory, beyond the capacity of Bomber Command. Although they did occur (with variable successes) they could not be maintained at that time. But, importantly, they achieved their aim. They alerted political and public interest in the potential of Bomber Command. They were executed to show that Bomber Command, provided it was given the resources, had a significant role to play. In this they were successful. The linchpin for success however, it was realised by the Air Staff, were large scale, concentrated and well-led raids.

— Gebhard Aders, *History of the German Night Fighter Force 1917-1945*  
Gee, although it had failed as a bombing aid was fulfilling all the hopes which had been entertained for it as a navigational device. Initially, only limited numbers of bombers were fitted with the equipment and these aircraft were employed as leaders to show the way for the non-Gee equipped Main Force. Even with Gee it still remained necessary to have the best and most experienced crews in the forefront of an attack because targets still had to be found and marked visually. Possession of Gee assisted timing and concentration but to achieve this raids could no longer be planned either at squadron or even Group level. Route planning and timing became a Command problem. It had become apparent that successful raids were those which had been well planned, closely co-ordinated, and professionally led. Discussions at many levels in Bomber Command and the Air Ministry during 1942 centred with increasing frequency on the pros and cons of the formation of a target marking, fire-raising or raid leader force. The consequence of these vigorous debates (and arguments) was to be the formation, in August 1942, of the Pathfinder Force.

Pathfinding tactics by bomber aircraft in the Second World War were pioneered by the Luftwaffe. Kampffruppe 100 (KGr.100) - a special beam-flying squadron with their Viking ship emblem - were in the forefront. Their specialised task, using radio beams from ground-based transmitters, was to drop incendiaries on their briefed targets to cause fires that would act as beacons to be used as aiming points for the main bombing force. KGr.100, with specially trained crews, achieved a notable success against the Midland city of Coventry on 14/15 November 1940. Under the code name Mondscheinsereade (Moonlight Sonata) it was the first raid in a revised strategic bombing offensive. Rather than continue with the apparently futile attempt to destroy London, Luftwaffe bombing efforts were now turned against industrial and economic targets in Britain and the morale of its peoples.

For the attack on Coventry KGr.100 launched thirteen Heinkel 111s (He.111) each equipped with an X-Verfahren guidance system. Between 1920 hours and 2005 hours incendiaries from these aircraft started eight large and numerous small fires around the designated aiming point. Another 436 German aircraft then bombed these fires for ten hours killing nearly 400 people and seriously injuring another 800. Production in the Standard Motor Company, Alvis aero-


Ibid., p.15, X-System
Often the whole system, ground transmitters and aircraft receivers, are referred to as X-Gerät (X-Equipment). This is an error. The aircraft installation was X-Gerät; the total system should be called X-Verfahren.
engine works and other industrial concerns was brought to a standstill and the city centre devastated. Pathfinders, using a precise beam guidance system, had confirmed their worth.\textsuperscript{58}

The German X-system employed a narrow approach beam originated on the Cherbourg Peninsula and aimed to pass precisely over a selected target city. Three cross-beam transmitters sited near Calais provided warning of the approach to the target, ground speed of the bomber and, finally, automatic release of the incendiaries or high explosive bombs. The first cross beam visual or aural indication in the bomber cockpit, when 50 kilometres from the target, was the instruction to the pilot to maintain the approach beam at constant height and airspeed. The second cross beam, encountered 30km nearer the target, provided the signal to start the bombing clock. After another 15kms the third beam was crossed. This was the signal to stop the first hand of the bombing clock and start the second one. Between the second and third beams the aircraft equipment had accurately measured the aircraft's ground speed. Now the second hand on the bombing clock moved to catch up on the first but at three times the speed because the target was only five kilometres ahead. At the appropriate release point the hands on the bombing clock overlapped, electrical contacts closed, and the incendiary or H.E. load was dropped automatically and accurately. On occasions the leading aircraft in such raids remained in the target area reporting on the location of the fires, progress of the attack, and weather in the target area for the benefit of later arrivals. Again, a forerunner of R.A.F. Pathfinder tactics.

Of course the system had its disadvantages: it required accurate and precise flying by the pilot, it could only be used by specially equipped aircraft and trained crews, and it required a long, straight approach to the target. But it was accurate and as early as 1936 trials had shown that bombs could be put in a 300 metre square target area 300 kilometres from the transmitter.\textsuperscript{59} One must also remember, when assessing the success of the raid on Coventry, that it took place in 1940 when night defences barely existed.

While Churchill was expressing his concern at the accuracy of German bombing beams and British scientists were working feverishly to unlock their secrets, others denied their efficiency. In February 1941 the Deputy Chief of Air Staff questioned as to whether or not the British were 'tending to lose [their] sense of proportion over these German beams? We use no beams ourselves but we bomb just as

\textsuperscript{58} Price, \textit{op.cit.}, pp.44-5
\textsuperscript{59} Wakefield, \textit{op.cit.}, p.26
successfully as the Germans bomb ... I do not agree that the beams are ... a serious menace to this country ... They are simply aids to navigation and it is within our experience that such aids are not indispensable to the successful prosecution of bombing expeditions. I could go further and say that they are not even really useful'. The Deputy Chief of Air Staff at that time was Air Marshal Arthur Harris.

Admittedly Harris did change his opinion on the value of navigational and bombing beams but whether this was the result of a learning experience or was at the behest of superior authority remains a moot point. Unfortunately it was this reluctance to accept change, maintained not only by Harris but also by others with influence, the Group Commanders for example, that largely delayed the formation of the Pathfinder Force. Possibly they feared a loss of their independence. A certain euphoria existed for too long among senior officers over what were seen as the successes of Bomber Command. Perhaps the reality did not bear contemplation.

Even the Chief of the Air Staff, Portal, was not exempt from being suborned by the cloying air of unreality in the Air Ministry. In August 1942 in a letter to Air Marshal Tedder, Air Officer Commanding Middle East, declining Tedder's request for more heavy bombers, Portal said 'I am absolutely opposed to diverting more heavies from the attack on Germany which is really beginning to have great results'.

Winston Churchill also, played his part in the charade. In a message to President Roosevelt on 16 September 1942 he said, 'in spite of the fact that we cannot make up more than 32 squadrons of bombers, instead of 42 last year, we know our night bomber offensive is having a devastating effect'.

On a more mundane level, decorations for bravery or achievement were still being awarded on the basis of pilots' reports, while the photographs they had brought back, which were a denial of their claims, were ignored. Change was needed. Fortunately it was in the wind.

Pathfinding for the R.A.F. bomber crews became a necessity for many reasons. At heart was the reluctantly accepted lesson that the strategic bombing offensive would only provide adequate returns if the lesser able, or more inexperienced crews, were assisted in target location and identification. Inaccurate bombing, as confirmed by the Butt

60 Wakefield, op.cit., p.139
62 Webster & Frankland, op.cit., Vol.1, p.355
63 Ibid., p.425
Report of August 1941, however, was but one facet of a multi-sided problem. Much of the inaccuracy in bombing was the consequence of poor navigation which itself was the result of a lack of suitably accurate aids and insufficient training. There was also the belated recognition of the fact that to achieve wholesale destruction in the target area it was essential that the bombing force be concentrated in both time and space. With the German defences - searchlights, guns and night fighters - rapidly improving, the contraction in time of the bombing raid provided a form of defence for the individual bomber.

Allied to the aim of creating destruction, physical and mental, there was a growing awareness that bomb loads were not simply a matter of filling up the bomb-bays with what was most readily available. The proportion of incendiaries carried in relation to the weight of high explosives, and the order in which they were dropped on their targets, were critical elements in determining the success or otherwise of a particular raid. In order that the two-fold aim of physical destruction and lowering of enemy morale could be achieved, the Air Staff confirmed the principle of having raids led by an experienced Fire-Raising Party. They would be followed by the Main Force carrying high explosive bombs to be aimed at the established fires. These new tactics had been employed on the Abigail-Rachel attack on Mannheim as early as December 1940. Although unrecognised as such, R.A.F. pathfinding had commenced.

But even prior to the raid on Mannheim individual Groups in Bomber Command had attempted similar tactics. Lack of co-ordination and inadequate numbers, in combination with the failure to recognise and adhere to timing requirements, meant that such efforts were generally singularly unsuccessful. This expression of individualism by particular Group Commanders persisted and was encouraged by Harris even after the establishment of the Pathfinder Force in August 1942. While it is admitted that occasionally these initiatives were successful such splintering of effort was to the ultimate disadvantage of the strategic bombing offensive and a debasement of the efforts of the Pathfinder Force. The question must be asked: to what extent did Harris support and actively promote the individualism of particular Group Commanders at the expense of the collective effort of the Pathfinder Force? Harris had opposed the establishment of the Pathfinder Force and told Group Captain D.C.T. Bennett so when he was appointed leader. Harris agreed to support Bennett but as far as the Pathfinder Force itself was concerned he said, according to Bennett, that he 'would waste no effort on it'.

Did Harris harbour resentment? Was he obstructive? We will return to these questions.

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Although an Incendiary Plan had been prepared on the orders of Peirse in November 1941, it was not in fact implemented until March, 1942. By this time the plan had been refined to include the use of flares to assist in target identification. Air Commodore S.O. Bufton, Deputy Director of Bombing Operations (D.D.B.Ops), was the prime mover. In order that sufficient illumination could be obtained for target identification and accurate bombing, Bufton estimated that at least 100 flares would have to be maintained over the target for the duration of the raid. Provided flares could be maintained at this rate (and this meant the raid would have to be concentrated in time), then the initial Fire-Raising Force would be superfluous. There was always the problem, when it was the responsibility of the Fire-Raising Force to mark the target, that their success was dependent on weather conditions allowing target recognition and identification. Incendiaries in the wrong place meant scattered fires, confusion for the Main Force crews and consequent dispersal of the attack. Ideally, the combination of flares and incendiaries would have provided the best conditions. Flares would have helped to ensure that the incendiaries were dropped accurately and then the fires they caused would have provided the beacons for the Main Force. Continual supplementing of flares would have enabled Main Force crews to differentiate between real and decoy fires, or fires started by incendiaries in the wrong place.\footnote{Andrew, op.cit., pp.45-7}

\footnote{Ibid., p.48}
Bufton's suggestion was not well received either by Harris or the individual Group Commanders. Harris held firmly to his own theories on how the war was to be won while perhaps his Group Commanders were fearful of being reduced to playing minor roles. Harris was not a man either easily swayed by juniors or readily controlled even by his superiors. Therefore, the question of a Target Finding Force was held in abeyance.

After many delays Bomber Command finally accepted the Air Staff invitation to carry out an operational trial of the flare technique. On 3/4 March 1942 the Renault factory in Boulogne-Billancourt on the western outskirts of Paris was attacked by 223 R.A.F. bombers in three waves. A major consideration in planning this raid was that every effort had to be made to ensure that as few bombs as possible fell on the surrounding town. The operation order for the attack required that an advance force of heavy bombers was over the target from Zero hour to Zero +15. In this period they were to drop their flares, identify the target and then aim their 1,000 pound General Purpose bombs. This same force, operating between 1,000 and 4,000 feet, was then to drop additional flares up-wind from the target. From Zero +15 to Zero +45 Main Force aircraft, also flown by selected crews and equipped with flares and 1,000 pound bombs and operating in the same low altitude band, would then attack. Finally, from Zero +45 to Zero +60, the Rear Force flying between 4,000 and 6,000 feet were to drop their 4,000 pounders.

Results from this raid, despite the fact that no fewer than 367 French people were killed, were considered to be excellent. Bombing photographs clearly showing the targets were confirmed by later photographic reconnaissance damage reports. Concentration was shown to have been good.

The attack on Boulogne-Billancourt could, however, not be regarded at this time as providing a typical example of the difficulties facing Bomber Command and its crews. Firstly, the weather was much better than had normally been encountered when attacking targets in Germany, particularly those in the Ruhr Valley. The moon on 3/4 March was virtually full and although there was a slight ground haze there had been no cloud below 10,000 feet. Secondly, the defences were weak otherwise losses from attacks carried out from 6,000 feet and below would have been serious. Heavy bombers at such low levels were at hazard to even light flak defences. Finally, the attack had required no penetration of German territory proper and German defences were not aligned for the protection of either French people or property, even if they were producing war material for the Wehrmacht.

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67 Webster & Frankland, op.cit., Vol.1, p.388
68 Middlebrook & Everitt, op.cit., p.245
Only four nights later, on 8/9 March 1942, the next significant advance for Bomber Command took place. In a full trial of the flare and incendiary marking tactic, Essen was attacked by a force led for the first time by Gee-equipped aircraft. These aircraft in the vanguard, flown by selected crews, dropped flares to illuminate the target. Fire-raising aircraft then dropped their incendiaries by the light of the flares to provide fires to guide the Main Force. This test of the 'Shaker' technique9 (code-named 'Sampson' when the flares were dropped blind on Gee), produced only mediocre results. Gee had enabled the bombers to reach the vicinity of the target but industrial haze, typical of the Ruhr, had prevented accurate bombing.

By March 1942 there was increasing clamour, especially from those with operational experience, for the formation of some form of Target-Finding Force. These enthusiasts, led by Buxton, finally persuaded the Air Staff of the advantages to be gained from such an arrangement. Harris, supported by his Group Commanders, remained implacably opposed.

At this juncture it must be interposed that the experiences of Harris himself and his Group Commanders, of the use and purpose of air power, bore little relation to the requirements and difficulties pertaining in 1942. They were survivors from the biplane era and their practical experience had been gained, pre-war, on policing operations. While it cannot be denied that they may have accepted the efficacy of a strategic bombing offensive, it is nonetheless a fact that the plans that had been made in the mid and late 1930s, and in which they were often involved, had been found wanting in the first days of the war. Group Commanders could not admit to failures in their command because that meant the end of their careers. Additionally, with their ages averaging around the mid-fifties, were they at a stage of their lives where they could still readily accept not only radical but also rapid changes? Perhaps some of their opposition to the formation of any form of Target-Finding Force was based on narrow, personal reasons rather than accept what was necessary for the greater operational efficiency of Bomber Command. Baldwin, head of 3 Group in the pre-Pathfinder era, was the only Group Commander to have flown on operations. He flew, as a passenger, in a Stirling on the Cologne 1,000-bomber raid. Harris later ordered that his Group Commanders were not to take part in operations but Bennett was always of the mind they would have been better Air Officers Commanding had they done so.10

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9 See p. 273

10 Alan Bramson, Master Airman (Shrewsbury: Airlife Publishing Ltd., 1985), p.90
The acquisition of Gee, despite its failure as a bombing aid, provided the final justification as to the necessity for a Target-Finding Force. On 17 March 1942 Bufton again raised the question with Harris. Bufton's argument was based on an acceptance of the fact that Gee, as a navigational aid free from enemy interference, would have a finite life. The belief was six months at most. If the best use was to be made of the aid during the unjammed period it was essential that it was provided for the best crews so that they could act as leaders and markers. Even when the usefulness of Gee was denied, the existence of a group of competent leaders should, it was claimed, prove to be an inestimable advantage.

In April 1942 Bufton elaborated on his proposals. He suggested that six squadrons be formed into a specialised group and made responsible for target location and marking. For ease of coordination he recommended that these squadrons were based in close proximity. This arrangement, Bufton claimed, would allow for close coordination and ready consensus on the tactics to be employed. Naturally, because the selected squadrons would have the usual range of good, average and poor quality crews, they would need bolstering. Bufton suggested that 40 of the best crews in Bomber Command should be selected for dispersal among the selected squadrons to make them truly effective.\(^1\) It was Bufton's opinion that this measure would not unduly weaken those squadrons remaining outside the Target-Finding Force because, on average, only just over one crew per squadron would be transferred.

Bomber Command in the period from March to September 1942 was undergoing change. Medium bomber squadrons were phasing out their Whitleys and Hampdens and being re-equipped with Stirlings, Halifaxes and Lancasters. The heavy bomber force during this time increased from 14 to 25 squadrons while the medium bomber squadrons reduced from 30 in March to only 13 in September as a result of re-equipment and the transfer of squadrons to Coastal Command or other units. In mid-September 1942 there were, in theory, 38 squadrons in Bomber Command: 5 Stirling, 10 Halifax, 10 Lancaster and 13 Wellington.\(^2\) These figures formed the basis for Bufton's assessment.

Harris, outwardly at least, tried to give the appearance of being satisfied with both the results being achieved and the tactical methods being employed by the bomber force. In reply to Bufton, on 17 April 1942, Harris wrote that he was 'convinced now, after the last two months experience, that generally speaking the target when it can be seen at all is

\(^1\) Andrew, *op.cit.*, p.64

being correctly found'. Harris continued that he was 'not prepared to accept all the very serious disadvantages of a Corps d'Elite in order to secure possibly some improvement on methods which are already proving reasonably satisfactory'. Inwardly however, perhaps Harris was rather less satisfied with either results or methods than he claimed in public. In a letter to Air Vice-Marshall R.D. Oxland Air Officer Commanding No.1 Group, his assessment of the raid on Rostock on 23/24 April 1942, when weather conditions had been good, was that the bombing had been 'hopelessly wild'. Most effort, he continued was directed at 'burning down inoffensive villages, in some cases many miles from the target area'.

If read in isolation, this letter to Oxland, on 22 May 1942, could readily be construed as being written in support of the need for a Target Finding Force. Harris admitted the enormous difficulties facing the bomber crews but at the same time complained that crews were too often and too easily distracted from their correct target by either German decoys or fires started by ill-directed bombing. Harris in the same letter cited the attack on Mannheim on 19/20 May 1942 when 155 aircraft claimed to have attacked the city. Their bombing photographs showed mostly open country or blazing forests. Harris saw this raid on Mannheim as an example of crews taking too little trouble, of not coming sufficiently low to identify the nature of the fires, and of a lack of bombing discipline. It was also becoming clear to Harris that while there were a number of crews who regularly returned with good bombing photographs there were also others who 'consistently fail to get anywhere near the target'.

Support for Harris from his Group Commanders was somewhat negatively based. In general it would appear they were not optimistic of the future prospects for the bombing offensive. Their attitude, even if only by implication, appeared to be that better results could only be obtained if attacks were limited to easy targets in good flying conditions. Oxland, cited the Boulogne-Billancourt raid as having raised his crews' morale to 'an astonishing extent, and they are simply longing for the time when they can have a repetition of this sort of work'. But were they anxious to resume attacks on Ruhr targets? Or Berlin?

73 Webster & Frankland, op.cit., Vol.1, pp.421-2
74 AIR 14/3548, P.R.O. 88806, 22 May 1942, p.2
75 Middlebrook & Everitt, op.cit., p.267
76 Webster & Frankland, op.cit., Vol.1, p.425
77 Ibid., p.428
Baldwin, adopted much the same line. He recommended a revision of the target list inferring that raids on cities not previously attacked, where defences were minimal, would result in few bomber losses and therefore improved crew morale. Such tactics, he believed, would force the German defences to be spread more widely and would 'open up areas which at the present moment are so strongly defended as to be expensive when attacked'. Baldwin considered that too much was being expected of inexperienced crews and that operations on successive nights reduced both their efficiency and their morale.

Carr, accepted the problem of visual identification of targets and was thus a supporter for the continuation of either 'Shaker' or 'Sampson' techniques. By doing so he neglected the situation when Gee would not be available as a result of enemy jamming. He appeared ready also to overlook the displayed fact that attacks, particularly against prime targets in the Ruhr, were all too frequently failures.

The only other Group in Bomber Command equipped with heavy bombers at this time, No. 5, also had no wish other than to maintain the status quo. Already they were relishing their elitist role and this situation, with the support of Harris, was to persist even after the formation of the Pathfinder Force and throughout the duration of the war. In February 1942 it was the most powerful Group in Bomber Command and it had already been selected as the Group to be totally re-equipped with Lancasters during that year. When special missions were required 5 Group was given the task and the low level, daylight attack on the Maschinen Fabrik Augsburg – Nürnberg Gesellschaft (M.A.N.) factory at Augsburg in April 1942, was a prime example. Already this Group perceived themselves as specialists and leaders and they had no wish to be subordinated to another authority.

Harris, despite outward appearances, accepted that changes were inevitable. What he did not want were changes proposed by junior officers or enforced by his seniors. Harris wanted changes conceived and implemented by himself. He accepted the necessity of selecting individuals or units to lead attacks and in his Despatch pointed out that Bomber Command, as early as December 1941, had urged the formation of specialist squadrons to initiate raids. But he claimed that to establish a separate, permanent, Target Finding

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76 Webster & Frankland, op.cit., Vol. 1, p. 427

77 W.J. Lawrence, No. 5 Bomber Group R.A.F. 1939-1945 (London: Faber and Faber Limited, 1951), p. 59

80 Harris, Despatch on War Operations, p. 10
Force - a *corps d'élite* - could only result in a lowering of morale in Bomber Command. Individual crews outside the force would tend to feel inferior while squadrons would resent losing their best crews because it was from them that they had expected to promote their future leaders. Harris even suggested that individuals would resent being posted to another unit, not simply because they would then appear as new boys, but because by transferring they could forfeit good promotion prospects.

In rebuttal of this latter suggestion it was quickly pointed out, by the D.D.B. Ops, that few aircrew would be affected because it was intended that only one crew per squadron would be transferred to form the Pathfinder Force. He also made clear that nobody posted to the Pathfinder Force would fail to receive the promotion to which he was entitled at least as early as he would have received it had he remained on his original squadron. Additionally, as far as the P.F.F. was concerned, establishment strengths regarding the number of squadron leaders or flight lieutenants per squadron could be disregarded. In any case, surely the fixation for most was on the completion of the tour of operations rather than the prospects of promotion. Bomber Command crews had a difficult job to perform and most of those who succeeded regularly worked as a team. The individualism of the glory seekers in Bomber Command was rarely the recipe for successful operations. Team work meant survival; if promotion followed then well and good, and time for a party, but survival for most was the powerful driving force. Rank in a bomber crew was not a critical element.

Harris, on 12 June 1942, rejected not only Bufton's arguments but also those of the Air Staff, supported by Portal himself, which ran closely parallel. Again Harris claimed to have the support not only of his Group Commanders but also of the leaders of the best Target Finding Squadrons within the individual Groups. His assessment was that the system already being employed by Bomber Command - selected crews leading attacks - was working well and would not be improved by establishing a separate Target Finding Force. While they saw no advantage to be gained from such a formation, Harris and his supporters listed what they regarded as potential disadvantages.

Success for Bomber Command, they argued, lay not in the establishment of a Target Finding Force because that was no longer the problem. Seeing the target, they believed, now provided a greater challenge than its location. Darkness, industrial haze, searchlights, and the glare from their own flares were the problems to be overcome. Why, they questioned, would a Target Finding Force be better able to see than any individual crew in Bomber Command?
On a more practical level Harris suggested that because of restrictions on Foreign and colonial personnel and the technical attributes ... of some types of aircraft" he1 the choice of potential target locating squadrons was limited. He contended that only the Wellington and Stirling squadrons could be considered and to remove six of these when only thirteen were available would have disastrous consequences. Such a narrow choice, he claimed, could only result in lowered standards.

At this stage, and in the same letter to Portal, Harris now agreed to appoint 'Raid Leaders' on Squadrons, selected on a competitive basis as a result of successful operations in the previous month. Furthermore, in spite of his oft-repeated detestation of any form of corps d'élite, he suggested that these crews be distinguished by a special insignia. It was proposed that the large Royal Air Force 'eagle' as displayed on the warrant-officers' cap badge be worn on the left breast pocket of qualified personnel, below their aircrew brevet and medal ribbons.

By 15 June 1942, with already half the estimated jamming-free life of Gee gone, it was clear to Portal that the time for argument and discussion had finished. Naturally he was reluctant to impose his will upon a dissenting subordinate, particularly the Commander in Chief of Bomber Command. Fortunately the matter was resolved before drastic action was required. During an informal discussion between Harris and Portal on 15 June 1942, the C.A.S. persuaded Harris (whether by threat or cajolery will probably never be known) that some form of Target Finding Force must be established. Although Harris in his Despatch, written in 1945, said that the Air Ministry's insistence 'on the formation of a separate Pathfinding Force as a separate Group [was] yet another occasion when a Commander in the field was over-ruled at the dictation of junior staff officers in the Air Ministry' he hadn't always held this view. In a minute to Churchill on 6 July 1942, in relation to the Pathfinder Force he had written, 'I have been overborne by C.A.S. and the Air Staff'.

Perhaps the sorry saga over the procrastination in the formation of the Pathfinder Force had its roots in a fundamental difference of opinion between Harris and Buxton over the nature of an area bombing offensive. Did Harris view area bombing as an end in itself? Did he believe that sufficient bombs in built-up areas, urban and industrial, could create enough death and destruction to bring victory? Judging by his later reluctance to accept precision bombing

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81 Letter Harris to Portal ref. ATH/DO/6 dated 12 June 1942 held in Portal Papers, File 9, 1942, Entry No. 31
82 Harris, Despatch on War Operations, p.11
83 Webster & Frankland, op.cit., Vol.1, p.431, note 2
this would appear to be the case. On the other hand it is apparent that Bufton viewed area bombing as an interim measure. It was all that was possible at that particular time but it was a stepping-stone. With increased experience, improved aids and refined tactics, Bomber Command could, at some time in the future, look forward to a successful resumption of precision bombing.

The Pathfinder Force was finally established under Group Captain D.C.T. Bennett on 15 August 1942. Before we leave this section on its formation we must, however, give the last words to Harris. Again from his Despatch he wrote that 'the Pathfinder Force, although it did the most excellent work, nevertheless displayed all the handicaps and shortcomings which I had anticipated ... while in the latter part of the war my contention that each Group should find and maintain its own Pathfinding Force was proved infinitely the superior method when tried out in No.5 Group'. Harris' influence on the successes and failures of the Pathfinder Force will be assessed in the final section of this work when operations from August 1942 until the end of the war in Europe are discussed.

At the beginning of this section two factors were posited as dominating the considerations of Bomber Command planners in 1942 - experimentation and expansion. Experimentation has been discussed, now it is the turn of expansion. Expansion in 1942 remained the theory but it never became reality. As early as 1940 Churchill, after the defeat of France, had expressed his belief to the War Cabinet that 'The Navy can lose us the war but only the Airforce can win it. Therefore, our supreme effort must be to gain overwhelming mastery in the air ... the bombers alone provide the means of victory. We must, therefore, develop the power to carry an ever increasing volume of explosives to Germany'. Expansion of the bomber force in 1942 still remained the aim. Target Force 'E', 4,000 heavy bombers by mid-1943, was the goal. But hopes were fast fading that the aim could be achieved.

Target Force 'E' was based on the combined productive capacity of British and American factories. America's entry into the war, and the accord reached in Washington in 1942 in accepting the Presidential decree that as a general rule American aircraft would be flown by American crews, meant that Target Force 'E' ceased to be a viable concept. Target Force 'G' - 2,500 aircraft by December 1943 - became the new hope. Presumptions however do not necessarily translate into actuality. Particularly is this true when they are ill-founded. Target Force 'G' plans were not based on any realistic appreciation of the productive capacity of British

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64 Harris, Despatch on War Operations, p.11
65 Andrew, op.cit., p.1
aircraft factories. Orders were based on perceived needs rather than actual production capacities. However, it was the opinion of the C.A.S. that the "approved strategic needs of the R.A.F. should not, on principle, be subordinated to current production plans". Target Force 'G', specifying 135 heavy and 9 medium bomber squadrons, was therefore always just another phantasm in the time frame allowed.

Failure to meet production orders in the British aircraft industry was not simply the result of either an insufficient productive capacity or an unwilling or incompetent labour force. Had expansion plans simply required an increased number of Whitleys, Hampdens or Wellingtons, the targets could have been met. There had, however, been a growing awareness in Bomber Command in general, and the aircrew in particular, that quality improvement was as essential as quantity increase. If the bomber force was not modernised to cope with the increasing operational requirements and the improving German defences then the Command would continue to be cost inefficient and losses would rise to an unsustainable level. In 1942 new heavy bombers - Stirlings, Halifaxes and Lancasters - were slowly entering squadron service. They offered new prospects for the strategic bombing offensive.

Although welcome on Squadrons, new heavy bombers also placed a particular set of demands on the production system. They took longer to construct, required a more skilled labour force, and consumed more materials. There was also another demand in 1942 which affected all three Services as well as their supporting industries - an acute manpower shortage. The following table vividly shows that the enormous expansion of the armed forces between 1939 and 1943 meant reduced labour availability for even essential industries at a time when industrial demands were rising steeply.

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<thead>
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<th>Mid 1939</th>
<th>Mid 1943</th>
<th>Mid 1945</th>
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<tr>
<td>Total Labour Force</td>
<td>19,750,000</td>
<td>22,286,000</td>
<td>21,649,000</td>
</tr>
<tr>
<td>Armed Forces and Civil Defence</td>
<td>560,000</td>
<td>5,085,000</td>
<td>5,217,000</td>
</tr>
<tr>
<td>% of Labour Force</td>
<td>2.8</td>
<td>22.8</td>
<td>24.1</td>
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The manpower situation as far as the R.A.F. was concerned was equally worrying. Even the maintenance of the

86 Andrew, *op.cit.*, p.3
status quo required an expanded establishment to attempt to cope with increasingly complex equipment, an ever-growing training organisation and the rash of new airfields. Manpower insufficiency by itself was enough to show, by December 1942, that Target Force 'G' was yet another mirage. It was replaced by Target 'Force H' which although it aimed at increasing the number of heavy and medium bomber squadrons by 39 during 1943, at least tried to set strategic goals on the basis of the number of aircraft and personnel it believed would be available.

Quantitatively, Bomber Command strength during 1942 showed only a marginal increase. Figures provided by reputable authorities vary significantly but all have one common factor. Providing one only considers numbers, they all show the barely perceptible growth of Bomber Command over a particular period. Discrepancies can be partly accounted for by the fact that a squadron can be non-operational one day but operational the next - or vice versa. Another possibility is that a squadron could be loaned to another Command, or transferred to another theatre of operations - both these situations affect numbers. Perhaps the variations in numbers available that will be discussed confirm the truism that statistics never reveal the full truth.

According to Harris the average daily numbers of aircraft available with crews in January 1942 was 363 with this figure increasing to 418 by December of the same year. It was important that the figures were for 'aircraft with crews' because, until May 1943, the number of trained crews never exceeded 80 per cent of the establishment. Crew shortages were partially to blame for the fact that, compared with 1941, 1942 showed only a thirteen per cent increase in the number of sorties flown.

Another slightly different time frame is provided by the Narrative History. During the period 6 March 1942 to 4 February 1943 the number of heavy and medium bomber aircraft (not aircraft with crews) on unit charge in Bomber Command rose from 839 to 944. Throughout 1942 the same authority quoted an availability of aircraft with crews as only averaging 300. This figure of course could be exceeded by restricting leave or, in the cases of Cologne, Essen and Bremen, when special circumstances applied.

Harris, Despatch on War Operations, p.12

Note: The Official History in Bomber Command Order of Battle for 4 February 1943 (Vol.4, p.407) gives (by interpolation) a figure of 900 medium and heavy bomber aircraft on unit charge. Andrew's figures would appear to be for Total Strength of Established Squadrons rather than Aircraft on Unit Charge of Operational Squadrons.

Ibid., p.18
Numerically, therefore, Bomber Command's growth during 1942 was negligible. Mere numbers however are not the full picture. Bomber Command had increased its strength by its expansion of the heavy bomber force. According to Roberts there were 225 heavy bombers (including 61 Manchesters) at the beginning of this period and 662 (Lancasters, Halifaxes and Stirlings) at the end.\(^1\) These are aircraft numbers only and it must not be inferred, necessarily, that there were crews to fly them. Where Bomber Command had increased its strength was in the area of the bomb carrying capacity. In December 1941 the possible bomb-lift was only 1,609 tons but a year later it had increased to 2,721 tons.\(^2\)

However, it must not be assumed that Bomber Command's development in 1942 had only been an increase in bomb-lift capacity. Qualitatively, with the increasing number of four engine bombers entering front line service, there had been significant advances. As always, when new aircraft enter service, there were technical problems. Particularly is this the case under war conditions when time assumes especial importance. The Stirlings had encountered unforeseen delays in the production stage and high unserviceability rates when finally delivered to squadrons. On 30 December 1942 Harris complained to the Secretary of State for Air that the Stirlings had 'made no worthwhile contribution to the bomber effort for some time'.\(^3\)

Halifax production did encounter some problems, the tail wheel for example, but these were overcome. More serious was the fact that under operational conditions the Halifax performance did not meet specifications. Control difficulties – especially rudder over-balance, undercarriage problems, inadequate exhaust damping and the addition of external equipment, all contributed. By the autumn of 1942 the summation was that the Halifax had 'become incapable of meeting concurrently the operational requirements of both high loading and high-altitude cruising'.\(^4\) Halifax losses in August 1942 reached ten point one per cent – perhaps the only mitigating circumstance was that while only eleven per cent of Lancaster crews survived being shot down and seventeen per cent of Stirling crews, the figure for Halifax crews was twenty nine per cent.\(^5\) Structural modifications, cleaning-up of externals and the fitting of more powerful engines enabled the Halifax to extend its operational life.

\(^1\) Andrew, *op. cit.*, p.17
\(^2\) Ibid., p.18
\(^3\) Ibid., p.8
\(^4\) Merrick, *op. cit.*, p.34
\(^5\) Ibid., p.36
When the Pathfinder Force was formed on 15 August 1942 five squadrons were transferred from their parent groups. Aircraft types varied. Number 7 Squadron from 3 Group was equipped with Stirlings. Number 35 Squadron from 4 Group operated Halifaxes. Number 83 Squadron from 5 Group was flying Lancasters. Number 109 Squadron from the Wireless Intelligence Development Unit arrived initially with Wellingsons, as did Number 156 Squadron from 1 Group. Almost immediately 109 Squadron was re-equipped with Mosquitoes while numbers 7, 35 and 156 Squadrons were later re-equipped with Lancasters. Ultimately, by March 1944, there were only Lancasters and Mosquitoes in the Pathfinder Force. Therefore, we will look at these two aircraft types, both very different, in a little more detail.

Together, the Lancaster and the Mosquito were the most famous and successful bombers of the Second World War. This must be accounted strange because they came from opposing ends of the bomber designers' spectrum. While the Lancaster with both an offensive and theoretically defensive posture could be considered the ultimate aircraft of a type with its antecedents stemming from the First World War, the Mosquito marked the dawn of a new era in bombing aircraft design. Successors to the bomber version of the Mosquito, employing only passive defence systems, have been the Canberra, Vulcan and the American F-111 and B-1 bombers.

Stirlings, so their pilots claimed, were easier to fly than Lancasters but their poor ceiling made them the primary target of German anti-aircraft gunners and night fighter pilots. Halifaxes performed a tradesman's job but could at times require a maestro to control them. Lancasters, however, pleasing to the eye, admired by those who flew them, capable of carrying an enormous bomb load a long distance at a reasonable altitude and at a moderate speed, became the dominant heavy bomber in the R.A.F.

Harris called the Lancaster 'without exception the finest bomber of the war. It's efficiency was incredible ... It is astonishing that so small an aircraft ... could so easily take the enormous 22,000lb. 'Grand Slam' bomb ... The Lancaster far surpassed all the other types of heavy bomber'. Unfortunately its versatility and carrying capacity meant that it was expected to carry such loads that its performance was reduced. Increased bomb loads meant reduced speed, lower


Harris, *Bomber Offensive*, pp.102-3
operating altitudes and a loss of manoeuvrability - a potentially fatal combination. Air Commodore John Searby (nicknamed 'Honest John'\textsuperscript{98}), a decorated Pathfinder Force Captain, Master Bomber and Pathfinder Force Station Commander, wrote that the 'cursed Lancaster overload of an extra three thousand pounds (on top of an already significant bomb tonnage) imposed by Headquarters Bomber Command irked the crews more than somewhat'.\textsuperscript{99} Crews dumping their 'cookies' (4,000lb. bombs) in the North Sea while outward bound to a German target became not an infrequent sight.

Bomber design during the 1930s was based on outmoded thinking. It was a legacy of the First World War and its origins lay in the belief that bombers could compete with fighters and, if necessary, out fight them. Speed differentials between bombers and fighters for most of the inter-war period were minimal which buoyed the hopes of those claiming 'the bomber would get through'. In fact, however, the real question of bomber versus fighter in the First World War was never faced. Gothas operated over England virtually with impunity because there was no early warning system and no accurate knowledge of their movements above cloud. British fighters were unable to intercept in daylight because they were unable to reach the cruising level of the bombers in the time available. Another defensive measure, standing patrols, were simply non-viable. Perhaps, in 1918, it was fortunate for the crews of the R.A.F. heavy bombers built to attack Berlin that they were never put to the test. German fighters would have had time to reach the bombers' altitude if not on their way to the target then certainly on their return. With only limited numbers available in 1918 any strategic offensive may have been quickly ended.

Another deficiency in design of bombers in the 1930s, and it was not corrected even by May 1945, was an over-estimation of the bombers' defensive capabilities. With advances in armament technology, why were .303 inch machine guns persisted with for so long? Defensive armament should be effective - or was it a token gesture to provide the semblance of an effective defence? Also, why leave an unprotected undersurface which German \textit{Schräge Musik}\textsuperscript{100} equipped fighters exploited to the full? The defences of British bombers, including the Lancaster, were wasteful because they were generally ineffective and incurred a severe weight penalty.

\textsuperscript{98} D.W. Woolley, 'A Friend Remembered' in \textit{The Marker}, Spring, 1987, p.23


\textsuperscript{100} Literally, 'slanting music'. A pair of 20mm cannon fuselage mounted, firing upwards and forwards at an angle between 10 and 20 degrees from the vertical and using non-tracer rounds.
"COASTING OUT"
Lancaster III 166 Squadron

Michael Steele-Morgan
Lancaster Crew Positions

Navigator

From paintings by Michael Steele-Morgan
Lancaster Crew Positions

Pilot & Bomb-Aimer (above) Pilot & Flight Engineer (below)

From paintings by Michael Steele-Morgan
Lancaster Crew Positions

Rear Gunner

Wireless Operator

From paintings by Michael Steele-Morgan
which reduced both altitude and speed. Let an experienced bomber pilot have the last word. In his opinion, 'The Lancaster was therefore effectively unsuited for the purpose for which it was used. The armament weighed it down and was poor defence against night fighters. This was not the fault of those who designed and built it. They produced an aeroplane that had been specified by the Air Ministry'.

Let us turn now to an aircraft not originally produced to an Air Ministry specification - the de Havilland Mosquito, or 'Mossie' to its crews. The Mosquito was the classic example from the Second World War of an aircraft produced as the result of a private venture. Private ventures were never discouraged by the Air Ministry because they widened the choice for the Air Staff, ensured that requirements in specifications were kept under continual review, and were designed and built at no risk to the taxpayers. Normally a firm undertaking a private venture would examine the Air Ministry specifications but then proceed to build an aircraft outside those guidelines working on the assumption that 'we know what you want better than you do yourselves ... when you see our product you will agree that we are right and you will have to give us a production order'.

Perhaps, of all the aircraft designed and produced by British aircraft firms after rearmament commenced in the 1970s, the de Havilland Mosquito was the only example of an aircraft which came into quantity production whose performance filled an Air Ministry requirement which had gone unrecognised. As a 'family firm' de Havillands had received invitations to tender for aircraft to meet Air Ministry specifications but these aircraft, they believed, would be compromises. Conflicting demands of armament specialists, tactical requirements, and equipment installation needs, placed too many restrictions on design teams. At a time when the Air Ministry were being forced to convert Bomber Command from day, self-defending tactics to night infiltration, the idea was conceived at de Havillands that the R.A.F. required a fast, unarmed bomber capable of carrying out attacks by day. It was to carry two crew, a pilot and a navigator and, an evolutionary suggestion, would be of wooden construction. The firm decided on wood because they had extensive experience in its use in aircraft construction; the metal industry was already at full capacity and it was a time-saving initiative.

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Mosquitoes B Mk.IV
No.105 Squadron, Marham
December 1942

Royal Air Force Museum
With the support of Sir Wilfrid Freeman, (at that time Air Member for Development and Production), orders were placed late in 1939 for the Mosquito, but only for use in photographic reconnaissance. Unarmed bombers were not ordered until 28 July 1941 because latent opposition had been strong. It remained so and, as a consequence, despite its carrying capacity at high altitudes and high speed over a good range, the vast majority of Mosquitoes were employed other than as bombers.

Harris, just as he opposed the formation of the Pathfinder Force and Barnes Wallis's 'bouncing' bombs used on the Möhne and Eder Dams, opposed also the entry of the Mosquito to Bomber Command. It was alleged that in 1941 he wrote a memo to the effect that 'Anyone who supports having this wooden trash should be strung up from the highest lamppost in Whitehall'. Mosquitoes performed outstandingly well in their reconnaissance, night fighting and bombing roles and, if for no other reason than their success as 'Oboe' markers for the Pathfinder Force, deserve a prominent place in this account.

At the beginning of this section it was indicated that 1942 for Bomber Command was a year of experimentation. Oboe, a blind bombing aid developed during 1941 and 1942, and first used operationally on 20/21 December 1942, confirms this hypothesis. It had limitations, which will be discussed, but it was the most precise blind bombing system produced during the Second World War. Oboe was a radar aid based on the responder system. Aircraft engaged on Oboe operations carried a beacon capable of receiving and transmitting. Two triggering stations on the ground, normally not less than 100 miles apart, transmitted pulses which could be received in the aircraft beacon which then retransmitted. These retransmissions were received by the ground stations each of which was then able to accurately measure the range of the aircraft.

Early in 1941 the Telecommunications Research Establishment (T.R.E.) at Malvern were experimenting with a system they called 'Howler Chaser'. They were attempting to control an aircraft in azimuth by range measurements. A remote transmitter was to be modulated so that a pilot off-track to one side of the correct path would receive dots in his head-phones and when on the other side would receive dashes. On the correct track a continuous note would be heard. One member of the research team considered that the continuous note sounded like an oboe and, although the bombing system later employed by Bomber Command was markedly different from those crude beginnings, the name persisted.\(^{104}\)

\(^{103}\) Bramson, *op.cit.*, p.77

\(^{104}\) Air Ministry, *Signals* Vol.3 Aircraft Radio, p.212
Basically, the Oboe system employed two ground stations: one, the tracking station - called 'Cat' - by transmitting dashes and dots, advised the pilot whether he was to port or starboard of the correct approach path. If the aircraft was closer to the Cat station than the correct approach path dots were heard. Dashes were heard if the aircraft was further away from the Cat station than the correct approach path. The second station - called 'Mouse' - measured the aircraft's ground speed, provided warning to the aircraft navigator of the approach of the bomb release time and, finally, transmitted the release signal.

The approach path for the Oboe controlled aircraft was the arc of a circle with the radius being fractionally less than the distance of the Cat station from the target. This slightly lesser range allowed for the bombs or markers to continue tangentially to the curved approach path and thus strike the target. Oboe aircraft were navigated by the most accurate system available, usually Gee or another guidance beam, to be in a position ten minutes' flying time from the stores' release point. This position, together with the altitude and airspeed at which they were to fly had been provided to the crew at briefing. Each Oboe crew had its own callsign and when this was transmitted by both Cat and Mouse stations the aircraft repeater was switched on and the run commenced.

During the run-in the Cat Station would also transmit X, Y or Z, in morse, to indicate to the pilot his distance off the correct approach path. By hearing either dots or dashes he knew which side of the correct path and the letters told him whether he was 5, 10 or 20 miles off. This enabled the pilot to apply coarse or fine heading alterations to regain track. For the navigator's benefit the Mouse Station transmitted A, B, C, or D to indicate 10, 8, 6 and 3 minutes from the release point. Finally, the Mouse Station transmitted 5 dots then a 2.5 second dash to indicate the release point had been reached. On pressing the bomb release the aircraft transmitter was cut out so the ground stations were aware of the precise release time. The navigator then turned off the transmitter and the next Oboe aircraft was called in.105

This basic Oboe system had four major disadvantages. With the ground stations only able to handle one aircraft at a time, and with the best run taking ten minutes, the maximum number of aircraft that could be handled was only six per hour. Blind-bombing attacks therefore could achieve no concentration. This limitation was overcome later in the war by opening more Oboe transmitting stations and by developing multi-channel control. In the latter case a single

105 Musgrove, op.cit., pp.221-2
pair of stations, by using different pulse recurrence frequencies, could control more than one aircraft. Secondly, because each aircraft was expected to fly straight and level for at least ten minutes, it was believed they would be at risk from flak and fighter interception. By using Mosquitoes losses were kept very low. Thirdly, was the question of range. Some elements were mutually exclusive. Range at which Oboe signals could be used was a function of height but that was determined by the bomb load carried. Again, by using Mosquitoes with their high flying capabilities, and by employing them as markers and thus keeping weight down, maximum ranges were achieved. The final perceived disadvantage was that the aircraft itself transmitted signals so it was possible that they could be used by the enemy for homing purposes. The few, irregular losses incurred would indicate that this did not become a significant problem.

Because of the limited number of aircraft able to use Oboe its most useful function was in a marking role. Mosquitoes with their high speed and altitude capabilities came to be remarkably successful. Oboe was accurate but it was limited by range restrictions. At about 28,000 feet the range was approximately 270 miles so Ruhr targets were vulnerable. Deep penetration targets in Germany were safe from Oboe - led attacks until either airborne repeater stations were employed or mobile Oboe stations were established on the Continent.

H₂S is the third type of radar aid to be considered (after Gee and Oboe) and was based on the reflective system. A radar receiver and transmitter were both carried in the aircraft and the reflected echoes from ground, water and buildings were displayed electronically on a plan position indicator (P.P.I.) in the aircraft in a map-like form, with the aircraft's position being at the centre of the P.P.I. Although it was not used operationally until 30/31 January 1943 against Hamburg, the major developments had occurred during 1941 and 1942 so it fits conveniently into the 'experimentation' year. One credit for naming the equipment is accorded Lord Cherwell. When advised how long Bomber Command had been waiting its introduction he remarked that 'This whole affair stinks'.¹⁰⁶ He then suggested the equipment be called H₂S and thus it remained. At least the name provided minimal security risk.

Two problems, closely interrelated, dominated Bomber Command's concerns during 1942. Both navigational and bombing accuracy had fallen well short of expectations. Experiments in 1939, in navigation, using equipment called Airborne Interception (A.I.) had shown that radio waves of an

¹⁰⁶ Musgrove, op.cit., p.232
OBOE BOMBING and MARKING

Release point letter 'S' transmitted by MOUSE if aircraft was more than 10 minutes flying time from the target.

Mouse or releasing station

'CAT' or tracking station

Fig. 27
appropriate wave length were returned from the surface below. Depending on the reflective properties of that surface they produced distinctive and identifiable 'echoes' or returns on a cathode ray tube. Built-up areas produced the strongest returns and showed up brightest on the screen. Open countryside appeared less bright while water surfaces tended to leave the screen comparatively dark. Imperative defensive needs, however, dominated in 1939 and 1940 so it was not until 1941 that further consideration could be given to providing a visual presentation of the surface below an aircraft which could be used for navigational purposes.

Detection equipment using this reflective principle, Air to Surface Vessel (A.S.V.), was already in use in 1941 for Coastal Command aircraft in their struggle against the U-boats. A.S.V. presentation, however, was of a 'look ahead' type and only covered shallow angles to either side of the aircraft's fore and aft axis. It was readily appreciated that a navigator would be better served by being presented with a radar map of the surface surrounding his aircraft rather than a narrow view of what was ahead. Such equipment, with a rotating scanner or beam, and a P.P.I. presentation was already being used in Ground Controlled Interception (G.C.I.) stations. What was needed in an aircraft was a scanner to produce a narrow, horizontal beam of radiation with a wide vertical sweep; synchronised to a rotating time base on a C.R.T. Trials using two Halifax aircraft, which allowed a variety of scanner positions to be tested, were successfully held early in 1942.

At this stage of development it was still unclear as to the primary function of H.S. Was it to be used as a navigation aid, a bombing device, or both? On 19 May 1942 it was decided that it was to be used for 'the blind detection of built-up areas'. This definition did not really answer the question but there was no suggestion at this time that H.S could be used for precision bombing. All that was expected of the equipment was that it should enable an aircraft to home to a built-up area (defined as not less than one mile in diameter) from 15 miles distance while flying at 15,000 feet and that it could be used for area bombing.

With it becoming apparent that some form of H.S was to be installed in Bomber Command aircraft, a serious disagreement broke out between the senior naval and air members in the Chiefs of Staff. A.S.V and H.S developments had been proceeding in parallel using a Klystron valve. But now the Magnetron, considerably more powerful than the Klystron, and offering significant operational advantages, had been

107 Andrew, op.cit., p.78
108 Air Ministry, Signals Vol. 3 Aircraft Radio, p.43
109 Ibid., p.37
developed. With the Magnetron Britain had a substantial lead over Germany in centimetric radar. The navy feared that the loss of a bomber fitted with a Magnetron valve in its H₂S could reveal the secret to the German authorities. Such a revelation would mean that the advantages held would be lost and the anti-U-boat campaign would suffer. Destructive devices, activated in the event of a crash, had been tried in aircraft but they failed to conceal the dimensions of the solidly constructed Magnetron. One experiment, tried by the British authorities in a captured Junkers 88 aircraft, blew a 10 foot hole in the fuselage but did not prevent experts from later gauging the size of the valve.¹¹° Strangely, although the scanner would also reveal the centimetric wavelengths being used, no clamour was raised with regard to its destruction in the event of a crash in enemy territory.¹¹¹

On 15 July 1942 the Chiefs of Staff agreed that H₂S, fitted with the Magnetron valve should be provided for use by Bomber Command. Doubtless their agreement was strongly influenced by Churchill's insistence, on 3 July 1942, that every effort was to be made to equip two squadrons of heavy bombers by October 1942.¹¹² Production and development problems clearly indicated that in that time frame two squadrons would be a maximum. In the meantime an embargo was placed on using H₂S equipped aircraft over Germany.

As time went by the Air Ministry became increasingly convinced that in conjunction with the new marker bombs being developed H₂S would vastly improve bombing results. They pressed for the immediate introduction of H₂S. Winter was approaching and the longer nights allowed for attacks on more distant targets. H₂S was vital in determining their location. Especially was this true after August 1942 when Gee signals were subjected to increasing enemy jamming. The navy remained implacably opposed. Centimetric radar was unknown to the Germans and they did not want to run any risk of having its secrets revealed.

On 8 December 1942 the Secretary of State for Air convened a meeting attended by the C.A.S., Lord Cherwell, Harris and others, to consider the use of H₂S in bomber operations. Harris was anxious that the Pathfinder Force receive the equipment first (he was not always so disposed) and that, even if only two squadrons were equipped, that its operational use be authorised immediately. Agreement was reached that Numbers 7 and 35 Squadrons be equipped with H₂S and their crews trained in its use. This decision really

¹¹° Air Ministry, Signals Vol.3 Aircraft Radio, p.40
¹¹¹ Ibid., p.45
¹¹² Ibid., p.38
presented a fait accompli to the meeting because it determined when operations using H$_2$S would commence. They would start when equipment and training of the two Squadrons had been completed. Bomber Command could not afford, over the winter of 1942/43, to have two squadrons withdrawn from front-line service because of any ban on the use of H$_2$S. Nor could they afford the luxury of screening H$_2$S-trained navigators from operations while they awaited the equipments introduction into service. On 22 December 1942 Churchill and a majority of the Chiefs of Staff Committee found in favour of Bomber Command using H$_2$S as soon as possible. This finding was confirmed by the Combined Chiefs of Staff in the United States on 8 January 1943.

On 30/31 January 1943 Hamburg was the first German target to be attacked by P.F.P. aircraft equipped with H$_2$S;\footnote{Andrew, \textit{op.cit.}, p.82} Cologne was the second, on 2/3 February 1943. During this second raid an H$_2$S equipped Stirling of 7 Squadron was shot down by a German night fighter near Rotterdam. Wreckage investigation by a German team revealed the presence of some new radar equipment operating on centimetric wave lengths but to what purpose was not immediately clear. In this particular case the P.P.I. display unit was not recovered at the crash site. Weeks were to pass while German scientists built up a picture of how the equipment worked while months passed before they learned of the display provided in the aircraft. Provision of H$_2$S detection devices for the \textit{Kriegsmarine} and the \textit{Luftwaffe} proceeded apace. By May 1943 'Naxos', a radar receiver for homing on centimetric wave length transmissions, was being developed for installation in German night fighters.\footnote{Price, \textit{op.cit.}, p.143} On 11 September 1943 the equipment, which the Germans would later identify as SN-2, was air tested and gave good results.\footnote{\textit{Ibid.}, p.192}

SN-2 was a German night fighter radar with a maximum range of four miles but a high minimum range of 400 yards, and because of this latter disadvantage, only became operational when it was appreciated that its high operating frequency meant it was not affected by 'window'. 'Window' as it was called by the allies, or \textit{Düppel} by the Germans, were metallic strips dropped by aircraft to provide a multitude of targets on radar screens.
Nor was this all. Ground based radar stations, code-named 'Korfu', were built in a network across Germany which were capable of receiving \( H_2S \) transmissions even from bombers on the ground in England. Plotting their progress across the North Sea and into Europe was simple and accurate and thus the position of every bomber stream employing \( H_2S \) was known precisely to the German defence organisation.\(^{116}\)

As \( H_2S \) was completely self-contained in the bomber aircraft it offered advantages over both Gee and Oboe. Not only was its range unlimited but also there was no restriction on the number of aircraft able to use the aid at any one time. Enemy jamming was difficult but perhaps this was not especially advantageous as for too long, unbeknown to the R.A.F., \( H_2S \) transmissions were used to home-in the German night fighters. Navigationally, the possession of \( H_2S \) meant that weather, either en route or in the target area, was not necessarily a factor in raid planning. \( H_2S \) provided considerable tactical freedom. It also ensured accurate timing and track keeping, provided guidance in avoiding defended areas and helped in concentration of the bomber stream and in the actual attack. Finally, \( H_2S \) appeared to offer the prospects of bombing accuracy even when cloud conditions prevented precise, visual ground marking or wind problems precluded satisfactory sky marking.\(^{117}\)

Despite the wide use made of \( H_2S \) by Bomber Command in the Second World War, it had both limitations and disadvantages. High unserviceability rates imposed limitations on the use of the aid. The aircraft installation was also large and complex while the newness and novelty of the equipment plus the inexperience of the operators and the servicing teams created additional problems. \( H_2S \), because of operational demands, had entered service use before adequate trials had been completed. Interpretation of the P.P.I. also required training and experience. Naturally, training time was limited so crews went on operations attempting to use \( H_2S \) but lacking much of the necessary knowledge which would have provided better results.\(^{118}\) Coastal features were normally easily identified but built-up areas presented difficulties. The angle of approach caused both the shape and appearance of towns and cities to vary and nor did these necessarily conform to either what was shown on a map or could be observed visually. As well, the greater the size of the built-up area

\(^{116}\) Webster & Frankland, op.cit., Vol.4, p.13

\(^{117}\) Andrew, op.cit., pp.83-4

\(^{118}\) \( H_2S \) Mk 9, in use in Bomber Command in the mid-1960s, even with all the refinements and developments of more than 20 years, still required that qualified navigators had to pass a 12 months' training course on the equipment before commencement of any O.C.U. course.
the more the returns, the brighter the echoes on the P.P.I. and the harder it became to identify a particular target. Berlin, thanks to these limitations and the very considerable efforts made by the German authorities to disguise what would otherwise have been recognisable features, provided the classical example of a difficult H3S target. The major disadvantages of H3S were that the individual bomber provided a directional signal for its own destruction to suitably equipped German fighters while the bomber stream position was always able to be closely monitored when H3S equipment was operating. Nevertheless Bomber Command was, in 1943, about to enter a new era, equipped with a Pathfinder Force, new navigational and bombing aids and an expanding force of reliable heavy bombers able to deliver a heavy bomb load with increasing accuracy.
The Scheldt estuary photographed on the indicator tube of a 10-cm H2S set in a Pathfinder aircraft, on the night of 20/21 December 1943. The accompanying map (below) demonstrates the accuracy of the set.

Leipzig at eight miles' range. A photograph of an H2S Mk III indicator tube on the bombing approach during the raid on Leipzig, 3/4 December 1943. The straight thick line shows the aircraft's heading, while the circle is the bombing ring set at the appropriate range for bomb release—when the ring and heading line coincided with the aiming point the bomb aimer released his bombs. This system permitted quite accurate bombing through cloud.

H2S in Action

Dudley Saward, 'Bomber' Harris
13. Formation of the Pathfinder Force

Pathfinders played such an important role in Bomber Command's strategic offensive that it is necessary to consider more closely the arguments, both for and against, and the personalities involved, before the force was finally established on 11 August 1942. In theory, the pre-war training of aircrew, which until late in the 1930s meant only the training of pilots, was designed to ensure that all were experts in the arts of flying, navigation, photography and bombing. Peacetime training was completed with an acceptance that bombing operations would be carried out in daylight by powerful formations all flown by experts and with the capability of deterring all enemy opposition. Alas for misguided hopes! After the abortive and disastrous daylight raids in September and December 1939 it had, reluctantly, to be accepted that bombing could only be attempted during the hours of darkness by aircraft operating singly, in an unfamiliar and unfriendly environment, and flown increasingly frequently by inadequately trained crews. Bomber crew losses rapidly reduced hard-won experience and with training courses necessarily being reduced in length to fill casualty-caused squadron vacancies, Bomber Command's effectiveness was, by 1942, under severe threat. The final argument that confirmed the absolute priority for the establishment of a force capable of leading their lesser experienced brethren to their targets was provided by the failure of Gee to measure up as both a navigational and a blind-bombing aid. Air Chief Marshal Sir Arthur Harris, head of Bomber Command from 22 February 1942 had, until August of the same year, been able to deflect demands for the formation of a separate target finding force. Harris saw the establishment of any form of a corps d'élite as harmful to the overall morale of Bomber Command. He had also been buoyed by the belief that Gee would enable all crews to locate and destroy their targets despite the problems of navigation, weather and enemy defences. His arguments were, he claimed, supported by his various Bomber Group commanders.

It could reasonably be argued that Harris and his supporters were perhaps somewhat out of touch with the realities of the bomber war. Their flying experience had been gained between wars on vastly different aircraft and having to face no significant enemy opposition. They had achieved their high positions by having completed the appropriate staff and command courses and having served the necessary apprenticeships. But the question must be asked: were they fully aware of problems of navigation, target location and bombing, nightly having to be faced by inexperienced crews while at the same time they attempted to overcome the difficulties and dangers created by darkness, hazardous European weather conditions and the actions of a skilled and determined enemy?

Long after the formation of the Pathfinder Force (P.F.F.) the tragic losses in the attack on Nuremberg on the night of
Service Terms Illustrated
by
Well-known Newspaper Cartoonists
No. 1. WYNDHAM ROBINSON of The Star

BLANK'S ALES & STOUTS

PATHFINDERS

TEE EMM  Feb. 1943
13/14 March 1944 highlighted the problem of the exercise of control by leaders who lacked practical and recent operational experience. This raid provided the classical example of Harris overruling the planning of the P.F.P. in order to give his Main Force Group Commanders the opportunity of testing their own theories. Air Vice-Marshall Bennett of the P.F.P. supported by several of his squadron commanders objected strenuously, but without success, to the direct routing planned and the absence of major spoof raids to draw away enemy night fighters. From an attacking force of 795 aircraft no less than 94 were lost. Some viewed the disaster as a catastrophic accident but Bennett claimed that 'it would be best from an historical point of view and as a lesson for the future to realise that it was caused and not simply accidental'.

Air Vice-Marshall the Hon. Sir Ralph Cochrane, head of 5 Group, planned the raid as a novel tactic and his plan was accepted by Harris. Virtually direct routing to Nuremberg that would allow fuel loads to be reduced and bomb loads to be increased were the bases of Cochrane's plan. Even after the débâcle Cochrane reaffirmed that no other routing had been possible. Bennett, although not always happy with the official history of the bomber offensive, agreed with Sir Charles Webster and Noble Frankland that Bomber Command, on 13/14 March 1944 had been the victim of 'unusually bad luck and uncharacteristically bad and unimaginative operational planning'.

Bennett, never one to mince his words and frequently involved in differences of opinion with Cochrane (although he later claimed him as a personal friend*), provided his reasons for the disaster. He returned to the question of lack of operational experience among senior commanders. Bennett attributed the rejection of P.F.P. tactics, which had previously saved so many lives, to 'human weakness that they (Cochrane and his supporters) should revolt against the loss of their power to a youngster in another group ... one must remember that practically no senior officers in the R.A.F. had any appreciable first hand operational experience in the current war and they were therefore at a grave disadvantage in any tactical planning'.* At the time of Nuremberg, Bennett was 33 years of age while Harris and the other Group Commanders were in their fifties.

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1 Bennett, op.cit., p.190
3 Webster & Frankland, op.cit., Vol.2, p.209
4 Bennett, Pathfinder, p.176
5 Jackson, op.cit., p.92

* Indicates footnotes for further information.
It was not necessarily the fault of the senior commanders themselves that they lacked recent operational experience. Winston Churchill as Prime Minister, the Cabinet, and the Air Council, had all agreed because of the security risks involved, that senior officers should be prohibited from making operational flights over enemy territory. This of course was not a novel problem. Many different answers have been provided at different times as to whether or not a nation's leaders should be placed in positions of risk in times of war. As confirmation of the complexities involved even the R.A.F. and the U.S.A.A.F. adopted contrary positions in the Second World War. While senior U.S.A.A.F. officers were encouraged to actively participate in operations R.A.F. officers were ordered to remain chairborne. Bennett later considered that this embargo 'cost us thousands of lives and many failures and was in my view the most deplorable of all the mistakes which we made during the war'. Bennett's summation was that for every Air Vice-Marshals lost, at least 200 crews would have been saved.

Bomber Command's situation towards the end of 1941 was critical. The Butt Report of 18 August 1941 had clearly revealed the shortcomings of Britain's only offensive arm. Morale of the bomber crews, a vital element in the air offensive, was at a particularly low ebb. Crews felt they were being expected to achieve the impossible by faceless commanders who comprehended neither the risks nor the difficulties which they were encountering. Bomber Command's future as a separate, strategic entity was at risk.

In early 1942 the concept of a Target Finding Force manned by skilled and determined crews was nothing new. Gee, first used operationally in March 1942, had enabled most crews to reach the vicinity of a particular target area (accepting the limitations of range) but it had not solved the problem of target identification when crews were confronted by searchlight glare, anti-aircraft fire, enemy night fighters, and the additional difficulties posed by weather or the industrial haze prevalent in the Ruhr Valley. 'Shaker', the method whereby Gee-equipped aircraft visually illuminated the target, and its off-shoot, 'Sampson' - blind bombing using Gee - had both been tried and found wanting. Crews, in the final stages of a raid, were still dependent on visual methods to locate their targets. Essen, a major target in the Ruhr and the heart of the giant Krupps' empire, had proved invincible to current bombing tactics. Gee, it was also appreciated, could at any time have its navigational usefulness severely reduced by German jamming activities. Successful large scale bombing operations several of the Air Staff believed, depended utterly on the ability of the leading crews in any raid to locate and mark the aiming point for the benefit of the following and lesser-experienced crews. Too many examples had already been identified when bombing attacks achieved nothing because fires on the ground, even though they were not

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Jackson, op.cit., p.92
in the designated target area, were accepted by the majority of crews as being the correct aiming point.

In any discussion on a Target Finding Force it is relevant to note that as early as June 1936 Harris then a Squadron Leader commanding No.58 Squadron based at Worthy Down in Hampshire, had clearly expressed his ideas on possible future bombing tactics. Until 1926 night bomber tactics were to operate at low level, one aircraft at a time. Formation flying at night was not accepted as an option in the relevant Air Publication (A.P. 874) at that time. Harris had however proven to his own satisfaction, both earlier when based in the Middle East and again at Worthy Down, that 'not only is it feasible but it is comparatively easy'.

A.T. Harris, mistakenly identified as Squadron Leader A.H Harris in the Narrative History, in a report called for by the Director of Training on night formation flying tests that his squadron had carried out, pointed out the advantages he had identified. Harris urged that 'by flying in formation night bombers would be better able to defend themselves when returning in daylight or twilight from long raids, and would navigate more accurately in war since the lowering of navigational standards might be offset by the few really good navigators being able to guide the rest of the Squadron to its target'. His words provide a sense of déjà vu when the argument in 1942 over the need for, and the shape of, any form of Target Finding Force are considered.

During 1941 the Air Staff drew up an Incendiary Plan. It aimed not only at making particular German cities uninhabitable but also bringing to the notice of all Germans the dangers to which they were continually exposed. The principles employed, of having an Initial Fire-Raising Party saturate the enemy's fire-fighting organisation followed by a Main Force carrying high explosive bomb loads, was nothing new. Individually the bomber groups had already experimented along similar lines. Unfortunately their efforts were uncoordinated and of insufficient strength. Bomber crews in early 1942 still operated mainly as individuals, adhering to their own routings, bombing levels and timings. What was required was the combining of these individual pin-pricks into one massive blow. Although the first full trial of the Incendiary Plan was not carried out until March 1942 its relevance to this story is that it was the first major step towards a coordinated plan for the tactical employment of Bomber Command. It presaged the formation of what came to be called the Pathfinder Force.

Wernham & Frankland, op.cit., Vol.1, p.45

Ibid., p.45

Ibid., p.46
Weather conditions en route, in the target area, and on return to base, were the crucial elements in the Incendiary Plan and the greatest disadvantage. Even assuming that the best crews leading the fire-raisers were able to identify and set alight their briefed targets (always a major problem) there was still a requirement for good visibility in the target area to ensure the success of a raid. Fires lit in the wrong places always attracted more than their fair share of high explosives from raw crews anxious to vacate a dangerous area. Obscuration of the specific target by smoke from ground fires provided the excuse for the virtual random dropping of bombs by many of the Main Force. Because of the perceived short-comings of the Incendiary Plan no doubt the Air Staff received, with some relief, Air Commodore S.O. Bufton's paper, written in November 1941, suggesting a new approach to the bombing problem.

As Deputy Director of Bombing Operations Bufton had joined the Air Staff bringing with him wide and recent experience of bombing operations. He understood the difficulties, dangers, and the needs of bomber crews. Since July 1940 he had served successively as the Commanding Officer of Numbers 10 and 76 Bomber Squadrons and as Station Commander at RAF Pocklington, another bomber base. He had flown extensively on operations and, as Station Commander, had listened to the post-raid comments of crews at numerous debriefings. Aircrew in general, after the stress of a bombing raid, were usually in no mood to prevaricate. When criticism of commanders, tactics, or their aircraft were considered warranted their feelings and beliefs were succinctly expressed. Bufton's paper outlined a scheme whereby sufficient flares were to be dropped as to convert the normally shielding darkness into the clarity of day and thus simplify the problem of target identification. Implementation of Bufton's scheme required the establishment of a small force of highly skilled and determined crews who could locate, identify, and illuminate the target to act as both a beacon and an aiming point for following aircraft. Crews selected for such a force would have to be of above-average standard because their task required precise co-ordination, accurate timing and determination.

Meanwhile, other squadron commanders in the bomber force were formulating their own plans to improve not only their own squadron's performance in particular but also Bomber Command's performance in general. In a paper dated 18 April 1942 Wing Commander D.C.T. Bennett commanding No. 10 Squadron at RAF Leeming outlined a programme to ensure his crews secured a role as a target finding squadron. Bennett's guideline was 'nothing but the best'. Already he had recognised that
'Target finding is essentially a matter of navigation. All members of the crew with the exception of the flight engineer must be organised to work together in carrying out the navigation'.

Bennett, in the same paper, confirmed the essentiality of comprehensive training and the need for target finding crews to always be provided with the latest equipment for all their tasks. He defined the essential features of a target finding squadron as the provision of adequate facilities, the need for individual crew members to work as a team and that 'a spirit of precision (sic) be instilled into all air crew'.

Finally, Bennett pointed out that if targets were to be clearly marked, target indicators had to be available in different colour combinations so that other flares or incendiaries did not, inadvertently, act as decoys.

Bennett's plans at this time came to nought. In a personal letter to a colleague in the Air Ministry on 7 June 1942 he expressed his disappointment. 'The A.O.C. has apparently decided against the policy of having any particular squadron detailed for target finding purposes and therefore 10 Squadron will remain extraordinarily ordinary'.

Although the reaction of Peirse, then head of Bomber Command, to Bufton's paper is unknown, it had attracted the attention of Harris who replaced Peirse on 22 February 1942. Many historians dealing with the relationship between Harris and Bufton, including A.S. Jackson in his 1991 book on Bennett, talk of resentment and resistance on Harris's part.

Significantly, however, the demi-official letter from Bufton to Harris on 17 March 1942 indicated, in the first paragraph, that Harris had sought clarification of the ideas held in the Directorate of Bomber Operations on the subject of a target finding force. Bufton's letter addressed specifically to Harris began 'You were kind enough to ask me yesterday to send you any further ideas which we had here on the subject of a target finding force. I am very grateful to you for giving me this opportunity of expressing my thoughts on paper'. Even the fact that Bufton, then a Group Captain and only Deputy Director, wrote directly to Harris is unusual, but it is clear that Harris had sought Bufton's opinion.

Unaddressed letter by Bennett dated 18 April 1942 headed 'Target Finding Force. Memorandum on Squadron Organisation'. In Author's possession. From Bennett papers.

Ibid.

Letter, Bennett to Smith, 7 June 1942. In Author's possession.

Jackson, op.cit. p.59

AIR 20/489, P.R.O. XC 1312, 17 March 1942
Bufton's letter confirmed that the changes that were being promoted for Bomber Command were a cross section of ideas gained from experience over a considerable time. Operational units, Air Ministry staff, and officers still engaged in operations, all supported the proposals. In other words, although Bufton was in agreement with, and urged the formation of a target finding force, he was not acting in isolation. Bufton advised Harris that the proposal to form a Bomber Development Unit and a target finding force had been discussed by Air Commodore J.W. Baker, the Director of Bomber Operations (D.B.O.) and Air Vice-Marshal R.H.M.S. Saundby, S.A.S.O., Bomber Command. Saundby, shortly to become Harris's loyal deputy, and Baker were 'agreed that any decision on such an important step could not be taken until your arrival'.

Bufton's letter also pointed out that it was very difficult to arrive at a 'correct tactical method under the existing organisation. Squadron Commanders have, in practice, a very limited outlook and such thought as they find they have time to devote to tactical matters is almost entirely based on a Squadron outlook ... It is only when a problem is viewed from a distance that the solution appears'. Bufton argued that the tactics to be used to illuminate a target and create fires sufficient to provide a beacon for main force crews must be devised by squadrons themselves but not when acting in isolation. It was impossible to reach an appropriate consensus when squadrons were dispersed and operating without clearly defined responsibilities. He continued that 'If, however, six squadrons stationed in close proximity were given the sole responsibility of this work they would devise their own methods in an extremely short time and, as a result of discussion amongst themselves and the great force of enthusiasm that would be released, would quickly achieve results surpassing any we could expect of them'.

In conclusion of his letter to Harris, the D.D.B. Ops. detailed several advantages that he saw in the formation of a target finding force. By closely grouping the squadrons coordination was simplified and tactical refinements would be rapidly forthcoming because of the enthusiasm created. Once the force was organised illumination could be provided appropriate for attacks on either area or precision targets. Special techniques could be perfected rapidly so that targets outside Gee range could be effectively attacked. With the formation of a target finding force, full advantage could be

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15 AIR 20/4809, P.R.O. XC 1312, 17 March 1942 para.7
16 Ibid., para.8
17 Ibid., para.9
taken of the new equipment becoming available such as Oboe and H2S. By fully equipping a specialist target finding force Bomber Command as a whole would benefit long before it was possible to provide the new navigation and bombing aids for all aircraft in the Command. Squadrons in the target finding force would, from the very first, be infused with a sense of responsibility because as illuminators, markers, or bombers, they would recognise that they had a particular, specialised role in an overall plan and were not operating in isolation. Then, because crews were able to locate and actually identify their targets, inspiration and uplift would be provided for the force as a whole. This surge of spirit would easily overcome any lowering of morale that had resulted from the posting of either complete squadrons or individual crews, or even individuals, to the newly constituted force. Finally, Bufton admitted the changes that had already occurred in Bomber Command tactics. Whereas, earlier in the war, bombing success had depended upon operational ability now, in early 1942, with the provision of Gee, tactics and success were heavily reliant on the application of scientific principles. The ideal to be achieved was the combination of both, particularly if Gee was jammed. In that event unless a target finding force had been formed there would be a reversion to tactics which had already been shown to have been ineffective. A target finding force would, in Bufton's opinion, still remain an effective 'spear-head' even after the use of Gee for target finding had been denied by enemy counter measures.

In advocating the formation of a target finding force the D.B.Ops. was not working alone - he had also enlisted the support of the Director of Intelligence. One paper from this source entitled 'Bombing Policy', written 6 April 1942, dealt with the problems in fairly general terms. It admitted the criticism that had already occurred and the more than probable prospect that unless bombing results improved there would be a further calling to account. The same letter also confirmed that there had been a reluctance to learn from experience, and that conservation of effort, while awaiting weather conditions that would provide the prospect of success, had not always been followed. There was also the warning that the provision of new navigational and bombing aids did not necessarily guarantee the concentration of bombing required in the target area. Poor operating techniques, technical failures, or enemy counter measures could all reduce the usefulness of complex equipment. The paper then suggested that the work of the Luftwaffe unit KGr.100 in its pathfinding operations over Britain was proof of the success to be expected from the formation of specialist groups to lead attacks. The fact was also admitted that 'only a small minority of crews have the required combination of determination and ability to locate and mark the precise point, and these must necessarily be coordinated in one
unit to ensure that the target is unmistakably marked for the remainder.'

There was a warning in the final paragraph that 'During the next few months, the results achieved by Bomber Command will be most critically examined. If these fall below our anticipated expectations, there is a very grave risk of our striking force being subjected to a constitutional change which disregards the accepted principles of the role of a bomber force. This might prove calamitous in spite of an apparent justification for the disintegration of Bomber Command. There are powerful forces at work to bring this about'.

Air Vice-Marshal N.H. Bottomley, (D.C.A.S.), received a copy of this paper, and in a note to the Vice-Chief of the Air Staff Air Vice-Marshal Sir Wilfrid Freeman on 8 April 1942, he confirmed that he was 'strongly in favour of the proposal to create a well-trained target finding force'. Bottomley also regretted that Harris had reacted unfavourably to the proposal to establish a target finding force. Harris, Bottomley believed, was delaying decision making while he went through 'the whole gamut of experimentation of bomber tactics with the new 'Gee' equipment.' In view of the fact that Gee could at any moment have its usefulness curtailed, Bottomley called for an urgent decision on two specific and important points. Firstly, was a specially trained target finding force necessary to achieve the concentration essential to the success of bomber operations? Secondly, was the destruction of built-up areas to be achieved by incendiaries or by high explosive bombs?

Baker in a separate hand-written minute to Bottomley on 7 April 1942, also confirmed that he believed 'most strongly that valuable time and opportunities are being wasted...before facing what we believe to be the only solution to achieving concentration - namely, the formation of a nucleus force of experts, on the lines of KGr. 100 who could consistently locate and mark the targets for the remainder'. In conclusion, Baker wondered 'if C.A.S. could be persuaded to broach the subject to C in C'.

19 AIR 20/4809, P.R.O. XC 1312, 6 April 1942
20 Ibid.
21 Ibid., 8 April 1942
22 Ibid.
23 Ibid.
24 Ibid., 7 April 1942
Baker expanded somewhat on his ideas in a letter to Freeman on 9 April 1942. He cited the growing criticism being directed at the strategic bombing offensive 'not only in the other Services and in departmental circles but also more generally by members of the public ... we believe that a large measure of the indecisiveness of our bombing hitherto has been due to a failure in the Command to appreciate the need for closer tactical direction and control of our bomber force in the face of the gradually increasing development of the enemy defences.' Success from 1942 onward, argued Baker, would only be achieved by coordinated tactical direction, greater determination, and increased technical skill 'in conjunction with a target finding force, on the lines of Kg.100, [sic] to locate and mark the target either with flares, incendiaries or a combination of both to enable the remainder to find it'.

Harris responded to Bufton's demi-official letter on 17 April 1942 and claimed that he had 'a fairly open mind on the subject [of a target finding force] but [he was] not yet convinced by arguments put forward by Bufton.' Harris claimed that discussions he had held with Group Commanders on 16 April 1942 confirmed their opposition to the formation of a target finding force. He continued that he 'was not prepared to accept very serious disadvantages of a corps d'elite in order to secure some possible improvements on methods which are already proving reasonably satisfactory, at cost of serious loss of morale and efficiency in other squadrons'. Harris advised Bufton that existing practices would be further developed. Squadrons which, in a particular month, had produced the best target photographs would be designated as the Target Finding Force (T.F.F.) for the ensuing month. Gee would also continue to be developed for use as a blind-bombing aid.

Another paper prepared by the Air Staff on 25 May 1942 summarised the situation at that time regarding the effectiveness of the strategic bombing offensive and the

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AIR 20/4809, P.R.O. XC 1312, 9 April 1942

Ibid.

AIR 8/688, P.R.O. 1991152, 17 April 1942

Ibid.

Note: From approximately 17 April 1942 the Target Finding Force was usually accorded capitals because it had become the expected title. But their use was never consistent. Nor was consistency ever achieved over the title Pathfinder Force because it will also appear as Path Finder Force.

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AIR 2/7649, P.R.O. XC 623, 25 May 1942
apparent stalemate reached over the formation of the Target Finding Force. While prepared to acknowledge the successes gained by Bomber Command against lightly defended and easily located targets, the paper noted that failures were consistently recorded when attacks were delivered against targets difficult to locate, such as Essen, or those which were heavily defended. Nor were successes always attained even on short range, easily located and poorly defended targets. Incendiaries and fires in the wrong places, or enemy decoys, too often proved strong attractions to inexperienced and anxious bomber crews. These failures confirmed the importance of providing unmistakable evidence of the position of the target at the start of the raid and throughout the vital incendiary-dropping phase. Heavily defended targets demanded not only the greatest degree of operational skill but also the utmost determination — ingredients possessed by only a minority of crews. Fires in the wrong areas, for whatever reason, always raised doubts in the minds of inexperienced crews in the Main Force and thus compromised the success of the raid.

Harris's system of selecting lead crews from squadrons providing the best bombing photographs in the preceding month, was discounted by this paper because there was no adherence to defined and proven techniques. Additionally, under this system, it was impossible to build up the mutual understanding and co-ordination between leaders and those led, so vital if success was to be achieved. In all squadrons of Bomber Command at this time the numbers of crews able to act as target finders was strictly limited. To appoint a squadron as target finders would mean that while perhaps a quarter of the crews would adequately fulfil their role, at least three quarters could only be regarded as potential decoy-positioners.

Another argument raised by Harris in rejecting the notion of a separate T.F.F. was that squadron strengths would be diluted by the siphoning off of the best crews. His suggestion was that the crews selected to lead an operation should gather, the day before, at one or two aerodromes where briefings on their role could be held and take-offs accurately timed to ensure an adequate concentration at the target. After the raid the crews would return to the same aerodromes for debriefing. Several disadvantages to this scheme were pointed out.

During periods of intense activity selected crews would be operating continuously divorced from their parent squadron. Thus squadron dilution would be occurring without the compensatory advantage of having a specialised, permanent T.F.F. Temporary diversion of crews would create considerable administrative problems. Operations from advanced bases also involved the major risk that the ground crews and support systems might be unfamiliar with the
particular type or mark of aircraft being operated by the transients. A final but important disadvantage was that in these changing conditions it would be impossible to refine bombing techniques, encourage the development of team spirit, or develop the necessary sense of responsibility so essential to success. Leadership would be transitory and who was ultimately responsible for this diverse collection of crews?

It was accepted in this paper that there was only one solution to ensure the decisive concentration necessary to provide the success sought. 'A specially constituted force' would have to be formed 'consisting in the first instance, of three heavy and three medium squadrons, situated in the closest possible geographical proximity. The specialised role ... would be that of finding, illuminating and unmistakeably marking the target for the main striking force ... [end] ... these squadrons must be manned by the most able and determined crews available in the bomber force. In addition they must be given all possible scientific and navigational assistance'.

The advantages to be gained from the establishment of such a force were again pointed out and although this was an Air Staff paper perhaps the hand, or at least the ideas of Buxton, can be readily discerned. Buxton, and others, looked beyond the necessary area bombing because they saw it as a stop-gap measure until the bomber force had the capability of undertaking, and destroying, precision targets. This paper was not signed by an individual but the author claimed that 'there will be available at all times a highly skilled and co-ordinated force ready to undertake tasks of vital importance or of special difficulty ... or the precise attack of some target of outstanding importance, such as the Philips works at Enghoven (sic)'. Herein, perhaps, lay the crucial element on which Harris's continued refusal to form a permanent T.F.F. was based. Long after the formation of the P.F.F., and repeated displays of its accuracy, Harris continued to deny its precision capability. His opposition to the Transportation Plan, prior to invasion of Europe in June 1944, was at least partially based on his perception of the imprecision of the bomber force he commanded.

Considerable discussion took place during the war, and much argument has continued to the present day, over the role of Bomber Command at various stages of the strategic bomber offensive. Webster and Frankland posed the hypothetical question, could Bomber Command have profitably pursued a

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31 AIR 2/7649, PRO XC 623, 25 May 1942, para.11
32 Ibid., para.12(v)
33 Dudley Seward, 'Bomber' Harris (London: Cassell, 1984), pp.246-7
different kind of policy\textsuperscript{\textsuperscript{\textendash}34} as early as the Battle of the Ruhr? In other words, should Bomber Command, rather than placing reliance on area bombing, have been developing more precise forms of attack? Harris was, and still is, the prime target for much of this slanted criticism. However, the Official History did point out that 'the tendency has almost invariably been to lay down the law about what ought to have been done and to say little about what, in fact, could have been done'.\textsuperscript{\textendash}35 The point has been mentioned here because it is a recognition of Buxton's role in the drawing up of arguments for the establishment of a T.F.F. Nevertheless the question of precision versus area bombing is important and it is a matter to which more attention will be given later.

This particular Air Staff paper concluded with a warning. The continuation of tactics based on individualism must result in failure. It would become impossible 'to oppose, truthfully and logically, the strong pressure to divert the bomber force to other strategical employment; and, the doctrine of strategic bombing will remain unsubstantiated. The only possibility of success is ... in the formation of a target finding force ... without delay'.\textsuperscript{\textendash}36

By early June 1942 although Harris accepted the principle of a T.F.F. he remained firmly of the opinion that Bomber Command had too few squadrons to establish a permanent, specialised group without adverse affects on individual squadron morale. But the pressures continued to mount for positive initiatives. Bottomley, now titled Assistant Chief of the Air Staff (Operations) (A.C.A.S. Ops), wrote again to Freeman on 2 June 1942\textsuperscript{\textendash}37 suggesting another method of approach to the obdurate Harris. Bottomley's fear was that unless there were changes in bombing methods, concentration would not be achieved and dispersion of effort on open fields and enemy decoys would continue. He explained that 'the great problem we are confronted with is ability to locate our targets ... unless an unmistakeable target is presented to the average crew, we shall fail to obtain even a reasonable degree of accuracy ... A selected force of highly skilled crews knit into a target finding force whose prime aim in life is to locate the target, will enable us to do this'.\textsuperscript{\textendash}38 Bottomley's suggestion to Freeman was that D.B.0ps' blue-print for a T.F.F. be represented to Harris and his detailed criticism invited.

\textsuperscript{\textendash}34 Webster & Frankland, \textit{op.cit.}, Vol.2, p.113
\textsuperscript{\textendash}35 Ibid., p.114
\textsuperscript{\textendash}36 AIR 2/7649, P.R.O. XC 623, 25 May 1942, para. 17
\textsuperscript{\textendash}37 AIR 20/4809, P.R.O. XC 2668, 2 June 1942
\textsuperscript{\textendash}38 Ibid., para.3
Harris's letter to Portal of 12 June 1942 was not necessarily a response to this invitation but it was a repetition of arguments for the retention of his Raid Leader scheme. Furthermore, he claimed that all his Group Commanders and the Target Finding Squadron Commanders were 'utterly opposed to the formation of a Target Finding Force on the lines which hold favour in the Air Ministry'.\(^{39}\) Despite his earlier arguments concerning the undesirability of establishing a corps d'élite Harris suggested that 'when promoted to the grade of Raid Leader all members of selected crews should be entitled to wear a special badge'.\(^{40}\)

The head of Bomber Command then continued with the suggestion that the problem was not one of 'finding' the target but in actually 'seeing' it on the average dark night, with the industrial haze common to the Ruhr and the intense searchlight glare always to be found at heavily defended targets. This particular section drew two hand written marginal comments - 'finding' evoked 'quibble' while 'seeing' had the response '?' hitting it'. Harris continued this letter by arguing that 'bombing for instance in the Rhur (sic) except under the most unusually favourable conditions of visibility is area bombing. We have always said so'.\(^{41}\)

Harris ventured on to considerably weaker ground with his next argument that 'restrictions on Foreign and colonial personnel and the technical attributes and obsolescence (sic) of some types of aircraft practically confine the Manning and equipment of such a force to the 13 Wellington III and Stirling Squadrons'.\(^{42}\) Should six of these squadrons be formed into a T.F.F. he claimed that the effects on the remainder would be 'disastrous'. In this situation the formation of a 'T.F.F. drawn from such limited resources would be below rather than above the general standard of the present Raid Leader scheme'.\(^{43}\)

In his conclusion to this letter to Portal, Harris maintained that the 'existing Raid Leader scheme provides all the requirements of the Target Finding Force fanatic, bar living together in special Units. All my A.O's C. and all their best Squadron Commanders ... see no gain to be obtained from this getting together requirement. They were all decisively and adamantly opposed to the proposition for the above reasons'.\(^{44}\)

\(^{39}\) AIR 8/688, P.R.O. XC 199152, 12 June 1942, para.3

\(^{40}\) Ibid., para.6 (underlining in the original)

\(^{41}\) Ibid., para 7

\(^{42}\) Ibid., para.8

\(^{43}\) Ibid.

\(^{44}\) Ibid., para.9
Portal's response on 14 June 1942 was swift but dealt at considerable length with the arguments that Harris had raised. His overall summation was that the arguments presented were indicative of the need for a T.F.F. rather than the opposite. The C.A.S. was forthright. In his opinion Harris had provided 'no reasonable argument against the Air Staff proposal'.

Indeed, Portal went further. He pointed out that he detected ambivalence in Harris's attitude toward the establishment of a T.F.F. Harris appeared, according to Portal's interpretation, to be having second and even third thoughts over the problem. During a three month period Harris had moved, successively, from total rejection of a T.F.F., to a Target Finding Squadron plan, and now to a Raid Leader Scheme. Portal considered that it was not 'logical that you [Harris] should now reject the final and essential step of welding the selected crews into one closely knit organisation which ... is the only way to make their leadership and direction effective'.

Compromises suggested by Harris were totally rejected by Portal. Bringing selected crews into one unit and locating them permanently on one aerodrome provided for development and continuity of techniques, daily improvements in tactics, simplified the planning and briefing requirements for each operation, and was the only way to ensure that all plans 'were similarly and clearly interpreted and acted upon by the force as a whole'. To do otherwise would simply perpetuate the use of methods which had been proved to be inadequate and would put Bomber Command as a separate and offensive arm at risk.

The suggestion that either foreign or Dominion governments would raise particular difficulties over the inclusion of their nationals in T.F.F. was also brusquely rejected. In fact Portal saw benefits accruing in that 'the close association of specially selected crews in such a force might well be an excellent thing in balancing the main disadvantage underlying our present policy of segregating Dominion and foreign personnel within their own homogenous units'.

The C.A.S. was also quick to point out to Harris that his admission of the difficulty in actually seeing the target on a dark night was a 'convincing indication' that the methods being employed were in need of drastic revision. Ineffective raids in the past were usually characterised by reports of

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45 AIR 2/7649, P.R.0. XC 623, 14 June 1942, para.2
46 Ibid., para.3
47 Ibid., para.4
48 Ibid., para.6
intense darkness or thick haze. However, it had been shown that the haze factor could be reduced by effective illumination. 'What we need to aim at,' wrote Portal, 'is an effective degree of illumination and incendiaryism in the right place and only in the right place. It is our opinion that this admittedly difficult task can only be done by a force which concentrates upon it as a specialised role, and which excludes those less expert crews whose less discriminating use of flares or incendiaries in the vicinity of the target have recently led so many of our attacks astray'.

Portal conceded the practical difficulties in establishing a T.F.P. but was adamant that Harris's proposals did not meet the requirements for what was becoming a desperate situation. With the Singleton Report already before the Chiefs of Staff, it was vital that methods were put in place whereby more bombs were dropped in the actual target areas. Failure to improve bombing accuracy placed the whole of the strategic bombing policy at risk. Portal tempered this letter somewhat by admitting his reluctance to impose the Air Staff proposals while Harris remained so firmly opposed. Portal called for further discussion with Harris on the morrow.

Unfortunately, at this juncture, there is a gap in the material available from the files held in England in the Air Ministry and the P.R.O. The Narrative History, however, is clear as to when the decision was made, at least in principle, to form a Target Finding force. It claims that during the informal discussions between Portal and Harris on 15 June 1942 'the C.A.S. was able to persuade, if not entirely convince, the C-in-C of the necessity of the proposed step'. Minutes of the meeting, unfortunately not available, would make interesting reading.

Harris confirmed with Portal, in a letter on 19 June 1942, his reluctant agreement to establish a separate target finding force. At the same time he continued to maintain that all that could be done 'with the force at my disposal,' had, in fact, been done. He then proceeded to list certain conditions that he wanted fulfilled in relation to the scheme proposed by the Air Ministry. These included the provision of a special badge for aircrew personnel in the force, their name to be the Pathfinder Force, and promotion of one step in rank above that held in the Main Force for all aircrew personnel selected.

49 AIR 2/7649, P.R.O. XC 623, 14 June 1942, para. 8 (Underlining in the original)

50 Andrew, op.cit., p.66

51 Saward, op.cit., p.153
This latter requirement was instrumental in further delaying the establishment of the P.F.F. because it involved Treasury. Promotion on appointment to the P.F.F. was also objected to by Baker who regarded it as a cash reward and contrary to the spirit of the Royal Air Force. He wrote to Bottomley on 21 July 1942 and made his opposition clear. His feeling was that such promotion 'might well have undesirable repercussions by inducing personnel to volunteer for monetary reasons rather than through enthusiasm for the job. This would react on the efficiency of the force and would do much to throw it into disrepute. The essence of the T.F.F. is that it has the complete confidence and the respect of the remainder of the bomber force'. Baker wanted skill and enthusiasm to be rewarded by the special badge for members of the force and the extra risks entailed to be covered by an 'increase in the scale of decorations'.

Another objection that Harris had earlier raised against the formation of the P.F.F. was removed on 22 July 1942. By that date the governments in Australia, New Zealand, Southern Rhodesia and Canada had confirmed that they had no significant opposition to their personnel being selected for, and who then volunteered their services to, the target finding force. Both Australia and Canada embodied minor provisos for their aircrew, mainly centring around the desirability of placing completely national crews in national squadrons where possible. These conditions were only postulated as desirable and were never intended (or acted upon) as a sine qua non. Australia, in addition, requested that when aircrew finished their operational tours several crews should be returned to Australia 'to give the R.A.A.F. in Australia the value of their experience'. The first crew to be repatriated under this scheme was that of Flight Lieutenant P. Isaacson and they arrived home in June 1943. After a few flights in both Australia and New Zealand raising 'Bonds for Bombers' the crew dispersed to become instructors and their collective expertise, gathered in the Main Force on 460 Squadron, and the Pathfinder Force on 156 Squadron, was lost.

AIR 20/4809, P.R.O. XC 2668, 21 July 1942, para.6
Ibid., para.9
Ibid., 22 July 1942
Ibid.
In his book on 460 Squadron, Peter Firkins describes how Isaacson's gallant crew were confronted with the open hostility which seemed to traditionally greet battle seasoned veterans returning from Europe and the Middle East. Crew members on 460 Squadron, a Royal Australian Air Force squadron in Bomber Command, during 1942 and early 1943, sometimes even received white feathers with an accompanying note saying 'Jap dodger'. A strange perversion of the thought processes in some minds.

On 23 July 1942 Bomber Operations crew up a paper titled Target Finding Force (strange how long that name persisted) which defined the basic principles to be considered when the organisational and tactical planning was considered. This plan envisaged, initially, three heavy bomber squadrons, one medium, plus No. 109 squadron then in the process of conversion to Mosquito bombers. They were to be affiliated to a parent group but concentrated in 3 Group and under its administrative control. Operationally they were to be commanded by a Group Captain directly responsible to the C-in-C Bomber Command.

Crews were to be drawn from both operational squadrons and the Operational Training Units (O.T.U.s) with at least two-thirds of the crews having completed a minimum of 15 sorties. Training for the force was to take up at least a month with individuals doing cross-training to enable them to carry out, to some degree, other crew duties. Wireless operators were to be trained to use Gee and gunners to carry out map reading, both to be of assistance to the navigators. The paper was most insistent on the training period because it was realised that 'To use the force before they are fully trained will be disastrous because not only will it lose the confidence of the main force in their ability to mark the target but will also falsely persuade everybody that such a tactical employment is of no value'.

Target marking for the force, allowing for the type of target, defences, and weather, was to be carried out using marker bombs and fire-raising incendiaries, marker bombs and flares, or simply, fire-raising. With these multiple options it was essential that a variety of marker bombs were available when operations were due to commence. Development work was in progress on 2,000 and 4,000 pound incendiaries and a special 250 pound marker bomb to emit marker candles of different colours. The disadvantage of the short burn period of these candles, it was planned, would be overcome by including T.F.P.


AIR 20/4809, P.R.O. XC 2668, 23 July 1942

Ibid., para.16
aircraft, at regular intervals, in the main stream of bombers. A wide range of colour combinations had to be available to ensure that the candles could not be compromised by enemy decoys. As far as flares were concerned hooded specimens (to prevent upward glare), fitted with an aneroid fuse were being developed and, it was hoped, these would go a long way toward solving the problem of turning night into day.

On 11 August 1942 the Air Staff confirmed with Harris that approval had been given 'for the establishment in your Command of a Pathfinder Force'. Harris was instructed to 'proceed at once with the establishment of the force' on the understanding that there would be four squadrons, crewed from the O.T.U.s and established squadrons, plus the best crews from other existing squadrons. Accelerated promotion to acting rank was to be accorded to individuals on the basis of sorties completed subject 'to the overriding principle that the members of aircrews shall not fail to get their promotion as quickly as they would have got it had they remained with their old squadrons'. Normally on squadrons there was a limit to the number of officers holding a particular rank but it was agreed that this situation, called the establishment, could temporarily be disregarded in founding the Pathfinder Force.

Considerable attention was given to the selection of aircrew for the Pathfinder Force. With the exception of O.T.U. personnel they were to have carried out at least twelve sorties, shown proven determination in pressing home attacks, reached a high standard of proficiency, and have displayed adaptability to new methods. Pilots were expected to possess above average navigational knowledge while navigators had to be able to navigate accurately using position lines obtained visually, from astronomical observations, Gee, or wireless direction finding. Wireless operators had to be capable of plotting bearings, able to use Gee and transmit and receive morse accurately at speed. Air gunners were required to be capable of taking accurate drift observations as well as map read from high altitudes. Bomb aimers, who were increasingly often trained navigators, had to be proficient at their trade as well as good map readers but it was considered of little importance as to the type of bomb sight on which they had qualified. Finally, flight engineers had to possess a thorough knowledge of their aircraft type, its fuel and oil systems, emergency bomb door opening procedures, flap and under-carriage operation as well as cruising techniques for best fuel consumption. Selected crews were all to be checked by examining officers of the Pathfinder Force to confirm their knowledge and suitability.

AIR 2/7649, P.R.O. XC 623, 11 August 1942, paras.1 and 8
Ibid., para.4
According to the senior recruiting officer for the Pathfinder Force, Group Captain Hamish Mahaddie, candidates from the O.T.U.s were required to be highly recommended by the Chief Flying Instructor, or a Flight Commander, before they were considered. With the wide gulf between the training and operational environments in mind the need for careful assessment is obvious. This problem was eased later in the war by the establishment of the Pathfinder Training Unit which gave increased opportunities to test candidates before their final acceptance into the Pathfinder Force.

Pilots and navigators trained in Canada, Rhodesia or South Africa under the Empire Air Training Scheme who showed exceptional promise would find on arrival in England that they were expected. According to Mahaddie they 'would be silently withdrawn once the boat had docked and would be posted in the normal way to the Pathfinder Training Unit at R.A.F. Warboys'.

Although Bomber Command Headquarters did not issue the Administrative Instructions for what they termed the 'Path Finder Force' until 21 August 1942, the accepted date for its inception is 11 August 1942. Five squadrons formed the nucleus of the Pathfinder Force, each affiliated to an operational Group in Bomber Command: No.156 Squadron in the process of conversion from Wellingtons to Lancasters from 1 Group; No.7 Squadron with Stirlings from 3 Group; No.35 Squadron, Halifaxes from 4 Group and No.83 Squadron, Lancasters from 5 Group. No.109 Squadron was a special case. Prior to the move to the P.F.P. it had been serving with the Wireless Intelligence Development Unit based at Boscombe Down. Its task there had been the developmental flying for Oboe. At the time of the transfer the crews were converting from Wellingtons to Mosquitoes. Those still on Wellingtons were affiliated to 3 Group while those operating Mosquitoes became the responsibility of 2 Group.

Despite the admonition contained in the paper issued by Bomber Operations on 23 July 1942 confirming the absolute necessity for at least a month's training, Harris ordered that operations were to commence immediately. Because of the wrangle over promotion and pay, crews only assembled on 17 August 1942 but they were still expected to operate as Pathfinders that same night. Bad weather meant that that particular raid was cancelled. Although barely settled into their new quarters, elements of the P.F.P. went into action the next night, 18/19 August 1942, against Flensburg. Six nights earlier Gee had been jammed by enemy counter-measures, neither H.2S nor Oboe were yet available and the P.F.P. possessed no marker bombs. In other words, although some

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62 Letter to the author, 24 March 1992
63 AIR 20/4809, P.R.O. XC 2668, 21 August 1942
64 Ibid., 23 July 1942
PATHFINDER FORCE
FOUNDER SQUADRONS
August 1942

No.7 Squadron

Badge:
On a burt, seven mullets
of six points forming a
representation of the
constellation Ursa Major

Motto:
Per diem, per noctem
(by day and by night)

No.35 Squadron

Badge:
A horse's head winged

Motto:
Uno animo spinus
(We act with one accord)

Name:
'Madras Presidency'

No.83 Squadron

Badge:
An attoe

Motto:
Strike to defend

No.109 Squadron

Badge:
A panther rampant
crested

Motto:
Primo hastati
(The first of the
legion)

No.156 Squadron

Badge:
A figure of Mercury
holding a torch

Motto:
We light the way
crews may have been flying more modern aircraft, they could only employ the same techniques that were in use in 1941. It could be inferred from Harris’s haste to employ the P.F.F. that he was anxious to confirm his belief that they would provide no significant advantage.

Flensburg, in theory, should have provided a relatively easy target. It was situated on a clearly defined coast line and such targets, in good weather, were normally easily located. Unfortunately two factors combined to make this first P.F.F.-led attack a total shambles. The forecast winds provided at briefing were wildly inaccurate and virtually total cloud cover (contrary to the forecast of clear skies), meant that very few crews actually sighted Flensburg. A total of 31 P.F.F. crews flew on this raid and although 16 of them and 78 of the Main Force claimed to have either marked or bombed Flensburg, German reports indicated that the city on that night was untouched. Scattered bombing did occur in Denmark 25 miles to the north and in the Heligoland Bight and Kiel Bay areas. It was an inauspicious beginning.

One other factor contributed to the early failures of the Pathfinder Force—crew inexperience. The first squadrons selected were average, with one or two crews being of P.F.F. calibre but the majority were unfitted for the tasks they were expected to accomplish. There had been no weeding out of unsatisfactory crews when the squadrons were transferred to the P.F.F. and there had been no recruitment of outstanding crews from the other front-line squadrons. Buxton confirmed, on 5 September 1942, that there had been a marked reluctance to volunteer for duty with the P.F.F. and this he attributed to the terms of service laid down by Bomber Command.

Volunteers for the P.F.F. were initially expected to complete 60 operational sorties (a figure which included the operations prior to joining the Pathfinders) before they would be considered as having fulfilled their obligations. However, as Buxton noted in the minute to Bottomley, "This stipulation shows a complete lack of appreciation of the psychological factors involved. At present only one crew in four completes 30 operational sorties; there is thus no prospect whatsoever

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65 Middlebrook & Everitt, op.cit., p.301, see also Musgrove, op.cit., pp.10 and 14
66 AIR 20/4809, P.R.O. XC 2668, 5 September 1942, para.6
of a [sic] T.F.P. personnel completing the operational tour for which they are expected to volunteer'. Bufton called for immediate action to revise the terms of service.

Bottomley, in passing this minute on to the C.A.S. the next day, said he thought 'it would be a mistake to press these points with the C-in-C Bomber Command at this stage ... it would be premature to criticise or urge the C-in-C ... until we have given time for the Force to bed down and until the C-in-C has had some opportunity of observing its development and the reactions to conditions of service outlined in the original orders...'.

On 22 September 1942 Headquarters Bomber Command revised the number of operations required to complete a tour in the Pathfinder Force to 45. This number included those carried out before posting to the Force. The total of 45 was to count as the equivalent of two complete operational tours after which nobody could be ordered back on operations.

In this discussion on the formation of the Pathfinder Force there only remains one pertinent consideration - the appointment of its first Commanding Officer, Donald Clifford Tyndall Bennett. Don Bennett, born in Australia on 14 September 1910, joined the Royal Australian Air Force (R.A.A.F.) in July 1930 having topped the initial intake examination taken by more than 2,000 candidates. He graduated as a pilot on 31 July 1931. Prior to graduation Bennett had agreed to accept an attachment to the R.A.F. after receiving his 'wings' but still remain a member of the R.A.A.F. and thus be entitled to wear the darker blue uniform. This transfer was a consequence of the world-wide depression which had caused severe economic cut-backs on military expenditure in Australia. Bennett served firstly on fighters in the R.A.F. but was then posted to a flying-boat course at R.A.F. Calshot. In 1933 Bennett joined No.210 Flying Boat Squadron based at Pembroke Dock in Wales where that same year he had his first contact with Harris who became his Squadron Commander. Bennett next returned to Calshot where he served as navigation lecturer and flying instructor until his retirement on 11 August 1935 in the rank of Flying Officer.

67 AIR 20/4809, P.R.O. XC 2668, 5 September 1942, para.7
68 Ibid., 6 September 1942
69 AIR 2/7649, P.R.O. XC 623, 22 September 1942
70 Author's Note: Harris, in Bomber Offensive p.129, stated that he had known Bennett since 1931 but Harris was at the Army Staff College at that time, then served in Egypt, before being posted to Pembroke Dock in 1933. So it is possible 1931 was a slight error.
Air Vice Marshal D. C. T. Bennett
Air Officer Commanding 8 Group
Pathfinder Force

Photograph courtesy of
Imperial War Museum, London.
With assistance from Harris Bennett joined Imperial Airways in 1936 and, after the outbreak of war in 1939, as a civilian, helped to establish the Atlantic Ferry Organisation. This group was responsible for the delivery of aircraft, built in North America, to England by flying them across the Atlantic. Aerial delivery meant more available shipping space and removed the chance of their being lost in U-Boat attacks. Such flights at that time were still hazardous ventures. The first formation flight of Lockheed Hudson aircraft, and the first winter crossing of the North Atlantic, was led by Bennett on 10 November 1940.

Bennett had been Lord Beaverbrook's man in the Atlantic Ferry Organisation and when Beaverbrook was removed from the Ministry of Aircraft Production, Bennett, in July 1941, was also replaced. Ironically, his replacement was Air Chief Marshal Bowhill who had, at the outset, vigorously opposed trans-Atlantic flights because of the dangers involved. Bennett, who had never lost contact with the R.A.F., was no doubt mollified by Bowhill's statement that he would be welcome to rejoin the R.A.F. with the rank of acting Group Captain. Bureaucracy, however, found it difficult to appoint an apparent civilian to a senior position in uniform. Appointment as a Squadron Leader was declined but eventually, on 14 August 1941, Bennett rejoined the R.A.F. as an acting Wing Commander and commenced his duties at a new elementary air navigation school at Eastbourne.

Thanks to a contact in the Personnel Department at Bomber Command Headquarters Bennett, in December 1941, was posted to command No.77 Squadron based at R.A.F. Leeming in Yorkshire. At that time No.77 Squadron was a part of 4 Group under Roderic Carr and was still only equipped with Whitley bombers—much to Bennett's chagrin. He commanded this squadron until mid-April 1942 and was then posted as Commanding Officer of No.10 Squadron, also based at Leeming, but equipped with the 4-engined Halifax. His conversion to the Halifax must have been swift because he flew his first operation on the new type on 27/28 April 1942 in an attack on the Tirpitz anchored in Trondheim Fiord in Norway. His aircraft was shot down on this operation but Bennett and his wireless operator evaded capture successfully, reached Sweden, and Bennett was back with his squadron only one month later. Bennett was promoted to Group Captain on 5 July 1942 and instructed to assist in the formation of the Pathfinder Force and then become its leader.

Harris was the prime-mover in Bennett's appointment but his choice was possibly two-edged. Firstly, and perhaps it was the most important, he professed the greatest respect for Bennett not only as a navigator and aviator of extraordinary

competence but also as a person. Harris who had known Bennett since 1933, considered he was 'the obvious man at that time available for the job of head of the Pathfinder Force. He was in his early thirties ... but his technical knowledge and his personal operational ability was [sic] altogether exceptional ... His courage, both moral and physical, is outstanding...He will forgive me if I say that his consciousness of this own intellectual powers sometimes made him impatient with slower ... minds, so that some people found him difficult to work with ... he is, in fact, very much an intellectual and, being still a young man, had at times the young intellectual's habit of underrating experience and overrating knowledge'.

He appeared to be the right man at the right time.

Secondly, perhaps Harris chose Bennett as a means of short circuiting the Directorate of Bomber Operations who possibly had a name in mind for the important role. Harris had been forced to yield when he agreed to the establishment of the Force but he determined that it was to be on his terms, in his own way and with his selection as leader. Bennett, as a Group Captain, could only command the Pathfinders in Harris's name, as a Staff Officer of Headquarters Bomber Command. Harris thus maintained a dominant position. He made his attitude to the Pathfinder Force very clear when he told Bennett that 'whilst he was opposed to the Path Finder Force and would waste no effort on it, he would support me [Bennett] in every way'. Bennett considered that he was personally supported by Harris but, at the same time, Harris 'never really gave the Pathfinders a fair chance relative to other special units'.

It cannot be denied that Bennett was highly qualified but very frequently his youthfulness and methods acted as abrasives to other Group Commanders. Promotion for Bennett was rapid and he attained high rank - he was an Air Vice-Marshall at 32 - but this had been accomplished without his having 'served his time' and without his attendance at the appropriate staff and command courses. These facts rankled his peers. Additionally his methods were unorthodox. The correct channels were satisfactory if results were immediate but if there were delays then it was clear to Bennett that they had to be circumvented. When irregularities had to be employed in the Pathfinder Force to achieve a particular aim, the expression 'we'll D.C.T. it' became the catch phrase. Bennett shunned publicity in war-time not only for himself but also for the Pathfinder Force. Media personnel were not

72 Harris, *Bomber Offensive*, pp.129-130
73 Bennett, *op.cit.*., p.133
welcome on Pathfinder Force stations. Bennett made it clear to his crews that there 'will be no living VC's in 8 Group'.

Three supreme awards were made to pilots - Squadron Leader Bazalgette, acting Squadron Leader Palmer and Captain Swales - but they were all posthumous.

Bennett's aim was efficiency in every area of both ground and aircrew duties. On one occasion he was in attendance when a Station Commander was hearing a charge against an airman for having walked across the grass contrary to Station Standing Orders. Bennett intervened to enquire what was the shortest way between the Photographic Section and the squadron offices. When he learned that it happened to be across the grass he then issued a warning. He threatened that if anybody on any station in the Pathfinder Force ever followed anything but the shortest route between work places he would be on a charge of having sabotaged the war effort. A trite story but indicative of Bennett's attitude. No doubt his interference rankled with the Station Commander even if the particular airman was appreciative.

Bennett's loyalty to his Pathfinder Force crews both air and ground was legendary. He insisted that members of his Force only came under his jurisdiction and he would never permit other commanders to punish any of his men who, it was alleged, may have transgressed.

The Pathfinder Force leader was youthful, he was purposeful, he was unorthodox, he was persistent, and he could also be abrasive but, perhaps too frequently for his own good, he was correct in his arguments. In the hierarchy of the Royal Air Force, even in wartime, however, the measure most frequently held against him was that he was an Australian and therefore a Colonial and had apparently received favoured treatment at someone else's expense.

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75 Francois Prins, 'Donald Bennett Pathfinder' in 
Fly Past, June 1987, p.23

76 Bennett, op.cit., p.170
V.C.s
of the
PATHFINDER
FORCE

These Officers lost their lives on
Bomber Operations

S/Ldr. R. A. M. PALMER
109 Squadron

S/Ldr. I. W. BAZELGETTE
635 Squadron

Capt. EDWIN SWALES
182 Squadron

The Marker
Vol. 6, No. 9, December 1952
SQUADRON LEADER IAN WILLOUGHBY BAZALGETTE, DFC
RAFVR 635 SQUADRON

"On 14th August, 1944, Squadron Leader Bazalgette was 'master bomber' of a formation of 33 aircraft of the Second Group which attacked the marshalling yards at Cologne. At the target, the formation was met by fighters which attacked at a height of 8,000 feet and at a speed of 350 miles per hour. The aircraft of the formation was hit by enemy fire and the cockpit was filled with smoke. Leader Bazalgette, realizing the danger, flew his aircraft in a low dive and, with great skill and precision, he flew his aircraft over the target, dropping his bombs with great accuracy, The bombs fell with great accuracy and the result was devastating. The enemy fighters gave up pursuit and the formation continued to the target. Leader Bazalgette's actions were brilliant and his leadership was outstanding. His courage and determination were beyond praise."
ROYAL AIR FORCE

PATH FINDER FORCE

Award of Path Finder Force Badge

This is to certify that

FLIGHT LIEUTENANT N.D. GREENAWAY, 78998

having qualified for the award of the Path Finder Force Badge, and having now completed satisfactorily the requisite conditions of operational duty in the Path Finder Force, is hereby

Permanently awarded the Path Finder Force Badge

Issued this 19th day of NOVEMBER in the year 1944

Air Officer Commanding, Path Finder Force.

N. Dudley Greenaway, The Long Haul
(Warkworth: Private Printing, no date)
THEORY VERSUS PRACTICE

In 1943 an attack was planned on Friedrichshafen. Four Lancasters of 97 Pathfinder Force Squadron were to mark the target which would then be attacked by 60 Main Force Lancasters. A rehearsal for the raid was carried out on the bombing range at Wainfleet in the Wash - it did not go well. Crews next day were told that if they could not hit the target on the bombing range then it was hardly worth while briefing them for targets in Germany. The rehearsal would have to be repeated. A 'very senior officer' at the briefing told the assembled crews that even several years previously 'flying a Hart with only a Course Setting Bombsight, I was getting errors of only 20 yards'. A voice from the chastened crews, identified only as 'antipodean', called 'what was the flak like?'

'Rod', 'Shuttle Run' in Marker, Summer 1991, p.27
14. The Pathfinder Force and the Strategic Bombing Offensive August 1942 – May 1945

Hasty committal of the Pathfinder Force (P.F.F.) to operations on 18/19 August 1942 in an attack on the submarine construction yards at Flensburg meant that it went into action not as a force in being but as a group of individuals in the process of change. In relation to the P.F.F. 'change' was of considerable relevancy and reflected their condition throughout the remainder of the war. High casualty rates in 1943, although they decreased in 1944, meant a constant winnowing of hard-won battle experience. Tactics, techniques and equipment were also in a constant state of flux in response to particular needs of the moment and their leader's demands for 'maximum efficiency'. Near enough was never good enough for the perfectionist Group Captain (soon to receive further, accelerated promotion) D.C.T. Bennett. It is never sufficient, indeed it is misleading, to claim that 'this was how it was done in the Pathfinders' without adding the proviso of specific dates. Nor must it be assumed that innovations were either minor or on a gradual basis - major changes were often demanded overnight. From the beginning Pathfinders fully realised that the responsibility for the success or failure of a bombing raid rested on their shoulders. It was their task to confirm the location of a particular target, establish and mark a precise aiming point, guide the Main Force bombers to the target area and ensure continual and exact definition of the aiming point. For reasons beyond the control of any participating crew member, despite their willingness, very few of these aims were achievable by the P.F.F. on 18/19 August 1942.

The crews that gathered at Wyton, Oakington, Graveley and Warboys on 17 August 1942 (after pay wrangles had caused delays) were not, as yet, confirmed Pathfinders. Nor had the best crews from the various squadrons concerned - Numbers 7, 35, 83, 156 and 109 - always been transferred. Service in the P.F.F. was voluntary but Group Commanders could, and did, refuse applications for posting. Most Group Commanders opposed the formation of a corps d'élite and thus saw no valid reason for losing their best crews to a force which they had no desire to support. This spirit of non-co-operation - Carr of 4 Group (Bennett's old Group) excepted - was encouraged by Air Chief Marshal Harris's attitude of laissez-faire. Many of the crews that had volunteered and been accepted for the initial move were simply not up to the standards required but their weeding-out required time. Nor, despite the absolute necessity, had any time been allowed for training in a specialised role. Additionally, the crews that were in the forefront of the raid on Flensburg on 18/19 August 1942 had been provided with no special equipment to assist their navigation or bombing. Even worse, Gee, which had provided significant navigational assistance in recent months, was now subjected to efficient German jamming which
considerably degraded its usefulness. Even had these embryonic Pathfinders still been able to locate their target, at this stage of the war, they possessed no special flares, target indicators (T.Is) or marker bombs to define aiming points for the Main Force following behind. Nor had the time been made available for consideration of any specific tactics that could be employed. On this first operation Bennett was forced to launch a motley collection of aircraft (Wellingtons, Stirlings, Halifaxes and Lancasters) with variable operational capabilities and manned by crews whose qualities were still to be determined.

The final elements which virtually doomed this raid to failure were the inaccurate forecast winds provided for the crews and virtually total but unforecast cloud cover over the target. Perhaps the opponents of the P.F.F. may have smiled sardonically when the results of this attack were learned but in the long term they would not have the last laugh. Perhaps, also, considering the circumstances under which Bennett felt compelled to mount this attack, we can perceive a glimmering of meaning to the unofficial motto of the P.F.F. 'press on, regardless'.

Bennett’s plan for the utilisation of the P.F.F. in the Flensburg raid formed the basis from which more refined tactics and techniques were developed as improved equipment was provided for navigation, illumination and bombing and crews gained greater experience. Flensburg was chosen by Harris as the target partly in an attempt to reduce the U-boat threat and partly because it fitted in with the area-bombing programme he had inherited and of which he approved. Flensburg was also accepted as a suitable target because of its coastal situation on an inlet in the Baltic which, provided clouds didn’t interfere, should have enabled easy identification.

Pathfinders were to lead the raid and, in the first five minutes after illuminating the target with flares, were to drop salvos\(^1\) of incendiaries to create blobs of fire in the target area. These fire areas were to provide the aiming point for the Main Force crews who were to follow in three waves. The first wave of the Main Force carried a mixture of incendiaries and high explosive (H.E.) bombs, the second mainly incendiaries while the rear group was loaded with H.E. only. At the commencement of the raid some of the P.F.F. aircraft also dropped H.E. bombs to deter German fire-fighters.

\(^1\) When bombs or incendiaries were dropped in 'salvos' they fell in a group. When dropped in 'sticks' they fell from the aircraft bomb bay at regularly spaced intervals and created a line of explosions or fires on the ground.
Gee's unavailability, inaccurate forecast winds and cloud cover, meant that although 16 P.F.F. and 78 Main Force crews (from a total force of 118 aircraft) claimed to have attacked their primary target, no bombs fell on Flensburg.²

Yet another problem for the P.F.F. in these early days was the complicated command and organisational structure devised by Harris. It provides a classical example of British administrative 'muddling through'. Pathfinder Force aircrew and groundcrew were the responsibility of Bennett but all were lodged on aerodromes where the chain of command for the permanent staff went via the Station Commander to Air Vice-Marshal J.E.A. Baldwin head of 3 Group. A further restraint on Bennett was that, although newly promoted to acting-Group Captain, he did not possess the authority to actually command the newly constituted force. This he could only do in Harris's name as a Staff Officer of Headquarters (H.Q.) Bomber Command.³ Thus, orders for the P.F.F. were routed through their host 3 Group. To further complicate matters both aircrew and aircraft losses were the responsibility of the original sponsor. If an 83 Squadron aircraft or crew were lost, 5 Group (who opposed the P.F.F. on principle), had now to provide a replacement Lancaster and/or another of their top crews. It was akin to rubbing salt into an already festering wound. To organise, train and employ the force on which so much rested, Bennett was provided with a staff of three officers plus a corporal of the Women's Auxiliary Air Force (W.A.A.F.) as his secretary. Appointment as a Staff Officer at P.F.F. H.Q. did not entail a complete rest from operations as it was policy, initially, that all (and Bennett did not exclude himself), maintained their operational efficiency. Even before the end of August 1942 the first Staff Officer had gone missing. Eventually, higher authority intervened and Bennett was ordered not to assign himself a place in bombing raids. There is plenty of evidence however that this specific order may not always have been obeyed.⁴ Even as late as September 1943 Bennett was still pleading with Harris that he be permitted, officially, to take part in operations. He was prepared for the ire that such a request may arouse but made it clear that even 'with the risk attached to resurrecting a sore subject I feel I must stress once again the urgent necessity for myself to fly on operations, and I feel certain that I can never do this job as

² Middlebrook & Everitt, op.cit., p.301
³ Bennett, Pathfinder, p.133
⁴ Jackson, op.cit., p.67, see also
⁵ Mahaddie, op.cit., p.52
it should be done unless I am permitted to operate'. Bennett argued that the 'case of the A.O.C., P.F.P. should be regarded as an exception' despite Harris's known wishes and relevant Air Council instructions. His request was declined. One of the first Staff Officers appointed by Harris, and who survived the war, thought that 'that little chance of death infused the staff with a lot of extra life!'.

In view of the controversy over area bombing which arose even prior to the end of the war, and which has continued spasmodically ever since, it is perhaps prudent to examine some of the facts. Although it had not, in the summer of 1941, become official policy, area attacks on German cities were being carried out by Bomber Command even at that comparatively early stage of the war. Particular industrial concerns, railway marshalling yards, or military objectives were usually the designated targets but these normally formed part of an extensive urban area. Thus bombs, even when inaccurately placed, still caused physical and mental damage. In this situation a miss on a specific target was still considered to constitute a useful operation. Bomber crews in 1941 were instructed that, although they may not have been able to identify either their primary target or their secondary, their bombs were not to be returned to England. In such a situation the bombs were to be dropped on targets of last resort.

A New Zealand navigator in Bomber Command in these early days, at a briefing, was given the primary target of Hamburg, secondary Bremen, with the last resort being Semo and Mopa. Being unfamiliar with the geography of Germany and not wishing to display his ignorance, a lot of time was spent, without success, trying to locate the last resort target on the planning map. Normally the target of last resort would be in the vicinity of the primary and secondary objectives. At a later briefing Cologne and Dusseldorf were the primary and secondary targets but again Semo and Mopa were the targets of last resort. Apparently they were moveable targets and this time the Ruhr area was carefully covered in another fruitless search. It was not until several weeks later that the mystery, quite by chance, was solved. SEMO was 'self-evident military objective' and MOPA was 'military objective previously attacked'.

— AIR 14/2701, P.R.O. 3859, Bennett to Harris
25 September 1943, para.10

— William Anderson, Pathfinders
(London: Jarrolds, 1946), p.51

— Gp. Capt. Sam Hall, 'Where Ignorance is not Bliss', in The Marker, Spring 1990, pp.5-6
Harris, although he undoubtedly shares a major portion of the responsibility for the over-perpetuation of area bombing, was not responsible for its initiation. From late May 1941 until February 1942 he was in the United States as head of a purchasing and procurement delegation. Thus his possible policy input in support of an area offensive was undoubtedly restricted. Bombing Directive Number 22 issued to Baldwin as interim head of Bomber Command on 14 February 1942 and inherited, willingly, by Harris, when he assumed command on 22 February 1942, was unequivocally explicit. Under the terms of this Directive it was ordered that Bomber Command's major efforts 'should now be focused on the morale of the enemy civil population and in particular, of the industrial workers'. This Directive, in various Annexes, then listed Primary and Alternative Industrial Areas within Gee range plus other Alternative Industrial Areas outside the range of Gee. Targets were given in general terms, transportation and heavy industries, naval dockyards, Heinkel factories etc., but each was related to a particular city and the Directive was specific in describing them as 'selected area targets'.

Military policy and long term strategy rarely come within the area of influence of a field commander. His responsibility is to devise the means by which the policies of the Chiefs of Staff, War Cabinet and, ultimately the Prime Minister, are carried out. Harris's duty, clearly, on assuming command, was to implement the area bombing directive. Although he was later to argue that the notion of breaking German morale was 'wholly unsound' he fully supported the area bombing policy. He abhorred changes of strategy and remained convinced that given sufficient aircraft Bomber Command, by laying permanent waste to a succession of German cities, could, by itself, win the war. There is a germ of truth in his assertion if Albert Speer, Hitler's Reich Minister of Armaments and War Production, is accepted as a reliable witness. Speer admitted that the raids on Hamburg in late July and early August 1943 'put the fear of God in me ... a series of attacks of this sort, extended to six more major cities, would bring Germany's armaments production to a total halt ... Fortunately for us, a series of Hamburg-type raids was not repeated on such a scale against other cities. Thus the enemy once again allowed us to adjust ourselves to his strategy'.

8 Webster & Frankland, _op.cit._, Vol.4, p.144
9 Ibid
10 Harris, _Bomber Offensive_, p.78
The crucial factor in the area bombing theory was 'sufficient aircraft'. Portal, on 3 November 1942, provided the Air Staff assessment. In a War Cabinet paper he wrote 'that a heavy bomber force rising to a peak of between 4,000 and 5,000 bombers in 1944 could shatter the industrial and economic structure of Germany'. Harris, in December 1943, was even more optimistic. In a letter to the Air Ministry he claimed that with an average of only 40.25 operational Lancaster squadrons this 'should be sufficient but only just sufficient to produce in Germany by April 1 1944, a state of devastation in which surrender is inevitable'. Both Portal and Harris made critical over-estimations - Portal of the number of heavy bombers that would be available for a strategic bombing offensive and Harris, of the destructive capability of the bomber force he commanded.

Whatever the arguments, or the perceived needs, the Bombing Directive issued on 21 January 1943 provided Harris with the opportunity to pursue an area offensive. Subsequently known as the Casablanca Directive it had been approved by the Combined Chiefs of Staff (American and British) and was addressed to 'the appropriate British and United States Air Force Commanders to govern the operation of the British and United States Bomber Commands in the United Kingdom'. In the accompanying covering letter it was stated that this Directive 'replaces the general directive of 14th February 1942' which had clearly ordered the area offensive and stressed the importance of the morale element. The Casablanca Directive inclined more to a policy statement rather than clear instructions as to the manner in which Harris should employ his bomber force.

Bearing in mind the fact that the Casablanca Directive was addressed to both the British and American bombing force leaders, the preamble began 'Your primary object will be the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened'. It then proceeded to list submarine construction areas, the German aircraft industry, transportation, oil plants and other

13 Webster & Frankland, op.cit., Vol.2, p.56
14 Ibid., Vol.4, p.153
15 Ibid., Note 1, p.153
16 Ibid., p.153
war industry targets. In his post-war memoirs Harris wrote that in this Directive 'The subject of morale had been dropped' and that he was 'required to proceed with the general 'disorganisation' of German industry ... which allowed me to attack pretty well any German industrial city of 100,000 inhabitants and above'.

Harris was quick to take advantage of the perhaps deliberate vagueness of his latest Directive. Writing to the Air Ministry on 6 March 1943 he ignored the fact that it had been originally addressed to both the Royal Air Force and the United States Air Force commanders. Harris ignored the word 'Your' and substituted 'Bomber Command' and then continued to give a further misquotation. He claimed that the Casablanca Directive stated 'categorically' that the 'primary objective of Bomber Command will be the progressive destruction and dislocation of the German military, industrial and economic system aimed at undermining the morale of the German people to a point where their capacity for armed resistance is fatally weakened'. In his letter Harris also used inverted commas for this section, implying that he was quoting verbatim the agreed words of the Combined Chiefs of Staff. Clearly, he had not done so. Whether the altered wording was deliberate or otherwise will probably never be known but Harris had given it his personal interpretation. In so doing he made the undermining of German morale the primary objective. Almost certainly the 'progressive destruction and dislocation of the German military, industrial and economic system' had been the intended primary aim with lowered morale a secondary consequence.

Harris's mistranslation passed unremarked by the Air Staff and, even further, Portal virtually agreed with his Bomber Commander. Harris had pointed out the broadness of the Directive and awaited the Air Ministry interpretation. Portal replied, on 11 March 1943, that Harris was to 'obliterate Hamburg, Bremen and Kiel as quickly as possible and that when weather does not allow attacks on these cities he should go for others of the highest industrial value ... Berlin and the Biscay bases are extras'.

Clearly, Harris had received his mandate for the continuation of an area offensive. He was in command of what he hoped was an expanding bomber force, new navigational and bombing aids (H2S and Oboe) had just been, or were about to be

17 Harris, *Bomber Offensive*, p.144
18 Webster & Frankland, *op.cit.*., p.14
introduced, new target marking flares and bombs were being tested and the Pathfinder Force had been established. A major imponderable was the threat posed by the rapidly expanding German ground and air defences.

Final German military preparations in 1939 were based on the perception that if war did eventuate then it would be of limited duration and confined to the European mainland. With these limitations as the guide line the Luftwaffe had prepared for an offensive war. The fighter arm was trained and equipped to achieve local air supremacy where required, to be capable of providing efficient escorts to both bomber and fighter-bomber formations plus the provision of direct tactical support to army battle groups. Defensive operations had been little considered because it was believed they would not be necessary. Britain and France had yielded over Czechoslovakia so why should German encroachment into Poland expand into a major war? Reich's Minister of Air, Hermann Göring, in command of the Luftwaffe, saw nothing to fear from the French Air Force. In the event that Britain became involved then, Göring believed, the day defensive system that had been developed, centred mainly on anti-aircraft guns ("Flak")\textsuperscript{20}, would provide more than adequate protection. Additionally, the Luftwaffe possessed 7,500 dayfighter aircraft in 1939 - both single and twin-engined - while the aircraft in R.A.F. Bomber Command capable of posing a threat to the Ruhr amounted to only 400 Hampdens, Whitleys and Wellingtons.\textsuperscript{21}

There was also another factor that gave confidence to both Hitler and Göring - the deterrent threat posed by the Luftwaffe force. As early as 1935 one writer had claimed that 'Germany possesses bombers of sufficient speed and load-carrying performance, and in sufficient numbers, to launch and sustain massed air attacks from her frontiers ... to a complete range of 1,246 miles'.\textsuperscript{22} Little wonder that Hitler accepted, and frequently claimed, that the Luftwaffe bomber force was capable of achieving the degree of Schrecklichkeit\textsuperscript{23} that his potential enemies feared. Nor was it either in jocular vein, or for political point-scoring, that Göring in

\textsuperscript{20} Flak, abbreviation for Fliegerabwehrkanonen or anti-aircraft guns


\textsuperscript{22} F.P.R. Dunworth, 'Germany's Air Force' in J.R.U.S.I., Vol.LXXX, No. 519, August 1935, p.521

\textsuperscript{23} frightfulness
a speech in the Rhineland in July 1939 had declared that 'If an enemy bomber reaches the Ruhr, my name is not Hermann Göring. You can call me Meier'.

Very early in the war the German air defences by day proved themselves to be totally efficient. Bomber Command was forced into a night role for which it was totally unprepared. Although darkness provided protection for the British bombers it had the disadvantage that it made target identification extremely difficult. Apart from some strategically sited listening posts, searchlight batteries and Flak guns, weather was the greatest threat facing the bomber crews. In response to the first leaflet raids over Germany, some German night fighter units were formed which flew uneconomic dusk and dawn patrols around both Cologne and Stuttgart. Lacking either information or control from the ground it was a forlorn, rewardless, and dangerous task. Their lack of success in combination with the British failure, at this time, to intensify their night operations, provided considerable encouragement to Göring that expansion of the night fighter force was unnecessary.

Thus, even in mid-1940, the primary night defences in Germany against British bombers remained searchlight and Flak batteries - elite arms of the Luftwaffe. A searchlight battery consisted of three lights and a sound locator, while a heavy Flak battery was usually equipped with four guns (each manned by ten men early in the war) and a predictor for aiming purposes. On clear nights air defence was given over to the Flak gunners but they were fixed defences and not all German cities had such protection. When the bombers came, protected by cloud, German night fighters based mainly in the Rhineland were launched to attempt to carry out visual interceptions. They recorded few successes. With the tempo of the night war increasing it was obvious that improvements to the defences were essential. On 17 July 1940 Oberst Kammhuber was given the responsibility of organising of the first Night Fighter Division. German ground radar now entered the night fighting equation and Kammhuber was charged

25 Aders, op.cit., pp.13-14
27 Equivalent rank to Group Captain in the R.A.F.
28 Air Ministry, The Rise and Fall of the German Air Force (1933 to 1945), p.186
with the responsibility of co-ordinating the activities of the Luftwaffe aircrew, air reporting service, searchlight and Flak batteries and the radar. The previously fragmented command structure was now unified. No longer, for example, would the pilots and the searchlight units receive their orders from different sources.

*Helle Nachtiagd* or 'illuminated night fighting' was the first tactic adopted by the German night fighter pilots. *Freya* ground radar with a range of approximately 75 miles, but with no height finding capability, would provide early warning of the approach of unidentified aircraft. On receipt of this alarm the German night fighters on stand-by would get airborne and circle specified radio beacons to the east of the searchlight zones. Should a bomber be illuminated in the searchlight area (and it was crossed by a bomber in about three minutes) then the fighter would attack. Cloud frequently was a problem but even on clear nights the searchlights too often failed to reveal a target. This system provided a poor defensive screen for a limited number of German cities and failed to cover popular entry routes into German air space. British bomber crews making their individual ways towards their German targets were quick to realise that the absence of *Flak* in an area of intense searchlight activity could only indicate the presence of German night fighters. Bomber routes were adjusted to clear the isolated defended areas. Few interceptions were made and even fewer British bombers shot down.

It was becoming clear that the *Würzburg* radar system with its height-finding capability, which had been usurped for use by *Flak* batteries, perhaps held the answer to the night interception problem. Kammhuber, ever-ready to implement new ideas, ordered refinements to the *Helle Nachtiagd* system. Three night fighter zones covering an area of the Dutch coast 90 kilometres long by 20 kilometres deep were established during the autumn of 1940. All the zones were equipped with two *Würzburg* radars, each with a range of 30 kilometres, and a searchlight battalion. One *Würzburg* in each zone controlled a master searchlight linked to a searchlight group while the other *Würzburg* directed a night fighter to an interception position. *Freya* radar plotted the track of the bomber. This system only provided limited successes for the German night fighters so a further tactical change was made. *Freya* radar provided a general area surveillance and while one *Würzburg* was used to track the bomber the other followed the German fighter. A control room in the zone calculated tracks and speeds for interception and these were transmitted to the fighter. Controlled night fighting had begun and the tactic, with refinements, was to last until 1943. The system was known as *Himmelbett*.

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29 Aders, *op.cit.*, p.18

30 Literally 'four-poster bed'
These defensive boxes, which the British named the 'Kammhuber Line', started slowly but expanded rapidly as the British bombers planned their routes to go around either the northern or southern extremities of what was for them a dangerous area. By the end of 1942 the Kammhuber Line extended from Denmark to south eastward of Paris while additional protective belts were formed to guard the approaches to Berlin and also those to targets in the Frankfurt, Mannheim and Stuttgart complex in the south.

Himmelbett had its limitations. Although the Würzburg radars when replaced by Würzburg Riese\(^3\) units doubled their range, each zone could only control one fighter at any one time. This mattered little while the British bombers operated independently in respect of both routes and timing and their numbers remained small. As the numbers of bombers increased, when set routes were laid down for the bombers to follow, and when the duration of raids was shortened dramatically, it became obvious to the German authorities that too many enemy bombers were proceeding, unmolested, to their targets. The advent of the bomber stream led by the Pathfinder Force plus rapid developments in electronic counter-measures required a major reassessment of the German defensive system and this will be discussed later in this section.

Before closing this discussion on German defensive measures up to the end of 1942, mention must be made of another unit also commanded by Oberst Kammhuber. Equipped with twin-engined modified Ju88s, and a few Do17s, they were employed as intruders to harry British aircraft at their own bases. Operating from former Dutch airfields they attacked British Bomber and Training Command aerodromes from Yorkshire to the Home Counties. Night intruder operations posed a special problem for the bombers because take-offs and landings were the times when they were most vulnerable. Airfield lighting was required for such operations so the aerodromes were readily located and bombers on take-off, fully loaded with fuel and bombs and below safe manoeuvring speed, were unable to initiate violent avoiding action. On landing the crews were tired, all knew the sky was full of unseen aircraft, they were often short of fuel or the aircraft could have suffered earlier critical battle damage. Fortunately for Bomber Command, despite strenuous efforts by Kammhuber, rarely did his intruder force operate more than 20 aircraft and they were withdrawn in 1941 for operations in the Mediterranean. Although there was a renewal of intruder operations in 1945, Hitler's direct order for their discontinuance in 1941 was a fortunate reprieve for the R.A.F. As an illustration of the threat they could have offered, an intruder operation mounted by the Luftwaffe on 3/4 March 1945

\(^3\) Giant Würzburg
resulted in the destruction over England of no less than 13 Halifaxs, 9 Lancasters, 1 Fortress and 1 Mosquito in a two and a half hour period.\(^{32}\)

Bennett’s situation on 5 July 1942 when he was appointed leader of the P.F.F. was not one to be envied. He was a commander without aircraft, aircrew or groundcrew, with no history or tradition to follow, no equipment and no preconceived tactics, while at the same time he faced considerable opposition from most of the other Group Commanders. Harris, although he had strenuously resisted the formation of the P.F.F. and had stated he would waste on effort on it, had still promised Bennett that he would help him in every way.\(^{33}\) The incongruity that can be noted in this situation was to be further compounded by the loyalty that Harris continued to maintain with regard to his other Group Commanders in general and Cochrane of 5 Group in particular. Bennett initially focused on three particular needs – selection of suitable personnel, development of navigation and bombing aids and the provision of suitable flares and target markers.

Recruitment and training of suitable personnel, Bennett realised, was a long term consideration. Time was required and he appreciated that initially he had to submit to the whims of the various Group Commanders. Provided they were prepared to release their best crews then the P.F.F., in the majority of cases, would have the crews he wanted. If they demurred, then only time would correct the situation. Further, remembering that the P.F.F. only accepted volunteers, would all the best crews come forward? Were they all prepared to expose themselves to the extra risks involved in being not only permanent leaders but also by the considerable extension to the length of the operational tour? Tour lengths for Bomber Command crews in 1942 were the completion of 30 sorties. Volunteers for P.F.F. duties were, at first, expected to complete 60 operations before being taken out of the front line. Admittedly the P.F.F. tour length was early reduced to 45 but it still remained a formidable undertaking. During the Spring of 1942 it was calculated that only one crew in four could contemplate completing a tour of 30 sorties. Transfer to the P.F.F. with the commitment to 45 sorties increased the odds against completion to one in six.\(^{34}\) Although, on the surface, aircrew assumed a phlegmatic approach to casualties nevertheless the risks were very real.

\(^{32}\) Simon W. Parry, Intruders over Britain (Surbiton: Air Research Publications, 1987), pp.194-7

\(^{33}\) Bennett, Pathfinder, p.133

and were well understood. Empty beds in the Nissen huts and vacant chairs in the different messes were constant reminders.

From the outset it was clear to Bennett that the P.P.F., without new navigational and bombing aids, would not be able to help Bomber Command to achieve the successes that the effort and expenditure demanded. New aids were primary essentials if the P.P.F. in particular and Bomber Command in general were to accomplish their tasks. Fortunately, two new revolutionary radar aids, $H_2S$ and Oboe, were in the pipe-line. Development of $H_2S$ was delayed somewhat by the perhaps unnecessary deaths, in June 1942, of six of the twelve or so scientists working on the project. They were airborne in a Halifax fitted with a prototype of the new target-finding equipment when an engine caught fire and the aircraft crashed. No one survived but the dilemma revealed later was that although the five R.A.F. crew had parachutes (none were used), the scientific team was not so-equipped.  

Recognition of the great potential offered by $H_2S$ was immediate for Bennett and he spent several weeks at the T.R.E. at Great Malvern after his appointment as leader of the P.P.F. but prior to the movement of the squadrons and crews. By virtue of his position he was largely instrumental in speeding up the development programme. Bennett insisted that aircraft be made available for $H_2S$ flight testing when the scientists requested them rather than, as had been the case, when the R.A.F. declared them serviceable. $H_2S$ was complex equipment and it required great skill in its operation but the advances that had been made were recognised when it was first used on 30/31 January 1943, for operations against Hamburg. Development work of course, continued with $H_2S$, but it was a slow process and the skill levels for those required to install, maintain and use it, remained high.

Oboe's development followed less orthodox lines than those used for $H_2S$. Close co-operation between the scientists and the user aircrew often short-circuited possible bureaucratic delays. Much of the development and testing was done in Mosquito aircraft belonging to 109 Squadron which had earlier been involved in identification of the German Knickebein beams. Thus, when the Oboe system was declared operational it was already fitted in front-line aircraft and crews were trained in its use. Oboe provided a very significant advance in bombing accuracy in all weathers although, until a foothold had been won on the European mainland, its restricted range was a notable disadvantage. While $H_2S$ range was limited only by the bomber's radius of action, Oboe range depended on the bomber's altitude which

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confined its use initially to targets in the Ruhr. Oboe accuracy bordered on the uncanny and targets in the Ruhr, formerly shielded by industrial haze and cloud, could no longer consider themselves invulnerable once it came into operation. Perhaps Oboe also provided another significant gain for the R.A.F. Originally, the intention had been to fit Oboe into an improved, pressurised version of the Wellington but the Mosquito had been preferred by the 109 Squadron pilots who carried out the testing. The construction of a limited number of Mosquitoes, as a trial, had been approved by the Ministry of Aircraft Production and some of these had been made available to 109 Squadron for testing. Both Bomber Command and the Air Ministry had argued against their acceptance. They claimed that the large amount of wood involved in the construction rendered the Mosquito frail, it lacked defensive armament, they were too small and they were difficult to fly at night. Fortunately the wiser counsels of the users won the day and the Mosquito bomber became a very valuable addition to the P.F.F. and Bomber Command.

Oboe-equipped Mosquitoes carried out their first operation on 20/21 December 1942 in an indecisive attack on a power station in the Dutch town of Lutterade. Only six Mosquitoes were involved and while three experienced equipment malfunctions the others completed their bombing. Subsequent photographic reconnaissance was unable to distinguish between the effects of the Oboe bombing and that caused by a Main Force attack (P.F.F. led!) which had mistaken Lutterade for the briefed target Aachen.\(^{36}\)

Oboe also had an additional limitation. One pair of ground stations could only control six Oboe aircraft per hour so with the bombing accuracy achievable it was logical to try the Mosquitoes as target markers. On 31 December 1942/1 January 1943 two Oboe-equipped Mosquitoes marked Dusseldorf for a trial attack by eight Lancasters.\(^{37}\) Another page had been turned in the bomber war.

Bennett's third focus of attention was on the provision of suitable and sufficient flares for the illumination of target areas and targets, and purpose-designed target indicators that could be clearly distinguished on the ground but which could not easily be duplicated. Target illumination at the beginning of P.F.F. operations, with concentration a primary aim, was an immediate problem. The four point five inch reconnaissance flare, in wide use since the beginning of the war, could be fused to release a candle on a parachute at a selected altitude. The candle produced a yellowish/white flame of 750,000 candlepower and burned for

\(^{36}\) Middlebrook & Everitt, *op.cit.*, pp.338-9

three to four minutes. When only small numbers of aircraft were involved these flares had been useful. Unfortunately, when dropped in large numbers they provided an upward glare which not only prevented the bomb-aimers from sighting their target but also silhouetted the bombers to the benefit of prowling German night fighters. Hooded flares to increase downward illumination were the obvious answer but there were many difficulties and in fact they did not become available in quantity until January 1944. 

Flare fusing was yet another problem to be faced by P.F.F. and Main Force crews in late 1942. The standard fuse had a habit of not always operating after the pre-set time interval. Operation immediately on release was very disturbing for the crew involved while operation at too low a level considerably reduced its usefulness. Assuming that the fuse would operate after the pre-set time interval, then it was imperative that the aircraft was flown at the briefed altitude when the flare was released and until the flare was extinguished, if best use was to be made of its illumination. If the aircraft was above the briefed altitude at release, the flare, if operated correctly, would be too high to provide adequate ground illumination. Should the releasing aircraft be lower than the briefed release altitude then it was possible for the flare to hit the ground before ignition occurred. Severe restraints were placed on tactical freedom by the requirement to fly at a specific altitude and crews were much relieved when barometric fuses became available. Set to operate at a particular height above the target these fuses were uninfluenced by the aircraft's release altitude.

Makeshift incendiary markers were used from the earliest operations of the P.F.F. to confirm aiming points revealed and located by the first crews reaching the target area. A mixture of benzol, rubber and phosphorous, appropriately coloured to be clearly visible despite many distractions, was put in either 250 pound or 4,000 pound bomb casings. The smaller casing provided a distinctive Red Blob fire which burned for almost ten minutes and was first seen in an attack on Nuremberg on 28/29 August 1942. Crews for this raid were briefed to attack at low level and the target was precisely marked but, despite contrary claims from Main Force crews, the actual bombing was scattered. Losses on this raid were particularly heavy - 14.5 per cent of the total force involved while Wellington losses were 14 aircraft from a total of 41. The 4,000 pound casing provided an incendiary marker weighing 2,800 pounds called a Pink Pansy. First seen at Dusseldorf on

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39 MacBean & Hogben, op.cit., p.111
40 Middlebrook & Everitt, op.cit., p.304
10/11 September 1942 they provided a brilliant but unfortunately virtually instantaneous display and thus failed to mark a continuous aiming point. This fault meant they were used infrequently as markers but they reappeared as incendiaries in 1944 although again their operational life was short-lived. 41

Target indicator bombs (T.Is) had long been a requirement for Bomber Command but the first ones available to the P.P.F. were again, not purpose-built. Surplus 250 pound incendiary bomb cases were utilised to carry 60 coloured candles. 42 These candles, coloured red, green and yellow, were ejected from the tail by a bursting charge controlled by a fuse set according to the particular attack parameters. In the case of small precision targets ejection was on impact. Against area targets ejection was normally at about 1,500 feet and the candles cascaded down in a very visible display and gave a ground cover approximately 80 yards in diameter. Normally, four T.Is of this type would be dropped in salvo to provide a recognisable pattern and a distinctive aiming point. When air bursts were required then the lower the release point of the candles the more accurate the target marking. This was because the ballistic properties of the 250 pound cases were vastly superior to the erratic ballistic behaviour of the candles. Reds and greens burned for three minutes while the yellows, shortly to be abandoned because they were not always readily visible, lasted for five minutes.

With cloud frequently shielding targets in Germany, not only in the Ruhr, attempts were made with the improvised 250 pound T.I. to use it as a sky marker. Candle ejection was so arranged that they were visible above the cloud tops. Bomb aimers would then aim at these markers with the hope of hitting the area target somewhere below the clouds. Precision was lacking in this type of attack because strong winds could cause the candles to rapidly drift off the aiming point. They could also disappear in the cloud. Although in the early days of P.P.F. operations sky markers were inexact aiming points, at least they were no worse than simply bombing on the expected time of arrival (E.T.A.) at the target. This form of attack, using skymarkers, was employed against Berlin (a notoriously cloud-affected target) on 16/17 January 1943. The method went into abeyance fairly quickly when it was realised that decoy candles were being used by the Germans at their elaborate spoof targets. But slightly more sophisticated sky-marking will reappear later in the P.P.F. story.

41 MacBean and & Hogben, op.cit., p.72
42 Authorities disagree as to their length. Musgrove in Pathfinder Force, p.248 states 12 inches. Hecks, Bombing 1939-45, p.198 agrees. On the other hand, MacBean and Hogben, Bombs Gone, p.110 state that they were only 9 inches long.
Pathfinder Force operations were always tests of personnel, tactics, and equipment, and never was this more true than in the months from the formation of the force and leading up to the commencement of the Battle of the Ruhr on 5 March 1943. Changes were constantly being introduced in the effort to provide greater assistance to the Main Force crews not only for their guidance and protection but also in the effort to achieve improved bombing concentration. New flares and T.Is were constantly being introduced and when H2S and Oboe became available further tactical refinements became necessary. It was very much a settling-down period but because it was virtually being conducted on a 'trial and error' basis not all the methods proved successful. Nor were some of the innovations always popular. Route marking - introduced on 19 September 1942 - was a case in point. In an effort to narrow the bomber stream, particular Pathfinder crews were briefed to drop marker flares as route guides for Main Force crews on their way to Munich. Naturally, the next time they were employed, they also served as a focus for German night fighter crews who happened to be in the area. There were failures both human and technical but that was only to be expected in what was becoming an increasingly technological war. Amidst all the changes one element remained constant. Weather conditions provided the fulcrum for either the success or failure of any particular raid up to the time when H2S and Oboe became available. Prior to the introduction of the new radar aids bad weather made success problematical. Even reasonable weather gave no guarantee of bombs on their briefed targets. The new radar aids altered the balance - the problem of weather was reduced but never totally overcome.

The first operations carried out by the P.P.F. were basically a continuation of earlier Bomber Command tactics in that they took place in three distinct phases. Firstly the target had to be located, illuminated and marked. Secondly, fires had to be started in the immediate target area to act as a bombing beacon and aiming point for the third phase, the assault by the Main Force. Prior to the introduction of H2S and Oboe the target marking technique relied absolutely on the ability of specialist crews to visually mark the target by the light of flares. Particular crews in the P.P.F. were allocated specific tasks in a raid and thus, gradually, they assumed the name of the function they were charged with performing.

'Finders', normally the best crews, were first used over Essen on 16/17 September 1942. Their task was to drop sticks of flares about six miles in length on a specified geographical line in the target area at a specific time but without necessarily having identified the target. Theirs was a vital task and required accurate navigation and precise timing. Finders were closely followed by 'Illuminators' who
were required to positively identify the target and then drop salvoes of flares on or around the aiming point. As soon as the target had been identified and illuminated 'Marker' crews entered the action. Their task was to place their ground markers, of the type and colour specified at the briefing, precisely on the aiming point. Accurate navigation was required but bomb aiming was their forte. It was clearly laid down, and always repeated, that Marker crews were only to release their T.Is provided their bomb-sight was fully serviceable and the aiming point had been positively identified. When these pre-conditions were not fulfilled then the markers had to be returned to base. Experience had shown that bombing raids could go badly wrong when markers were put in the wrong place. Markers were jettisoned on many occasions when bombers came under severe attack and these, plus Marker aircraft shot down with their loads intact, all added to the confusion.

Other crews that performed a useful function in all Pathfinder raids were 'Supporters'. Usually they were inexperienced P.P.P. crews but their orders were to arrive with the Finders, re-emphasising the absolute importance of timing in all Pathfinder operations. Supporters had two functions. Primarily they were to distract the German defences simply by their presence. The chances of a particular bomber being engaged either by Flak or German night fighters were reduced by an increase in numbers over the target at any one time. Secondly, they could distract the ground rescue organisations by dropping high explosives. The danger here was that their efforts could create problems for the Markers with smoke, fires, or explosions, concealing the target. Thus the bombs the Supporters dropped were normally fitted with time-delays.

By now the target had been found, illuminated and marked but pyrotechnics have a finite burn time so it was essential that throughout the raid, 'Backers-up', at regular intervals, dropped ground markers aimed at the centre of those already burning. Backers-up were later called 'Visual Centerers' and their secondary markers were usually of a different colour to those dropped by the first, or primary markers, over the target. Other name changes and additional descriptions also occurred after the introduction of H2S and Oboe but these will be described later.

Although their task was a difficult one, the requirements for a successful P.P.P.-led attack can be expressed in simple terms. To achieve success, however, required very careful planning. How many of the various categories were required for a particular operation? Too many T.Is were as bad as insufficient. Then there was the distribution of duties. It was no use saying that such and such a squadron would do one particular function because at a crucial time their runway
may be blocked and no aircraft were able to take-off. It was necessary to allocate all duties throughout the squadrons taking part so that Finders, Illuminators, Markers or Backers-up were always available at the precise time required.

Successful attacks may, at times, have been the result of luck but it was early recognised that the clarity and adequacy of the instructions and information provided at the pre-flight briefing were of extreme importance. As the war progressed operational briefings had become more formalised. Normally the briefing was conducted by the squadron or wing commander assisted by such other specialists as were considered necessary. These normally included officers from intelligence, meteorological service, navigation, photography, armament and signals, while others could be co-opted as required. Briefings were the formal means of passing to the crews concerned their commanding officer's interpretation of the orders he had received.

Ideally, orders for the night's operations were received early in the day in signal form but possibly amplified on a 'scrambler' telephone. Individual specialist officers who were to be involved in the briefing were advised of the task to allow them time for preparation. Crews would be informed that 'ops were on' for that night and crews lists published. These nominated crews were responsible for carrying out night flying tests (N.F.Ts) to check the serviceability of the aircraft they would be flying that night including its ancillary equipment. At this stage they were not aware of the target. By keeping in close touch with their armourers or the refuelling section they could hazard guesses as to whether it was a short or long range target but that was not necessarily an accurate guide. Targets could be changed at short notice and armourers spent many long hours loading, unloading and then reloading bombs and associated pyrotechnics. The change overs disconcerted and overworked the armourers and helped confuse the aircrews.

Inside the briefing room the target route map was normally kept under cover until the pregnant words of the senior briefing officer announced, 'Gentlemen, your target for tonight is - '. Although the briefing was to be given verbally all the information was displayed visually for the crews to note. Aircraft identifications, captain's names, routes, turning points, timings, altitudes, positions where route markers could be expected, type of target marker to be employed - all were written up. When visual identification and marking was to be the tactic then photographic mosaics or sketches of the target and its surrounds were available for study.

Briefings always commenced with a roll-call, captains answering for their crews. Next the Intelligence Officer detailed the type of attack that would be carried out and the relevance of the target. By this stage the crews had an
overall picture of the forthcoming operation although most had still to absorb the finer detail. Intelligence briefing was normally followed by the Meteorological Officer who provided forecasts of surface wind and weather to be expected at take-off, weather and upper winds en route, weather and upper winds at the target, weather and winds for the return flight, and the weather and surface wind to be expected on return to base.

At this point the senior briefing officer took over again and gave a complete description of the procedures to be followed on the way to the target, in the target area and on the return. He would then detail the crews for their specific duties (Marker, Illuminator etc.) followed by precise instructions on the methods each was to employ during the attack and the timings they were expected to meet. This, of course, was the crucial part of the briefing because success depended on it having been fully understood. If necessary, further specialist briefings could then be given on any aspects that required amplification.

Finally, when questions were complete, crew coach and meal times were announced and then the flight engineers, gunners and wireless operators left the briefing room. Pilots, navigators and bomb aimers then began the detail of flight planning — measuring tracks and distances, calculating headings, ground speeds and times and then, working back from the time that they were due 'on target', calculating their particular take-off time. 

The P.F.F. commenced its operations in August 1942 but they had to face virtually the same difficulties that bomber crews had encountered prior to the introduction of Gee. Their only advantages were that some were equipped with better aircraft — notably the Lancaster, because at this stage neither the Halifax nor the Stirling were significant advances — and they had Gee available over the North Sea both outward and homeward bound. A preliminary survey conducted at the end of November 1942 by the Operational Research Section on the first 26 attacks carried out by the P.F.F. revealed several points of considerable operational importance.** The first appreciation was that on several raids targets had not been located because insufficient Finders had been detailed for the task. The employment of at least eight to twelve Finders became obligatory even on average-difficulty targets.

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8 Group H.Q., Path Finder Force Instructions (Huntingdon, 1943), 4th Edition, Section 1, Instruction 4, pp.8-10. From Bennett papers.

** Andrew, op.cit., Appendix 7
whenever weather conditions were, or threatened to be, anything less than ideal. More were required on difficult targets or when the weather was only moderate or poor. Secondly, target identification problems were all too frequently the consequence of unsatisfactory fusing on the make-shift flares in use. Insufficient illumination and impenetrable glare were the results and these problems were not rectified until 1943 when barometric fusing was introduced.

The analysis completed by the O.R.S. in November 1942 was done in three stages. The first consideration was the effect that the weather had had on P.F.F. operations against German targets. Italian targets, Genoa, Milan and Turin, which had also been the subject of P.F.F.-led attacks, were not considered in the analysis because, despite the hazards of winter flights across the Alps, weather conditions in Northern Italy were normally much better than in Germany and the defences were lighter. The second examination concerned the target finding abilities of the P.F.F. in both good and moderate weather conditions. The final question to which answers were sought was what were the effects of P.F.F. tactics on the bombing results of the Main Force.

Six of the twenty-six raids led by the P.F.F. during the period August to December 1942 were in bad weather when cloud cover over the intended target was from eight to ten tenths. These operations were all total failures in that the targets were never located. Eleven raids in moderate weather conditions, three to seven tenths cloud cover, resulted in the target being located on six occasions. In good weather with the sky clear, or when there were only up to two tenths cloud cover, the target was located on eight occasions out of nine.

With respect to the target marking ability of the P.F.F. analysis of the fourteen occasions when the target was located revealed that it had been successfully marked eight times and partially marked on six. Failure to locate the target, even in good or moderate weather conditions, was attributed to target mis-identification four times, insufficient flares once and P.F.F. crew-inexperience once. Thus, on all the operations in which the P.F.F. had taken part, the target had been either partially or successfully marked on 54 per cent of the raids. Such a reasonable beginning, considering the circumstances, held out great promise for the future.

Ten tenths cloud cover meant total cover. Five tenths cloud cover meant half of the sky above the target was covered in cloud. Estimation of the cloud cover required the addition of the cloud in different places over the target. Since the war, measurements of cloud cover have been in eighths, with eight eighths now being total cover.
The third section of the O.R.S. analysis concerned the effects that the P.F.F. efforts had had on the results achieved by the Main Force crews. Of the eight occasions on which the target had been marked successfully, improvements were noted in six raids. No improvements were measurable twice; once for unknown reasons and once when a smoke screen thwarted Main Force efforts. Whether that smoke screen was from fires caused by the bombing, or was a defensive measure adopted by the German authorities, was not specified. Of the six attacks when the P.F.F. marking was only partially successful, improved results by Main Force crews were still noted on three. Failure to improve results was blamed twice on the insufficiency of flares and once because of the late arrival of the Finders. In other words, when the P.F.F. had operated, 35 per cent of all raids against German targets had shown improved bombing concentration by Main Force crews. Assessment of raids prior to the introduction of the P.F.F. had shown that, in good or moderate weather against certain selected German cities, only 25 per cent of the aircraft involved would produce bombing photographs within three miles of the aiming point. An examination of bombing photographs of these same cities, with the same weather conditions but when the P.F.F. had been involved, showed that 41 per cent could now be plotted within three miles of the aiming point.

From this analysis it could be assumed that at least in conditions of good or moderate weather, the efforts of the P.F.F. had resulted in significant improvements in both bombing concentration and accuracy. New bombing aids, improved target markers and flares, plus the increased experience of the P.F.F. crews promised even greater threats to German and Italian targets. Unfortunately, perhaps because the camera never lies, the bombing photographs taken after August 1942 revealed a problem that was not satisfactorily resolved even by the end of the war. The central point of all the bombs dropped was becoming increasingly further removed from the actual aiming point.

Prior to the advent of the P.F.F. bomber crews individually identified and bombed their briefed aiming point. When the target could not be identified they aimed their bombs at the centre of the largest conflagration. Provided they dropped only one bomb at a time the bombing pattern produced by such attacks was circular and possessed a Gaussian distribution.46 That is, the greatest concentration of bombs was in the centre of the bombing pattern with the concentration reducing markedly toward the circumference. The centre of the bombing pattern was known as the mean point of impact (M.P.I.). But bomber crews were rarely keen enough

46 Tait, op. cit., p. 84
to make more than one bombing run across a heavily defended target so their bombs were dropped in sticks. When all the bombers approached the target virtually on the same track the bombing pattern, by virtue of their having released their bombs over a particular time interval, became elongated along the direction of approach. Natural anxiety meant that crews released their bombs earlier and earlier so the elongation backwards was continually being extended. This backward elongation was known as 'creep back'. Bomber streams had been introduced in March 1942 (in conjunction with Gee) so the elongated bombing pattern had been recognised prior to the establishment of the P.F.F. Operations by the P.F.F. simply confirmed that the bombing tactics required, because of the increased numbers of aircraft involved, that all the aircraft approached the target on the same track. However, there was one vital change introduced by the P.F.F. - Main Force crews were no longer required to identify the aiming point, they were ordered to bomb the T.Is placed by the P.F.F. What became of concern was that although bombing photographs revealed a significant improvement in concentration about the M.P.I., the M.P.I. itself was becoming increasingly displaced from the actual aiming point. More bombing photographs were being obtained, thanks to the P.F.F., within three miles of the M.P.I. but the increase in the number of bombing photographs within three miles of the aiming point was markedly less. From March 1942 until August 1942 35 per cent of bombing photographs were plottable within three miles of the M.P.I. Between August 1942 and March 1943, with the P.F.F. involved, that figure had increased to 50 per cent. However, the percentage of photographs falling within three miles of the aiming point only rose by five per cent during the same period - that is from 32 to 37 per cent. In moderate weather conditions operations by the P.F.F. were of considerable assistance in increasing bombing concentration but this notable improvement was nullified to a large extent by the unfortunate introduction of systematic errors.

The introduction of Oboe on 20/21 December 1942 and H2S on 30/31 January 1943 brought a new dimension to the bombing war. As a pure bombing aid Oboe had four distinct disadvantages. Each linked pair of ground stations could only handle one aircraft at a time and each bombing run they controlled took at least ten minutes to complete. The second disadvantage was that during the bomb run the user-aircraft had to be flown straight and level. Thirdly, Oboe range was only optical line of sight which, until airborne repeaters were available or stations could be established on the Continent, restricted its use to targets in the Ruhr. Finally, the user aircraft radiated signals which were capable of being used by German fighters to carry out interceptions.

Harris, Despatch on War Operations 23 February 1942 to 8 May 1945, p.79
The first limitation was overcome by using Oboe not as a blind-bombing device but as a target-marking aid of considerable precision. Because Oboe was normally only fitted in Mosquito aircraft capable of an excellent performance at high altitude, the apparent dangers of straight and level flight in target areas never became real. Operational losses for the prime-user Squadron, No.109, totalled only five aircraft between 20 December 1942 and 31 December 1943. Of these five, one was on take-off and another on landing at base.\(^{46}\) Strangely, the fourth perceived disadvantage of Oboe never eventuated and German interceptors were never provided with the equipment to enable them to home on to Oboe transmitters. Even jamming of the Oboe signals did not occur until late in 1943 and then only the early marks of Oboe were affected. Jammers were established in the Pas de Calais area to interfere with the ground control stations and in the Ruhr to affect the airborne equipment.\(^{47}\) By early 1944 the jamming problems had been overcome. Subsequent non-availability of Oboe or abortive operations were usually as a result of unscheduled equipment modifications, ground station failures, problems with mobile ground stations or bad navigation by the user-crews.

Oboe, installed in Mosquitoes, was first used on 20/21 December 1942 in a blind-bombing attack primarily for calibration and crew training purposes. The target was a power station at Lutterade and it was hoped that it would give an accuracy in the order of 650 yards but, as was explained earlier, the results of this raid were inconclusive. As a marking aid Oboe was first used on 31 December 1942/1 January 1943 in a trial against Dusseldorf. The first full-scale attack using Oboe as the means of providing accurately placed ground markers took place on 5/6 March 1943 when the target was Essen. As usual with Ruhr targets industrial haze and cloud were problems, but the accurately placed T.Is were clearly visible to the Main Force crews. The subsequent attack marked the end of the immunity previously enjoyed by targets in the Ruhr. It also marked the beginning of the so-called Battle of the Ruhr.

Although Oboe offered unparalleled accuracy in all weathers its limited range was a distinct disadvantage. Bomber Command, if it was to achieve its potential, required a bombing aid which provided equivalent accuracy but without the drawback of restricted range. A self-contained bombing aid, H.S, offered the prospect of successful attacks on enemy towns and cities, wherever located, limited only by the bomber aircraft’s radius of action. In its initial form H.S was

\(^{46}\) Webster & Frankland, op.cit., Vol.2, p.128

\(^{47}\) Musgrove, op.cit., p.226
expected to be capable of enabling a bomber flying at 15,000 feet to home on a built-up area from a range of fifteen miles. In other words, at first, it would be useful only for area bombing purposes. The expectation, however, was that, with improvements, H₂S would be capable of accurate selective bombing within an area target. Delays were many and arguments against its use over enemy territory, especially by naval authorities, vehement. Prime Ministerial intercession was required before agreement was reached that H₂S could be used by the P.F.F. in January 1943.

Hamburg, on 30/31 January 1943, was the first target. Despite the known limitations of the usefulness of the first mark of H₂S the hope still remained that it could be used as an aid to target-marking. Crews soon discovered that H₂S was of more use as a navigational rather than a bombing aid. Returns from built up areas produced such a clutter on the screen that it was virtually impossible to accurately select and mark the correct aiming point. Provided, however, that the H₂S screen was continuously monitored during flights over land the position of the user aircraft could be accurately determined at all times. This was achieved by measured bearings and distances from large cities or well isolated smaller towns as the aircraft proceeded on its track. An accurate position of the aircraft could be determined by the H₂S operator provided the identified cities or towns were only an average of not more than 25 miles distant. Constant attention to the screen was the secret of accurate navigation when using H₂S. The equipment differentiated well between sea and land returns so that the operator was usually able to determine exactly where the enemy coast was being crossed after the aircraft's passage over the North Sea. But because of the multiplicity and confusion of returns over land, and the difficulty of screen interpretation, it was no use just switching on the H₂S and believing that the aircraft's position could be determined with certainty. Constant monitoring was the only guarantee of accuracy. Visual map reading provided the same difficulties. Even at 420 knots and only 250 feet above the ground visual map reading was comparatively easy provided the navigator had kept a constant check on the aircraft's position. Should the navigator be distracted from map reading, even for only a short while, reorientation and position determination became a worrying and difficult task.

Thus, with the usefulness of H₂S as a navigational aid recognised bomb aimers, usually trained navigators by 1943, also became H₂S set operators. They identified the aircraft's position and then monitored progress by constant reference to the cities or towns their aircraft was passing.

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Webster & Frankland, op.cit., Vol.4, p.81
Good set operators (those who supported the navigator doing the plotting) took fixes at not more than two minute intervals.\textsuperscript{51} Not all of these were required by the navigator plotter but it meant that accurate fixes were available whenever they were wanted. It also meant that inadvertent deviations from the required track could be brought immediately to the plotter's attention. This information could prevent lone aircraft from wandering into known heavily defended areas.

Target marking using H$_2$S was attempted early in its operational life but with the expectation that markers would be fairly widely scattered. Marker crews were therefore introduced whose function it was to estimate the M.P.I. of the primary markers dropped blind and to then drop secondary markers of a different, distinctive colour on that point. Selection of the M.P.I. was not an easy task. On a training device the average radial errors for inexperienced crews was 354 yards. Even trained crews still averaged an error of 194 yards.\textsuperscript{52} These secondary markers dropped by Marker crews defined the aiming point for the Main Force crews following. This particular marking method proved, in practice, to be rather less than satisfactory. Tactical changes were introduced in April 1943. From this date H$_2$S-equipped, P.F.F. aircraft dropped flares and markers at the beginning of a raid. Backers-up then attempted to identify the target and mark it with secondary T.I.s. This technique called Newhaven, with modifications, remained the standard H$_2$S marking method until the end of the war.\textsuperscript{53}

As a navigational aid H$_2$S was invaluable. With its assistance aircraft could maintain track within narrow limits, arrive on time at the target, avoid known defended areas, provide concentration over the target and it reduced the effectiveness of enemy decoys. As a bombing aid of unlimited range it eliminated the problem of searchlight or flare glare and offered the prospects of reasonably accurate area bombing when cloud or weather conditions made either sky or ground marking impossible. But H$_2$S, rather more than Oboe, depended to a very large extent on the human element - the skill of the operator. Short training periods and heavy casualties meant operational experience was hard won.

Before examining the role of the P.F.F. in the Battle of the Ruhr it is necessary to understand the marking techniques that were employed either early in 1943 or which were shortly to be introduced.\textsuperscript{54} The success of bombing operations

\textsuperscript{51} E.L. Killip, 'H$_2$S and the Navigator' in T.R.E., Journal, January 1945, p.92

\textsuperscript{52} Musgrove, op.cit., p.36

\textsuperscript{53} Webster & Frankland, op.cit., Vol.4, p.82

\textsuperscript{54} P.F.F./S 49/AIR, undated. In Author's possession.
depended on the ability of P.F.F. crews to locate and mark the target and the skill and determination of the Main Force crews to accurately bomb the aiming points provided. Experience during 1941 and 1942 had shown that visual bombing was rarely possible in European weather conditions. Thus it was necessary that Main Force crews bombed markers of various types rather than the particular target which occasionally they believed they could identify. Successful bombing depended utterly on every crew - Pathfinder and Main Force - thoroughly understanding the procedures to be followed on each specific occasion. With target markers of perhaps two or even three different colours burning at the same time, German decoys, ground fires and Flak distractions, accurate bombing could only be achieved when every bomb-aimer knew the particular aiming point for the actual time that he was in the target area. At their briefing all Main Force crews were clearly told the 'P.F.F. Method' that was to be employed on that night's attack. Crews, no doubt in the stress of the moment, continued to aim their bombs at incorrect markers and German decoys. They reported bombing red T.Is when no reds were employed.

Basically there were two methods of marking employed by the P.F.F. - ground marking and sky marking. When a target had been ground marked Main Force bomb aimers were expected to carry out their bomb runs aiming at the centre of the markers of the correct colour. They had to ensure that this centre point had been selected rather than any particular marker. This principle of centering was vital because the reality was that the F.F.P. markers were not always placed precisely on the target. However, it was hoped that the spread of T.Is would be centered on the precise aiming point. Main Force bomb aimers had also to ensure that they distinguished between the salvo of markers placed by an individual P.F.F. aircraft and the centre of the salvos placed by all the Pathfinders. This central aiming point, easily expressed, was most often difficult to locate. As an attack progressed many of the markers would die out or become obscured by smoke, other fires, or changed weather conditions. Later arrivals at the target would see most clearly those markers furthest removed from the aiming point - those to one side or other, or those on the approach to the target. 'Creep-back' was the result when centering was done on only those markers visible early in a bombing run. Thus, if the Main Force attack track was planned to go from south to north, the area of the greatest concentration bombs would gradually move from the initial aiming point in a southerly direction back along the bombers' approach path.

Centering was also difficult in broken cloud conditions when T.Is could be obscured at any stage of the bombing run. When ten tenths cloud covered the target and ground markers provided the aiming point, then normally individual ground markers were not distinguishable. In these conditions bomb
aimers would see only a circular glow from the T.Is. However, unless they released their bombs prior to their bomb-sighting devices reaching the centre of the glow the bombs would overshoot. That is the bombs would impact at a point beyond the target. Naturally, if released too early they would undershoot - impact before reaching the target.

Sky marking was the other basic method employed by the P.F.P. to indicate the aiming point for Main Force crews. It was used when cloud, smoke or other phenomena, either natural or man-made, would prevent Main Force bomb aimers from sighting ground markers. Sky markers were positioned so that Main Force crews could expect their bombs to strike close to the target provided they had been able to fulfil certain stringent provisions. Bomb aimers, firstly, had to select the central point of all the visible sky markers. Secondly, the aircraft had to be flown at a specific altitude and airspeed with zero wind set on the bomb sight. Finally, and most difficult of all, during the final stages of the bombing run and at the moment of bomb release, the aircraft had to be flying the precise heading determined and advised by the Pathfinders. With all the other distractions it was difficult enough to find any heading which would allow the target to approach along the drift wires (or down the central line) of the bomb sight. The requirement to be flying a specific heading at bomb release required large 'S' turns and close co-operation between pilot and bomb aimers and considerably complicated the bombing problem.

Pathfinder crews had three specific aids they could employ to attempt to locate the correct aiming point for any particular raid - their eyes, H2S and Oboe. When the aiming point was identified visually and then marked with T.Is the attack was called 'Newhaven'. When weather or other conditions prevented visual location of the aiming point and the T.Is were dropped using H2S the method was called 'Parramatta'. The final technique employed, when cloud or other conditions prevented ground markers being seen and bomb aimers had to aim at sky markers, was called 'Wanganui'. These sky markers could be dropped using either H2S or Oboe. When Oboe was used to place either ground or sky markers then the prefix 'Musical' was applied to the particular attack. The crews could be briefed for a Musical Parramatta or a Musical Wanganui attack. Later, in April 1944, Musical Newhavens or Controlled Visual attacks were introduced as a further refinement of tactics but they will be dealt with in the discussion on pre-invasion bombing. There was nothing mystical regarding the allocation of code names for the various forms of attack. Newhaven was the home-town of Bennett's W.A.A.F. clerk, Parramatta in Australia had associations for Bennett, while Wanganui was home for Squadron Leader J. Ashworth one of Bennett's Staff Officers.

Bennett, op.cit., pp.153-4
Newhaven attacks were led by P.F.P. crews called Blind Illuminators who arrived in the target area approximately six minutes before zero hour - the raid commencement time. Using H₂S only, their task was to drop lines of flares at a low enough level to illuminate the area containing the detailed aiming point. They were closely followed by approximately six Visual Marker crews, the most reliable and experienced crews in the P.F.P., who were required to visually identify the aiming point and then ground mark it with large salvoes of mixed red and green T.Is. They were to drop their markers only after positive identification of the aiming point had been made and only provided their bomb sight was fully serviceable. Visual Marker T.Is of course were positioned prior to zero hour and unless they were of a very long burning time (T.I.V.L.B.) they had to be supplemented by further T.Is as the raid progressed. These were dropped by Backers-up who attempted to place their secondary markers, normally green in colour, on the centre of the concentration of primary ground markers still visible.

Weather conditions played a crucial part in the success or otherwise of Newhaven attacks. If the aiming point could not be identified, or should their bombsights be unserviceable, the mixed red and green primary T.Is carried by the Visual Markers were not dropped. Briefings for Newhaven attacks normally covered this eventuality by instructing crews that if, for any reason, no Visual Marker crew could drop their T.Is, the raid would become an Emergency Parramatta. In this event, provided that no Visual Marker crew had located and marked the aiming point, Blind Marker crews employing the best H₂S operators, equipped with the latest mark equipment, came into action. Using only their H₂S they were required to drop green T.Is on the aiming point two minutes prior to zero hour. It was recognised that target marking employing only H₂S was not the most accurate method but it was assumed that although their markers may have been scattered they would be centred on the correct aiming point. Backers-up in this situation then aimed red T.Is at the estimated M.F.I. of the primary greens and the Main Force crews were briefed to aim at the centre of the secondary reds. Crews briefed for Newhaven attacks were always reminded of the importance of not bombing prior to zero hour because of the risk of preventing the Visual Markers accurately marking the aiming point.

Parramatta attacks were essentially the same as the Emergency Parramatta just detailed. The main difference was that no Visual Marker crews took part and the Blind Markers knew that they had a vital role to play. They were not there

56 The colour patterns of course were changed at times for both tactical and technical reasons and to avoid their duplication by the Germans. They are given here for illustrative purposes.
simply as a reserve but were required to mark the aiming point with green T.I.s using H₂S. Backers-up were briefed to place their red T.I.s on the M.P.I. of the primary greens and Main Force crews were instructed to only bomb greens when no reds were visible.

Ground marking using Oboe-Musical Parramatta—provided accuracy but only on comparatively short range targets. Fortunately, Oboe coverage included the hitherto invulnerable Ruhr industrial area. Four Oboe-equipped Mosquito aircraft normally opened a Musical Parramatta attack immediately prior to the zero hour. Their task was to mark the aiming point with salvoes of red T.I.s. Oboe marking was planned to continue at ten minute intervals for the duration of the raid. Gaps in the marking were always possible because equipment malfunctions were not uncommon. To cover this possibility Backers-up were interspersed in the bomber stream to place visually-aimed green T.I.s on the reds. Main Force crews were ordered to bomb the greens only when no reds were visible.

Musical raids differed from Newhavens in one important respect—primary marking with red T.I.s continued at intervals throughout the attack. Thus, at any one time, only smaller numbers of primary markers were expected to be visible. On Newhavens, Main Force crews at the start of a raid could expect to see from two to six salvoes of up to ten primary markers. These numbers reduced to one or two salvoes of up to four primary markers on Musical Parramattas.

Wanganui, or sky marking raids, were normally undertaken when cloud conditions made visual identification of the aiming point impossible. Sometimes they were planned from the onset but on many occasions intended Newhavens or Parramattas had to be abandoned on arrival at the target because actual weather conditions were considerably worse than those forecast. In a Wanganui attack P.P.F. aircraft using H₂S (if Oboe was used they called Musical Wanganui attacks) released sky markers at intervals throughout the attack. The first sky markers were white-drip flares containing a magnesium alloy candle which burned for two minutes. As pieces fell away from the candle they provided vertical chains of light in the sky up to 1,000 feet in length. Improved reconnaissance flares were also used as sky markers. To make their duplication difficult green candles would be dropped which emitted red stars, or red candles emitting green stars. There were also other combinations that were used at times. The candles burned for three minutes and the stars were ejected at twenty second intervals. Because of the difficulties already discussed when attempting to bomb on sky markers, plus the fact that they moved under the influence of the wind, the system was usually less accurate than ground marking. There were, however, notable exceptions. Cologne, on 28/29 June

57 MacBean & Hogben, op.cit., p.109
1943 was a good example. Despite the fact that marking began later than scheduled, that only seven of the twelve Oboe Mosquitoes reached the target area, and that only six were able to drop their sky markers, Cologne suffered severely. No less than 4,377 of its citizens were killed (only about 480 were killed in the 1,000-bomber raid) and enormous damage was created.

On some occasions, usually because of weather conditions, both ground and sky markers were released over the target and Main Force crews had freedom of choice as to which they bombed. Crews were reminded that provided they could see the pattern of ground markers they were to be preferred to the sky markers. In conditions of thick cloud, although perhaps the glow of ground markers could be detected, it was normally only the nearest ones that were visible and thus it was impossible to estimate their M.P.I. In these circumstances the sky markers, despite the difficulties, offered the better prospects except when the ground markers had been placed using Oboe. This variation of ground and sky marking was called the Berlin Method.

Bomber Command at the beginning of 1943 still faced major problems. Shortages of heavy bombers and trained crews to operate them had not been overcome. In November 1941 there were a total of 610 medium and heavy bombers available for operations but only 506 fully trained crews. By January 1943 the average daily availability of bombers had fallen to 582 but with an average of 515 crews available to fly them. An even more dismal picture is painted when aircraft numbers are broken down into actual types. The January 1943 totals included 128 Wellingsons and 99 Venturas, Bostons and Mitchells. The Wellingsons were withdrawn from bomber operations in October 1943 while the twin-engined Venturas, Bostons and Mitchells of 2 Group were scarcely of any value in the strategic air offensive. Harris therefore implemented his interpretation of the Casablanca Directive from 21 January 1943 with 17 Mosquitoes, 56 Stirlings, 104 Halifaxes, 178 Lancasters and 128 obsolescent Wellingsons. The facts were even worse because eleven per cent of these aircraft had no crews available, trained in their operation. With the long-term goal of 4,000 to 6,000 front-line bombers but a memory in the past, Harris could only hope that there would be fewer diversions of much-needed bomber squadrons to the Middle East and that demands by Coastal Command, or the Royal Navy, for help in the struggle against the U-boats, would be kept to a minimum.

Middlebrook & Everitt, op.cit., p.272 and pp.403-4
Musgrove, op.cit., p.256
Webster & Frankland, op.cit., Vol.4, p.428
Another concern for Harris and Bomber Command in 1943 was the fact that the new aids, Oboe and H2S, had still to confirm their accuracy and usefulness under operational conditions. Gee had offered high hopes as a navigational and bombing aid when first introduced. It had failed to meet bombing expectations and, by January 1943, was largely unavailable as a navigational aid, at least over enemy territory, because of German jamming measures. Would the new aids provide the navigational and bombing accuracy essential if significant damage was going to be done to German industry and the enemy's morale?

The final major concern in January 1943 related to the German defence systems. It had become clear that they had improved markedly both in the numbers of aircraft and Flak weapons operating and their relative effectiveness. Casualties among Bomber Command crews were a cause for concern for two prime reasons. Should bomber crew losses increase only fractionally squadron morale could deteriorate. That meant fewer crews pressed home their attacks, bombing became scattered, and less damage was done to Germany. Crew losses were also of concern because they reduced the numbers of potential leaders available and made it difficult to meet the need for experienced instructors at O.T.U.s and Heavy Conversion Units (H.C.U.s). Aircrew training schemes by 1943 were at full stretch to meet the demands imposed by planned expansion and increasing casualty lists. Could the supply meet the demand? And could bomber production lines meet the demands they were receiving?

Bomber Command had won victories in 1942 but they were most often the products of circumstances neither easily nor often repeated. The inflammability of Lubeck, the use of O.T.U. crews for 1,000 bomber raids (and only one out of these could be construed as a victory), plus occasionally managing to avoid the German defences, all made their different contributions. Those few victories that had been won, however, were only achieved in the face of increasing losses in both aircraft and crews. Were more victories possible in 1943? Harris believed they were. In fact he still clung to his belief that the war could be won by bombing alone. But it was an out-dated tenet neither supported by his Commander-in-Chief nor any longer relevant in the changed strategic situation. Russian military victories, Montgomery's success in North Africa, the American invasion of North Africa from the west, these, together with the productive capacity of American arsenals, all promised ultimate victory. At Casablanca, Portal, while agreeing that considerable pressure would still have to be applied to Germany, admitted that 'air bombardment ... would not be sufficient in itself'.

61 Richards, _op. cit._, p.258
Area bombing by 1943 had become a radically refined technique. No longer was it a matter of arriving, hopefully somewhere in the target area, and then releasing your bombs on what appeared to be a suitable target. Hard-won experience had confirmed that if attacks were to be effective they had to be carried out by large numbers of bombers, concentrated in space and time, and capable of achieving bombing accuracy. Harris planned three major offensives for 1943 - against the Ruhr, Hamburg and Berlin - and these will all be considered from two points of view. Firstly, the effectiveness of the leadership provided by the P.F.P. Secondly the influence these attacks had on German morale and the productive capacity of German industry. It is also necessary to consider two other specific raids carried out in 1943 because of their relevance to the P.F.P. story. The first one, on 16/17 May against the Möhne and Eder Dams, confirmed the increasing rivalry between 8 and 5 Groups. Both possessed aircrews of outstanding ability, capable of fulfilling very specialised roles. The second, the attack on Pennewunde on 17/18 August, marked a further development in P.F.P. tactics when a Master Bomber and off-set bombing were employed for the first time on a major raid. Weather and tactical considerations ensured that none of the three major offensives were either self-contained or exclusive. Targets in the three areas (the Ruhr, Hamburg and Berlin) were attacked prior to the commencement of the particular offensive, while it continued, and after it had supposedly ended, all with varying degrees of success.

Unrecognised at the time, although rumours of a major bombing offensive were rife in Bomber Command circles, the raid on Essen on 5/6 March 1943 marked the beginning of the Battle of the Ruhr which was to last until 14 July of the same year. It was not a battle in the traditional sense, fought on a narrow front, but was rather a series of almost nightly confrontations ranging over targets in northern, eastern and southern Germany, as well as France and Italy, but returning consistently, and for the first time effectively, to targets located in the Ruhr Valley. Of the 43 major raids (those where more than 200 bombers were deployed) during the battle, all but five were directed at targets within Germany's pre-war borders. Twenty six of these raids were aimed at cities in the industrial Ruhr, the centre of Germany's heavy engineering and armament plants. U-boat and aircraft construction both took place in the Ruhr and thus area targets in that region accorded with the Casablanca Directive which had listed them as number one and two priorities in the bombing pecking order. The Ruhr had always been an attractive target to the planning staff but up to 1943 it had suffered very little. Most often hidden by cloud or thick industrial haze it had been difficult to locate and it was unpopular with bomber crews because of its heavy and effective defences. Perhaps it was an example of gallows' humour that caused them to name it 'Happy Valley'.
Although the crews of Bomber Command were unaware that the attack on Essen was to mark the commencement of a battle Harris, in retrospect anyway, was under no such illusion. Writing in 1947 he said 'on the night of March 5-6th, 1943, ... I was at least able to undertake with real hope of success the task which had been given to me ... more than a year before, the task of destroying the main cities of the Ruhr'.

At the same time it must be noted that Harris's post-war perceptions did not always accord with his war-time actions or understandings. On the same page of his book dealing with the commencement of the Battle of the Ruhr he observed that, as a consequence of the Casablanca Conference, 'the subject of morale had been dropped'. This statement of course is at considerable variance with what he had understood previously. On 6 March 1943, in a letter to the Air Ministry, Harris made clear that his interpretation of the Casablanca Directive was that the undermining of German morale had become the primary aim.

Oboe as a marking aid was given its first major operational test in the raid on Essen at the beginning of the Battle of the Ruhr. It had been a long-considered decision. On 19 June 1942 the Air Staff had decreed that Oboe was 'an immediate operational requirement ... to be used in attacks against the Ruhr area with Essen as the focal point'. While its limitations were recognised it was still believed that as an aid to the location of targets in the Ruhr it offered tremendous possibilities. In the hands of the P.F.P. crews and ground based operators in the United Kingdom, in conjunction with the ground and sky markers also developed in 1942, Oboe was to render significant service in the Battle of the Ruhr. Its usefulness did not end at the conclusion of that battle because after a foothold had been gained in Europe mobile Oboe control units gradually extended its range until no city in Germany could consider itself safe from accurate attacks.

Had Oboe been employed to drop bombs accurately it could only have been at less than squadron strength and attacks would have lacked both concentration and weight. By using Oboe as an aiming device to position either ground or sky markers the full weight of a Main Force attack could be brought to bear on a specific target concentrated in space and time. The decision to use Oboe as a marking device also

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Harris, *Bomber Offensive*, p.144
Ibid.
Air Ministry, *Signals Vol.3 Aircraft Radio*, p.218
helped determine the selection of the Mosquito as the aircraft in which the equipment would be fitted. The Mosquito possessed the performance to fly high and thus increase Oboe reception range; it could also fly fast and thus avoid interception. As a bomber the Mosquito had a limited bomb carrying capacity but if its bomb bay only had to contain four 250 pound marker bombs it was ideal. Oboe-equipped Mosquitoes of 109 Squadron P.F.F., employed as markers, led the first major raid against Essen in the opening round of the Battle of the Ruhr. Individual trials using Oboe had been conducted against German targets during January and February 1943 but after the initial success gained at Essen in the marking role Portal, on 11 March 1943, decided 'That Oboe should only be used by the R.A.F. over enemy territory on the occasion of heavy raids. Its use in light-scale and individual harassing attacks should be discontinued'.

Although Bennett protested vigorously because he wanted to continue operational training the risks entailed, should the equipment fall into German hands, were clear to the Air Staff. Their ban remained in force until November 1943.

Target selection was decided by Harris after consultation with various experts including representatives from the Ministry of Economic Warfare (M.E.W.). The chosen target was then passed by Air Marshal Sir Robert Saundby, (S.A.S.O.) in Bomber Command Headquarters, on a scrambler telephone line to 8 Group Headquarters which was the Pathfinder Group. Bennett, after consultation with his own Meteorological Officer, then decided on the plan of the attack. These plans included the marking method to be employed, the alternative marking method, route to the target and the direction of approach, and the 'spoof' raids that would also be carried out in an effort to draw away the German night fighters from the main attack. Bennett's P.F.F. plan was then passed by teleprinter link to Bomber Command Headquarters and all the different Group Headquarters.

The raid on Essen on 5/6 March 1943 opening the Battle of the Ruhr typifies the Oboe attacks carried out at that time. The Pathfinders of 8 Group provided eight Mosquitoes as Primary Markers and fourteen Lancasters and five Halifaxes as Backers-up. In addition two Stirlings and three Lancasters of the P.F.F. were to fly as part of the Main Force. In total the Main Force was made up of 52 Stirlings, 89 Halifaxes, 131 Wellwrights and 143 Lancasters.

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66 Panter, _op.cit._, Vol.5, p.37

67 It is difficult to determine exact numbers participating as authorities vary. Harris in _Bomber Offensive_, p.144 states 442 participated. But his figures only add up to 422. Musgrove, _Pathfinder Force_, p.33 also gives 442. Middlebrook and Everitt, _The Bomber Command War Diaries_, p.365 also give 442.
Orders for operations in Bomber Command always appeared in a standard format. Scrambler telephones were used between Bomber Command and the various Groups to discuss the target, size of the force, bomb load and the zero hour. After agreement was reached, Form 'A' (or Form 'Able' as it was known in the phonetic alphabet in use during the Second World War) was sent from Bomber Command Headquarters by teleprinter to all Groups to confirm the verbal orders. Each participating Group Headquarters after receiving Bennett's plans then drew up their plans for the night's operations. These were sent, via teleprinter, addressed to various stations in that Group whose squadrons were required for operations that night. Titled, for example No. 6 Bomber Group Operations Order, they appeared on a Form 'B' (Form 'Baker') followed by the date. The form then listed in order when the raid would take place, the squadrons participating and the numbers and types of aircraft they would provide, the times when all participants were expected to be on target and the raid commencement time. Normally in Operation Orders this was given as the Zero Hour but it was occasionally called the H-Hour in raid narratives. Then came the target markers, H.E. bombs and incendiary loads that each aircraft was to carry and finally, the special instructions applicable to the raid were given in detail.

Should Bomber Command Headquarters have required any change of plan after the A Form had been transmitted - change of route, different type of attack - then this revised information was sent on a C Notice. In typical Service non-conformity it was never referred to as a Form 'Charlie'.

The Pathfinder Operations Order - Form 'B' - 5 March 1943 provided the details that would be passed on at briefing to the participating aircrew by the appropriate authorities later that same day. The aim of the attack, specified as 'being on an enemy factory' was to 'groundmark the aiming point using special aircraft so that the main force may carry out a concentrated attack'. This raid on Essen was one of the first occasions when the Pathfinders provided direct navigational assistance to the Main Force by dropping yellow T.I. ground markers on track but fifteen miles short of the aiming point. Initiated by the first Mosquito this marking was maintained by the remaining Markers and Backers-up. The Mosquitoes were then to continue on to the target and using Oboe were to drop their red T.I. ground markers, in salvo, to provide an aiming point for the three waves of Main Force following. The Backers-up, with mixed loads of green T.I. ground markers, high explosives and incendiaries, were to aim at the red T.I's and release their loads in salvo apart from...

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the incendiaries. These were to be released after a one
second delay for the thirty pounders and an eleven second
delay for the four pound variety. The attack was planned to
last from 2106 (9 p.m.) until 2140 (9.40 p.m.) with the
Mosquitoes dropping their T.Is at Zero hour, Zero +3, Zero
Interspersed between the red T.Is at one and two minute
intervals were the Backers-up.

According to one author the raid was timed to commence
at 2058 (8.58 p.m.), that is two minutes prior to Zero Hour,
but the Form 'B' for the Pathfinders was quite explicit that
marking would begin at 2100. Therefore, the claim by Webster
and Frankland that the attack started fractionally early
would appear to be correct. This is confirmed in the Night
Raid Report No.284 prepared by Bomber Command which stated
that the 'first red T.I. markers had been dropped at 2658'.
Logically, had the first markers been due to go downs at Zero-
2 then T.O.T. for the first wave of Main Force would have been
Zero Hour. In fact the T.O.T. for the first wave was Zero +2
to Zero +20.

The Form 'B' despatched by 6 Group Bomber Group
Headquarters to its participating Wellington and Halifax
squadrons for the raid on Essen made special note of the
novelty of the tactics to be employed. It stated that the
'method of placing T.I. markers for this operation is a new
and very accurate one and it must be impressed on crews that
they should make every effort to concentrate their bombing on
the T.I. markers'. This instruction was repeated word for
word in 1 Group's Form Bravo.

The Pathfinder Method to be employed was given as
'Musical Parramatta'. That was to say that the aiming point
for Backers-up and Main Force crews would be defined by ground
markers which had been dropped using Oboe only. No flares
were to be dropped and no attempt would be made to visually
identify the aiming point. The method was then spelt out in
detail that 'Mosquitoes will drop ground markers T.I. red on
the aiming point, other aircraft of P.F.F. will keep the
target marked continuously throughout the attack with T.I.
green ... the T.I. red should be within 100 yards of the

69 Searby, The Great Raids Essen, p.32
70 Musgrove, op.cit., p.30
71 Webster & Frankland, op.cit., Vol.2, p.117
72 Searby, The Great Raids Essen, p.44
73 Ibid., pp.23-4
74 Ibid., p.22
aiming point. Main Force aircraft should therefore aim their bombs accurately at those T.I. red if they are visible, otherwise at the centre of the concentration of T.I. green'.

This instruction was also repeated on the Form Bravo issued by 1 Group Headquarters.

Both 1 Group and the Night Raid Report of Bomber Command were lavish in their praise of the efforts of the P.F.F. in particular and the success of the raid on Essen in general. In conditions of industrial haze and dense smoke which obscured ground details, and with the German defences as active as ever, the situation paralleled many previous ones when Bomber Command had been unable to achieve an accurate bombing concentration. The efforts of the Pathfinder Markers and back-up would appear to have made the difference. What previously would have been a raid of dubious value was converted into a startling success. Pilots spoke of 'never seen better attack' or, 'The best show I've been on. P.F.F. did an excellent job'. This, despite the fact that only four of the Oboe Mosquitoes had been able to complete effective marking runs.

Essen suffered a total of five such raids during the Battle of the Ruhr at the end of which more than 600 acres of the built-up area were either damaged or destroyed. In the first three attacks on the city more than half of the buildings in the Krupp works were damaged. Locomotive construction (high on German priority lists) was brought to a halt and was never restarted. The production of large shells and fuses was also halted. Reductions were also noted in the output of guns, gun tubes and liners as well as aero-engine crankshafts. The damage created was significant and much credit must go to the crews of the P.F.F. assisted, on this occasion, by having been accorded priority in receiving the latest equipment. This would not always be the case. Although not all the Oboe-led attacks in the Battle of the Ruhr were successes, it was proven that targets within its range were no longer protected by the weather.

Up to the beginning of July 1943 Oboe-equipped Mosquitoes had flown 415 sorties involving approximately 13,000 heavy and medium bombers. During August 1943 a detailed survey of raids was carried out by the Operational Research Section (O.R.S.) of Bomber Command, based on the bombing photographs obtained plus individual crew reports.

Searby, The Great Raids Essen, p.24

Ibid., p.34

Ibid., p.35

Harris, Despatch on War Operations, p.18

Air Ministry, Signals Vol.3 Aircraft Radio, p.228
was that when Oboe had been used for ground marking the number of Main Force aircraft actually attacking the target had trebled. Oboe had enabled targets to be successfully attacked which previously had been difficult to locate and had thus suffered little damage. The damage achieved on Ruhr targets when Oboe was used for ground marking increased dramatically. Raid failures, when Oboe was employed, were attributed either to gaps in the marking or the inaccuracy of the Backfire-up. Further improvements to Main Force results could be expected if the problem of gaps in the marking could be overcome. One way of achieving this was to plan more frequent Oboe marking but this required more radio channels and additional ground stations.

During the period from 5/6 March 1943 to 24 July 1943 more than 23,000 night sorties were flown from which 1,000 aircraft (4.3 per cent) were lost.\(^{80}\) For the five major attacks on Essen 2070 sorties were flown for the loss of 93 (4.5 per cent) medium and heavy bombers. Neither of these losses were light but they were bearable. It must also be noted that despite the attrition rate, Bomber Command was gaining strength. Where at the commencement of the Battle of the Ruhr approximately 400 or 500 bombers would be employed on a particular operation, 826 (four fifths of which were four-engined) were launched on 23/24 May 1943 against Dortmund.\(^{81}\)

A heartening aspect of Oboe operations in the Ruhr was the very great immunity from enemy action that the Mosquitoes enjoyed. Only two were lost on operations – one in the North Sea returning from Duisburg and one over Essen.\(^{82}\) Also, while 19 suffered some Flak damage, only one had been intercepted by German fighters. No jamming of Oboe signals was reported but with operations being conducted over enemy territory the probability was that sooner or later Oboe equipment would fall into enemy hands.

Attacks on major German targets beyond Oboe range during the Battle of the Ruhr presented a much less hopeful picture. It became clear that HeS was not always going to provide solutions to the bombing problems encountered on long range operations. A study of twelve major raids between 8/9 March and 13/14 May 1943 showed that only two could be considered successful. Weather conditions, even with HeS serviceable, continued to affect the outcome of attacks. Reduced visibility, cloud and undetected wind changes all played a part in no fewer than six raids in seriously reducing bombing

\(^{80}\) Middlebrook & Everitt, op.cit., p.409

\(^{81}\) Ibid., p.390

\(^{82}\) Webster & Frankland, op.cit., Vol.2, p.128
concentration. On 10/11 April 1943 a force of 502 bombers attacked Frankfurt. Cloud prevented the target being seen but there were no casualties reported in the city so that raid must be counted as one of the failures.

Two raids on Berlin, 27/28 March and 29/30 March 1943 confirmed that, despite H₂S, it remained a difficult target. The built-up area provided such a mass of returns on the Plan Position Indicator (P.P.I.) that set operators could not accurately determine their aircraft's position. On both occasions P.F.P. marking was astray. The first time, marker T.Is were positioned in two distinct areas but between seven and seventeen miles short of the target. Markers were well concentrated for the second attack but still south of the target. To compound the problem the Main Force was late arriving having encountered icing problems, and again the raid was a failure. Creep-back was also confirmed as a problem in both of these raids. It was the consequence of some P.F.P. Backers-up and Main Force crews failing to continue to the centre of the marked area and bombing the first markers sighted. Stuttgart, on 14/15 April 1943, provided a good example of creep-back and scattered bombing despite claims by the P.F.P. markers to have been accurate. But Stuttgart was never an easy target and the Germans employed dummy T.Is effectively. The late arrival of the Main Force at Stuttgart on 11/12 March 1943, and perhaps the use of decoys, saw the bombing concentrated ineffectively on open fields.

But these were still early days for both the P.F.P. and the tactics and techniques they were attempting to develop. From its formation the P.F.P. had fought under the disadvantage of having to operate with four different types of aircraft. When, finally, approval had been given for H₂S to be employed by the P.F.P. over Germany only two units were available. Churchill had ordered that they be fitted in Stirlings. Despite the fact that the Stirling had the least impressive performance of all the three heavy bombers, nobody argued the point. However, his decision was circumvented, to a degree, in that one set was installed in a Stirling of 7 Squadron while the other was fitted in a Halifax of 35 Squadron. The arguments for the Halifax fitting, had they been required, centred around the fact that it offered more positions for fitting the radar scanner. Thus it had come about that most of the illuminating and marking during the period of the Battle of the Ruhr on non-Oboe targets had been the responsibility of Halifax and Stirling squadrons. The crews of these squadrons lacked nothing in courage and determination. Unfortunately, they were charged with tasks of great responsibility for which their aircraft were largely unsuited. Neither the early model Halifax nor the Stirling possessed the performance to enable them to fly at altitudes

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Musgrove, op.cit., p.262
which would provide greater safety for the crews. Both also
lacked the operational speed range necessary for successfully
carrying out their essential tasks. If they were late getting
airborne, or if weather caused problems, they were unable to
increase their air speed sufficiently to ensure that they
arrived on time at the target.

The situation was righted somewhat in May 1943 when 156
Squadron, which had exchanged its Wellingsons for Lancasters
in January 1943, and 83 Squadron, already equipped with
Lancasters, were both equipped with H2S. A cupola housing the
radar scanner was fitted under the Lancaster fuselage in the
place previously occupied by a ventral gun turret. Change-
overs however, required time and training, so the newly
equipped squadrons were not ready for operations until the
middle of June 1943. At that stage 7 Squadron was briefly
stood-down from operations to enable it to convert from their
obsolescent Stirlings to the Lancaster.

Operations against targets beyond the range of Oboe
during the Battle of the Ruhr were not all failures and many
valuable lessons were learned. On 16/17 April 1943 a force of
more than 300 aircraft were briefed to attack the Skoda
factory situated on the western outskirts of Pilsen in German-
occupied Czechoslovakia. For this raid the P.F.F. markers
were only intended as a guide and Main Force crews were
expected to visually confirm their target before bombing. In
the event the P.F.F. misidentified a large group of buildings
(actually a mental hospital) about seven miles from the Skoda
factory and bombing was unfortunately concentrated in this
area. This attack confirmed that area bombing was most
successful when specific factories were but a part of the
larger built-up area of a city. Isolated factories were still
a precision target in the early Spring of 1943.

Timing was also confirmed as essential to the success of
raids. It was useless if the P.F.F., having arrived on time,
located and marked the aiming point, was not followed by the
Main Force after the briefed time interval. Late arrival
meant that the markers no longer provided a guide. When sky
markers were employed, late arrival by the Main Force meant
that the flares had disappeared in cloud.

The major lesson learned from the Battle of the Ruhr
was that H2S did not provide the accuracy given by Oboe. It
had severe limitations and, until September 1943, was in short
supply even for the P.F.F. It also suffered a high
unserviceability rate. Good results were obtained from H2S
but generally only when expectations were not too high and
there were reduced demands on those expected to operate the
equipment. Newhaven techniques were part-designed for use in
conjunction with H2S but the German defences forced the P.F.F.
to fly so high that visual target identification became almost
impossible.
To conclude on the Battle of the Ruhr, in two of the twelve raids considered, P.F.F. marking was good and the bombing results assessed as 'effective' at Mannheim on 16/17 April 1943 and 'very effective's at Stettin on 20/21 April 1943. Significantly, Stettin confirmed the usefulness of H2S when attacking targets on or near the coast where the contrasts between land and water showed up well, and recognisably, on the radar screen. Situated at the end of a major inlet on the Baltic Sea, in clear conditions, Stettin suffered an accurate and concentrated attack. It was a foretaste of things to come.

Several other events which occurred in the first seven months of 1943 also have a particular relevance to the story of the P.F.F. On 25 January 1943 the P.F.F. was accorded Group status and Bennett, who had been promoted to Air Commodore on 8 January 1943, was, on 13 July 1943, and at the very early age of 32, further promoted to Air Vice-Marshal. Although he lacked the seniority of the other Group Commanders he was their equal in rank. His relative youthfulness and rapid promotion combined with his thrustful personality did not always endear him to his peers. By retitling the P.F.F. 8 Group its position was regularised and removed, at one stroke, the impediment of being permanent guests on another Group's stations. It also meant that Bennett and his greatly enlarged staff made the plans for P.F.F. operations rather than having them made at Bomber Command Headquarters and receiving them via Baldwin of 3 Group. A demeaning step had been removed. Bennett was now commander in fact of the P.F.F. rather than, as previously, in name only.

In April 1943 the P.F.F. heavy bomber force was expanded. Two additional squadrons were added - 495 (Canadian) equipped with Halifaxes and 97 Squadron with Lancasters. Once the crews of these squadrons became operational in the P.F.F. role the duration of raids, from the continual marking point of view, became less of a problem. Previously, when Markers or Backers-up were in short supply, raids had to be compressed in time unless the risk was accepted that marking may not always be continuous. Naturally, best results were usually obtained when marking was both accurate and regular but this had been difficult to provide with only limited numbers of P.F.F. aircraft and crews available. Expansion of the P.F.F., at least in step with Bomber Command growth, was absolutely vital for its continuing usefulness.

Two additional Mosquito squadrons joined the P.F.F. in June 1943. The transfer was encouraged firstly, by the success of Musical Parramatta raids during the Battle of the Ruhr. Secondly, the promise of improved weather conditions in the Spring raised hopes that bombing would become even more
effective. One squadron, 105 from 2 Group, was transferred from a day role to assist 139 in their Oboe operations. This move would have left only one Mosquito squadron in Bomber Command, No.139, so for administrative purposes and to reduce servicing problems, that squadron also became part of the P.F.F. Until June 1943 there had been very few attempts to defeat the German defences by either electronic or other means. The acquisition of 139 Squadron meant that the P.F.F. had high performance aircraft to attempt to distract the German defences. Sometimes supported by a few P.F.F. heavy bombers, sometimes alone, Mosquito bombers carried out diversionary raids in the attempt to draw off enemy fighters from the main attack. On nights when the Main Force was not operating, nuisance raids, often directed against Berlin and frequently consisting of only one aircraft, were mounted. On other occasions, a single Mosquito loaded with four 500 pound bombs would attack different targets in four cities. The damage they created may have been negligible but their nuisance value was high. In fact they performed two functions - they provided a good anti-morale weapon and they roused a large part of the enemy defence organisation into attempting to find the proverbial needle in a dark haystack. Although the bomb load carried by the Mosquito was not large at this stage of the war when compared with the Lancaster, the bomb tonnages dropped for Mosquitoes lost was vastly superior to any other type of operational bomber.

The P.F.F. was also enlarged and its capabilities improved when, on 31 March 1943, weather flights called Pampas, which had been carried out by Mosquitoes of Coastal Command since July 1942, were transferred to Bennett's control.64 Successful bomber operations depended very largely on the weather both in the United Kingdom and over Europe and particularly in the target area. Weather movement was basically from the Atlantic, across the British Isles and then onto the European mainland. Reports of weather conditions were available from ships and aircraft in the Atlantic and from observers in Britain but once the fronts and associated weather had moved to the Continent their behaviour could become erratic and weather observations were not available. The prime purpose of Pampa flights was to note the actual weather conditions in particular areas or along specific routes in Europe so that forecasters in England could provide a more balanced assessment of the conditions likely to be encountered on any planned raid.

Initially, forecasters in Bomber Command Headquarters and in various Groups worked independently. Wide variations in their forecasts of expected conditions was the norm. Harris would decide on a particular target on the basis of the forecast provided by his chief meteorological officer.

Bennett would then determine the plan of the attack on the basis of the information supplied to him by his duty forecaster. Each participating Group Commander would then discuss the forthcoming night’s operation with their own forecaster. Naturally, without co-ordination there were many and often widely conflicting opinions. Bennett centralised and refined the system. Pampa flight observations were made available to all forecasters in Bomber Command. They then held a ‘scrambled’ discussion on a telephone link-up before arriving at a consensus forecast of expected conditions.

The final matter that must be noted before the P.F.P. story is continued concerns the raid on 16/17 May 1943 by 617 Squadron of 5 Group against the Möhne and three other dams in the Ruhr Valley. It was a specialised task and brilliantly carried out by the participating crews. Losses, however, were severe. Nineteen specially modified Lancasters took part and eight were lost. The squadron which had formed on 21 March 1943 specifically for the dams raid did not operate again until 15/16 July 1943. Such high losses of course were totally unacceptable on any on-going basis. So also was the length of time that the squadron was kept out of the front line. The P.F.P. certainly could not have been effective under such operating conditions. However, 617’s success at the Möhne probably defines the point at which the rivalry between Bennett and Cochrane became more public. Cochrane (nicknamed ‘Cocky’) sought glory for 5 Group and 617 Squadron was his standard bearer. It was kept for special operations and had in its ranks some of the outstanding bomber crews of the Second World War. Cochrane’s retention of such expertise was condoned and even supported by Harris who regarded the P.F.P. as an interim measure. Permission for 5 Group to operate as an independent unit and develop their own marking and bombing techniques, while boosting Cochrane, was to the detriment of Bomber Command as a whole and the P.F.P. in particular. Surely the aim should have been co-operation rather than competition. That way provided improvement for all rather than glory for a few.

Hamburg, Germany’s second largest city and, in 1943, Europe’s largest port, had long appealed to Harris as an attractive target. Had not weather intervened Hamburg rather than Cologne would have been the target for the first 1,000-bomber attack. Harris had intended the raid to be a centennial conflagration – repeating the devastation caused by fires in 1842 which had destroyed the medieval character of the city. On 27 May 1943 Harris forewarned his Group commanders to prepare for a heavy and sustained assault on

Hamburg. His instructions, issued as Bomber Command Operations Order No.273, pointed out that 'The total destruction of this city would achieve immeasurable results in reducing the industrial capacity of the enemy's war machine'. Harris was aware that the battle could not be won in a single night because, as he wrote, 'To achieve the maximum effect of air bombardment this city should be subjected to sustained attack'. Almost one hundred attacks had been launched against Hamburg since the beginning of the war but its suffering had been much less than Cologne. By mid-July 1943, with the Battle of the Ruhr at least in abeyance, it was time to refocus the attention of Bomber Command.

Hamburg appealed as a desirable target for several reasons. It was an important ship and U-boat construction area and, as well as aircraft components and oil targets, contained elements of most other war industries. Hamburg's situation was another attraction. Situated comparatively close to the North Sea on the broad river Elbe and possessing large, clearly defined wharf areas it would, it was believed, also provide an ideal and recognisable target for the H2S-equipped Pathfinder Force. Sufficient experience had been gained in the use of H2S during the preceding months to anticipate accurate marking by the P.F.F. and concentrated bombing by the Main Force.

By July 1943 it was acknowledged by most authorities that the strategic bombing offensive had become a war of attrition. Expectations of a knock-out blow had been largely forgotten. But in wars of attrition there is always the danger that the enemy may be able to inflict greater damage on you than you are able to inflict on him. The growing concern in Allied air power circles had been the high and increasing bomber losses suffered not only by the U.S.A.A.F. but also by the R.A.F. German day and night fighter pilots were exacting a heavier toll as the offensive progressed. Any balance sheet of bombers lost against the damage created required very careful and always arguable consideration. It was also becoming a question as to whether the bomber should continue by night to make their way to the target by stealth or strength. Cochrane- not nicknamed 'Cocky' without reason - thought the bombers should fight their way to the target with their gunners firing at everything that looked like an aircraft. But he displayed his operational ignorance when he wrote that 'In the process, we shall, no doubt, put a number of 303 bullets into our own aircraft, but I doubt whether that would matter very much'. When it became a question of the

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Panter, *op.cit.*, Vol.5, p.85

Ibid. p.85

Webster & Frankland, *op.cit.*, Vol.2, p.139
light defensive armament possessed by the bombers in a contest against the cannons of the German fighters few British bomber crews were in any doubt. Fire when about to be fired upon, if possible, but otherwise stealth and luck were the keys to survival.

The Directive issued to Bomber Command on 10 June 1943 recognised the problem. Subsequently known as the Pointblank Directive it reaffirmed the general aim of the bomber forces but ordered that priority was to be given to attacks that would 'check the growth and ... reduce the strength of the day and night fighter forces which the enemy can concentrate against us in this theatre'.

In an effort to reduce British bomber losses several radio counter-measures had, by the end of 1942, already been introduced. Two devices, both a form of noise jamming, were introduced in December 1942. Mandrel was used to reduce the reception range of the Freya radars, a vital link in the German controlled-night fighting chain. Tinsel was employed to attempt to block out communications between radar units on the ground and the German fighter pilots operating in the boxes on the Kammhuber Line. Wireless operators in the British bombers would check the frequency spectrum normally employed for German air-ground-air communications. If speech was located the wireless operator would then tune his transmitter to the same frequency and then switch on a microphone located in one of the engine bays of this aircraft. Engine noises then drowned out communications. Mandrel and Tinsel were active counter measures, that is both reception and transmissions were involved.

Boozer on the other hand was a passive device in that, although it warned a crew their aircraft was being tracked by radar, it initiated no further actions. First fitted in 7 Squadron Stirlings in late 1942 Boozer was expanded in 1943 so that warning lights were illuminated should the bomber be scanned by gun-laying radar (G.L.), ground control interception (G.C.I.) or airborne intercept (A.I.) radar. A bright red light was the indication given to the crew that their bomber was being tracked by G.L. radar, dim red for G.C.I. and yellow for A.I. radar. Boozer was useful in lightly defended areas when evasive action could be initiated but it provided too many indications in heavily defended areas to be of value. Neither did it warn of the approach of non A.I.-equipped fighters. Nor did it necessarily provide great comfort to a bomber crew to see the yellow light extinguished.

Webster & Frankland, op.cit., Vol.4, p.158

Air Ministry, Signals Vol.3 Aircraft Radio, p.388
That could also have meant that the fighter was about to attack. The German pilot would have called his ground controller 'wir berühren. Bitte warten!'\textsuperscript{91} (Visual contact. Stand by!)

Other radio counter measures were also implemented between 24 July 1943 and 18 November 1943 - the period generally accepted as covering the Battle of Hamburg. Monica was a tail-warning device which emitted a series of pips on the bomber aircraft intercommunication system. The pips increased in tempo as the range between the two aircraft reduced. Although ranges to activate Monica could be pre-set so as not to give warning until, say, the aircraft were 1,000 yards apart, flight in a compact bomber stream, with frequent alarms provided by other bombers, reduced the usefulness of the device.

Tinsel, introduced to interfere with High Frequency (H.F.) transmissions, was rendered useless when the German fighters and their radar controllers started using Very High Frequency (V.H.F.) radio early in April 1943. Cigar, sometimes called Ground Cigar, with a jamming transmitter located on the Suffolk coast, was the first British response. It worked well but, as with most ground-based radio counter measures in the higher frequency spectrum, suffered from reduced range. This deficiency was overcome in October 1943 when a jammer, called Airborne Cigar (A.B.C.) fitted in Lancasters of 101 Squadron, became operational. These aircraft carried a German-speaking extra crew man familiar with enemy fighter control communications. Jamming commenced when V.H.F. fighter control transmissions were heard and, with A.B.C. aircraft at intervals in the bomber stream, it proved very effective.\textsuperscript{92}

Naturally, because of their investigations at bomber crash sites, the German authorities were normally very quickly alerted to developments in the field of radio counter measures. The question that puzzled the Germans however was why had no efforts been made to jam their giant Würzburg radars? The Germans knew that the British authorities understood very thoroughly the make-up of the Würzburg radar because of their successful Bruneval raid on 27 February 1942. A special group of parachutists, engineers and a radar mechanic had been dropped at the Würzburg site at Bruneval near Le Havre on the northern coast of France. With limited time they removed the receiver, receiver amplifier, modulator (or timing control), transmitter and an aerial element. These were all taken back to England. With the secrets of Würzburg revealed, why had there been no attempt at jamming?

\textsuperscript{91} Martin Middlebrook, \textit{The Battle of Hamburg} (London: Allen Lane, 1980), p.59

\textsuperscript{92} Harris, \textit{Despatch on War Operations}, p.136
The short answer was the fear entertained by several British defence experts that such an action may well have prejudiced the security of their own radar network. British scientists had not worked on a system for jamming the Wurzburg radars. Rather, they had found a means of providing such a proliferation of returns on the indicator unit that individual bombers were no longer identifiable. Their agent was aluminium foil twenty five centimetres long by two centimetres wide. Dropped manually through the aircraft flare chute, in quantity, it would provide a confused mass of returns for the German radar controller. Such a simple solution could easily be copied and then Britain would become vulnerable to German attacks with her night fighters powerless.

'Window', as the foil strips were called, was first delivered to Bomber Command squadrons in March 1942 and Portal, on 4 April 1942, approved its use once supplies could be guaranteed and the tactics for its use agreed upon. However, before it could be employed, Sir Sholto Douglas, head of Fighter Command, convinced both Portal and Lord Cherwell that it would be an unwise action. On 5 May 1942 the use of Window was deferred indefinitely.

Webster and Frankland were critical of this decision which 'had allowed the much inferior and diminishing German bomber strength to deny an important tactical advantage to the much greater and increasing striking power of Bomber Command'. No argument can be raised with their contention that Window would have provided tactical surprise and been the means of saving British bombers and their aircrews. However, in May 1942, the strategic direction that the war would follow was far from being clearly defined. If Russia collapsed Germany could once again focus solely on Great Britain. In this event there is sufficient evidence to suggest that Britain would have been the greater sufferer. In December 1941 the Luftwaffe possessed 383 serviceable medium bombers

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93 Panter, op.cit., Vol.5, p.87
Authorities vary as to the dimensions. Middlebrook, The Battle of Hamburg, p.68 gives 27 x 2cm; Musgrove Operation Gomorrah, p.171 gives 25 x 5cm.
Author's note: Window was still in use in the 1960s but was then automatically dispensed and cut to the required length for the particular task it was to fulfil.

94 Price, Instruments of Darkness, p.116

95 Ibid., p.116

96 Webster & Frankland, op.cit., Vol.2, p.142
with crews to spare. By December 1942 there were 611 bombers available for operations but with a crew deficiency totalling 167.\textsuperscript{97} In January 1942 the average daily availability of bombers with crews in the R.A.F. was 363 but this total included only 42 heavy bombers. In December 1942 although the average daily availability had only risen to 418 bombers this total now included 261 heavy bombers.\textsuperscript{98} These figures would suggest that in 1942 the \textit{Luftwaffe}, if freed from any Russian commitment, would have been better placed to deliver a heavier load of bombs on London that the R.A.F. was capable of dropping on Berlin.

The British desire to preserve the secrecy of Window was mirrored in Germany. Scientists there had conducted experiments with radar obliterating foil in 1942 and were quick to appreciate the potential threat it offered to their own air defence system. Goring ordered that all investigations on \textit{Düppel}\textsuperscript{99} were to cease, including research into what counter-measures could be employed to nullify the effects.

In November 1942 the subject of the use of Window was again raised because by this time British scientists believed that the Germans were fully aware of the scientific principles involved. Saundby, who represented Bomber Command at the conference, opposed the suggestion. Mandrel and Tinsel were about to be used operationally and he did not want Bomber Command to play all its high cards at one time. He also argued that high concentrations of bombers in space and time were already confusing the German defences. Portal decided to review the question of Window in six months' time.

In retrospect, when it was virtually certain that lives of bomber crews would be saved by the use of Window, it is difficult to comprehend the rationale of the thinking involved in delaying its introduction. In the 1960s the R.A.F. investigated the provision of ejection seats for rear-crew members in Vulcans. Their finding was that it was cheaper to train two navigators and an air electronics officer than it was to retro-fit the Vulcan force with rear-crew ejection seats. Perhaps, even in peace-time, human life when measured against pounds, shillings and pence has little value.

On 2 April 1943 Portal convened yet another conference on the subject of Window. Concern was increasing in Bomber Command circles at the numbers of bombers being lost to enemy night fighters. The argument was that the introduction of

\textsuperscript{97} Webster & Frankland, \textit{op.cit.}, Vol.4, p.502

\textsuperscript{98} Harris, \textit{Despatch on War Operations}, p.12

\textsuperscript{99} Named after the area, the Düppel estate near Berlin, where experiments were carried out.
Window would radically reduce the losses caused not only by radar-controlled fighters but also by radar-controlled Flak. Fighter Command's objections to the use of Window were also muted because they now possess an A.I., fighter radar which they believed would be largely unaffected by foil strips should the Germans retaliate in kind. Window was also, by this time, available in sufficient quantities for it to be dispensed along long sections of the bombers' routes rather than only in the target area. Harris claimed that 'There is now a good possibility of saving one-third of our losses on German targets by using this counter-measure. The Command has nothing to lose and possibly much to gain by using it'.

Portal agreed and it was recommended to the Chiefs of Staff that from 1 May 1943 Window be used against the Würzburg radars. They called for another deferment because they wanted no disruption to their plans for the invasion of Sicily. On 15 July 1943, with ground operations proceeding satisfactorily in Sicily, it was finally agreed that Window could be used to provide protection for bombers from 23 July 1943. It was first used on the opening night of the Battle of Hamburg - Operation Gomorrah - on 24/25 July 1943.

According to one author the selection of Hamburg as the target involved limited discussion. Harris had a few words with the Command Meteorological Officer, took a searching look over the target map and then uttered but three words: Hamburg, Goodwood, late. Translated, this meant that the target for 24/25 July 1943 was to be Hamburg, the attack was to be at maximum effort and that it would commence after midnight.

Staff Officers at P.F.F. H.Q. after considering the forecast for Hamburg decided that the attack would be a Newhaven. That is, with the expectation of clear skies, twenty Blind Illuminators would lead the attack and drop lines of flares and yellow T.Is in the target area. They would be followed by eight Visual Markers whose task was to identify the target visually and mark it with red T.Is. Next, fifty three backers-up at intervals were to drop secondary green T.Is on the reds, if visible, otherwise on the yellows. Main Force orders were to bomb the red T.Is whenever visible and only bomb the centre of the greens as a last resort. They were also reminded that even if they did sight white illuminating flares or yellow T.Is in the target area they were to be ignored.

100 Price, *Instruments of Darkness*, p.141
102 Webster & Frankland, *op.cit.*, Vol.2, pp.150-1
The planned route across the North Sea was designed to keep the bomber stream clear of the German night fighter boxes along the East Friesian Islands. It then turned south eastward passing north of Heligoland and crossing the coast on a prominent peninsula south of the island of Sylt. Yellow T.I. route markers were to be dropped at the coasting-in point to assist Main Force crews in reaching the target. After crossing the target the stream was to fly south for a short distance before turning north-west to coast-out north of Bremen. Yellow T.Is were also to be placed at this point to provide navigational assistance. Only 140 miles of the route were planned to be over German territory which meant approximately 42 minutes of flying time.

Briefing on Window was provided to the crews by the various Intelligence Officers. Dropping was to commence prior to entry into the first of the German night fighter boxes and was to be maintained until over the North Sea again and clear of the German defences. The 'Instructions to Intelligence Officers on the Use of Window' issued on 17 July 1943 explained that Window was 'a new and simple countermeasure ... to protect yourself [the bomber aircrew] against the German defence system ... and you [the bomber aircrew] should stand a good chance of getting through unscathed while their [German defences] attention is being wasted on the packets of "Window"'.

The same instruction also pointed out that the benefits of Window were communal. Protection for a particular bomber was not provided by the Window that it was dropping but rather by the Window dispensed by preceding aircraft. For best protection it was essential that compactness of the bomber stream was maintained. Crews were also reminded that discharging Window would be a physically demanding task but that a steady flow of one bundle per minute was essential.

Window, aluminium foil cut to size and stiffened with a black paper backing so as not to reflect in searchlight beams, was made up in bundles of 2,000 strips held together for despatch by a rubber band. On entry into the bombers' slipstream the bundle came apart and produced an echo on the Würzburg radar similar to that provided by a heavy bomber.

Two other innovations provided by the P.F.F. appeared in this first attack of Operation Gomorrah. Firstly, six specially selected Blind Marker crews were required to determine the wind velocity at their flight level between their last good Gee fix and their fix on H₂S when crossing the

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103 Musgrove, Operation Gomorrah, p.11

104 Price, Instruments of Darkness, p.149
Plan for first R.A.F. Raid, 24/25 July 1943

Track distance: Between 980 miles (1 Group) and 1,220 miles (6 Group)
Aircraft: 347 Lancasters, 247 Halifaxes, 125 Stirlings, 73 Wellingsons
Time over target: First Pathfinders 00-57, Main Force 01-00-01-50
Other operations:
  6. Radio Counter Measures aircraft with Hamburg force
  6. Wellingsons minelaying in mouth of River Elbe
  9. Mosquitoes on diversionary raids to Kiel, Lübeck and Bremen
25 Intruders to German airfields (most were later cancelled)

The Bombing Plan for the First Hamburg Raid
Night of 24/25 July 1943

Route of Bomber-stream

Residential Areas
Industrial, Port or Railway Areas
U-boat Construction Yards
0 Blohm & Voss
1 Howaldtswerke
2 Deutsche Werft
3 Stülcken

enemy coast. This wind velocity was then to be relayed back to P.F.F. H.Q. The duty navigator at P.F.F. H.Q. was then to average these six winds and pass the resultant to Bomber Command H.Q. who would broadcast it in degrees true and knots to the bomber stream. This average wind obtained by specialist crews - code named Zephyr- was meant to provide an accurate wind for both navigational and bombing purposes.

Secondly, Recenterers were used for the first time on 24/25 July 1943 in an attempt to keep the attack concentrated. Their task was to re-mark the aiming point, when necessary, to prevent creep back. Remember, also, that the Backers-up were involved throughout the raid attempting to mark the primary reds if visible. If no primary reds could be seen the Backers-up had to mark the M.P.I. of the yellow T.Is dropped using H₂S. The raid was reasonably concentrated but, unfortunately, around four distinctive fire areas because the Visual markers' T.I. reds had been somewhat scattered. Despite the fact that the backers-up had employed their usual two second overshoot before release, creep back did occur. By Zero hour +30 'a long carpet of incendiaries extended back along the line of approach for seven miles'.

Between 24/25 July 1943 and 2/3 August 1943 Bomber Command launched four major assaults against the city port of Hamburg. After the first raid the United States Army Air Force (U.S.A.A.F.) also twice attacked industrial targets in Hamburg. Unfortunately, smoke from the fires caused by R.A.F. bombing severely hampered their efforts.

The second R.A.F. raid, on 27/28 July 1943, provided a new and awesome phenomenon in the bombing war. Hamburg was swept by a firestorm. Pathfinders and the Main Force approached their target on this occasion from the north east and the marking, although unusually concentrated, was approximately two miles east of the designated aiming point. Fifteen Blind Marker crews were operating that night and no fewer than twelve loads of markers fell in or near the suburb of Billwarder. This area had its own unique form of architecture which contributed to the disaster for the citizens of Hamburg. It was mainly a working class area, typically German, but not a slum. Street after street consisted of six storey buildings, often owned by trade union organisations or business firms, and housing eighteen families. A very large population was housed in a comparatively small area. Thanks to the perseverance of the backers-up and Recenterers, creep back was minimal and the Main Force bombing was unusually accurate. In combination, the high ground temperatures that night together with very low humidity, lack of fire-fighting appliances because they were otherwise occupied, and the accurate bombing, created unique

105 Panter, op. cit., Vol.5, p.88
circumstances. Huge fires combined in an attempt to extract oxygen from the surrounding air and walls of fire travelling at speeds of 100 m.p.h. spread the devastation. Citizens of Hamburg called it die Julikatastrophe von 1943.106

Only the first three R.A.F. attacks yielded significant damage at Hamburg. The last raid of Operation Gomorrah, on 2/3 August 1943, was nullified by appalling weather conditions when those who attempted to press on to the target had to penetrate cumulo-nimbus clouds with their perils of icing, turbulence and masive wind sheers.

Already we have seen Speer's assessment of these attacks on Hamburg. The United States Strategic Bombing Survey claimed that the 'results of the heavy raids of 1943 were felt up to the moment of the final collapse in May 1945'.107 As a further measure, war production in Hamburg never surpassed 89 per cent of the pre-July 1943 level although overall, productivity was rising rapidly in Germany in 1943 and did not finally peak until approximately September 1944.108 Bennett regarded the successes gained at Hamburg, which apart from the use of Window, advice of Zephyrs and the employment of Recenterers, were standard area attacks without the employment of special weapons, as 'the greatest victory of the war, land, sea or air'.109

Technically, Operation Gomorrah provided more than adequate justification for area bombing. However, on the three nights when bombing was concentrated, not once was it initiated on the designated aiming point. Nevertheless the H.E. and incendiaries dropped by the Main Force crews were accurately placed on the markers in compact residential districts of Hamburg. Creep-back, generally, extended over further built-up areas. Hamburg was a special situation compared with the Ruhr or Berlin. It was comparatively easy to locate (given good weather); bombing runs were virtually harassment-free and on one night, with almost unique meteorological conditions the theories of area bombing became awful fact.

106 The catastrophe of July 1943
Hans Brunswig, Feuersturm über Hamburg
(Stuttgart: Motorbuch Verlag, 1979), p.9

107 Musgrove, Operation Gomorrah, p.170

108 This production refers to armaments, tanks, weapons, ammunition, aircraft and shipbuilding.
Air Ministry, The Strategic Air War against Germany 1939-
1945. Report of British Bombing Survey
Unit
(London: Air Ministry, undated), Figs. 20, 21, 22, 23,
24, 25 and 26

109 Bennett, op. cit., p.164
Window was a success. Whether it was a long term success is highly debatable. Just over 3,000 sorties were launched against Hamburg of which 63.9 per cent bombed in the city area. Overall, the loss rate of 2.8 per cent measured up well against an average loss rate of 6.1 per cent over six earlier attacks on the same city. It would be invalid, however, to claim that the reduced loss rate was necessarily due to the release of Window. Increased concentration of the bomber stream, reduction in time over the target and shallow penetration of enemy air space may have all been important elements. Use of Window was also instrumental in bringing about radical and rapid changes in the German air defence system. Hajo Herrmann and his Wilde Sau free-lance night fighters were undergoing training at the commencement of Operation Gomorrah. Speculation was rife in the radar controlled night fighter units as to their potential usefulness. Doubts were quickly dispelled as British bomber crews were to learn to their cost over the next few months. Not only would they have to attempt to counter new tactics but they were also faced with increasing numbers of night fighters as German aircraft production was increased.

Operation Gomorrah had marked the first steps along what was to prove the difficult road to Berlin. Before considering the problems encountered by both P.F.F. and Main Force crews in the Battle of Berlin it is necessary to examine the raid, on 17/18 August 1943, directed against the German rocket research establishment at Peenemunde on the Baltic Coast. This raid had several unique features. Although it entailed a round trip distance of 1,250 miles, because of the accuracy deemed necessary, it was planned to take place in moonlight conditions. It was also planned as a precision attack in that three specific groups of buildings were nominated as aiming points. To confirm the importance of the target, bombing was to be carried out by the Main Force at altitudes between 6,000 and 10,000 feet. Another novelty for most of the participating crews was that this was the first major raid to be controlled by a Master of Ceremonies or Master Bomber. Another first, although the fact remained unknown to R.A.F. bomber crews for some considerable time, was the employment by German two-seater night fighters (Me110s) of twin, upward-firing cannons - the very accurate and destructive schräge Musik.\footnote{jazz music Hastings, \textit{op.cit.}, p.239} This required no deflection shooting and aim was taken normally on the fuel tanks between the port or starboard inner engines and the fuselage. This usually created a fatal fire but not the risk of an immediate and devastating explosion had the cannons been directed at the aircraft's bomb bay.
E.B. Panter,
The R.A.F. in the Bombing Offensive against Germany
(London: Air Ministry, no date), Vol.5, Map 2
Night-fighter attack methods

Long radar approach ending in a visual sighting

The von unten hinten attack. The fighter, in a slightly nose-up attitude, aims its fixed forward firing guns at the bomber's fuselage. The tail gunner and the bomb bay were particularly vulnerable to this fire.

The schräge Musik attack. The fighter, from the safety of the blind spot under the bomber, fires into the petrol tanks of one wing.

(The drawings are not intended to be to scale; the angles of the fighter's approach path in particular are exaggerated)

Martin Middlebrook, The Nuremberg Raid
(London: Allen Lane, 1973), p.71
A final first was the use by the P.F.F. of a new and improved marker bomb which came to be known as the Red Spot Fire. Impregnated cotton wool, packed in a 250 pound casing, it burst and ignited at 3,000 feet and then burned on the ground for approximately ten minutes.\textsuperscript{112} It was very distinctive, difficult to simulate and proved to be a very useful addition to the pyrotechnic armoury of the P.F.F.

Although the bomber crews were not made aware of the exact nature of their target at Peenemunde they were under no misapprehension as to its importance. Group Captain J.H. Searby, who had been selected to lead the attack, together with his navigator and bomb aimer had examined a model of the target but they had been told neither its name nor location. Peenemunde was described to the crews at briefings as a site where the Germans were working on countermeasures against the bombing offensive. This would, it was hoped, encourage the crews to press home their attacks and, in the event of their becoming prisoners of war, would conceal the extent of British knowledge concerning activities at the site. It would also help prevent the British people from becoming aware that the Germans were preparing a rocket offensive for action against their country. The vital importance of the target was revealed at the end of the briefings when a message from Harris was passed on to the assembled crews. They were told that if the 'operation failed of its object on the first night it would have to be repeated on the next night, and on all suitable nights thereafter, regardless of casualties and regardless of the fact that the enemy would obviously do everything possible to increase the defences of the place after the first attack'.\textsuperscript{113} The memory of that threat lingers with Bomber Command survivors to this day.

Morale in Bomber Command at this time was especially good. Successes won at Hamburg and the Ruhr coupled with the successful introduction of Window and generally lowered loss rates all contributed. Harris, aware that he would be calling for a maximum effort against Peenemunde had conserved the strength of his force. Some squadrons had not flown operationally for a week. Most crews were rested, refreshed, and increasingly hopeful of completing their tours.

It is believed that Harris gave Cochrane and 5 Group Staff the task of planning Operation Hydra - the raid on Peenemünde - because of their previous experience of attacking precision targets.\textsuperscript{114} However, Cochrane's plan of a

\textsuperscript{112} MacBean & Hogben, \textit{op.cit.}, pp.111-2

\textsuperscript{113} Harris, \textit{Bomber Offensive}, p.183

\textsuperscript{114} Martin Middlebrook, \textit{The Peenemünde Raid} (London: Allen Lane, 1982), p.51
precision attack by a limited number of Lancasters was rejected by Harris. This rejection provided confirmation that Harris still accepted that the P.F.F. possessed the capability of locating and marking three small aiming points at long range.

It would appear that the original Operation Order, Number 176, issued on 9 July 1943 for the attack on Peenemünde never reached the Public Record Office but Middlebrook managed to obtain a copy from a private source for his book. Confirmation, by omission, that it was not available is provided by Searby in his book on the Peenemünde raid where no mention is made of the original Operation Order. The attack on Peenemünde was planned as a Newhaven with two shifts of the aiming point to cover the three designated aiming points - the Development Research works, Pre-production factories and the Scientists' residential area. Shifting of the aiming point was to be done by false settings on the bomb sights. The raid was to be controlled by a Master Bomber, Searby, who had the authority to alter bombing orders as he deemed necessary during the 45 minutes he was to spend in the target area while the raid took place.

The notion of a 'Master of Ceremonies' or 'Master Bomber' as employed at Peenemünde was nothing new although this was the first time it was employed on a major raid. E.W. Anderson, a navigator, whilst employed in Bomber Command H.Q. in June 1942 had even written a minute on the subject. His idea had been rejected. On posting to the P.F.F. Anderson repeated his suggestion. In a jocular manner he described how, as a timid fellow, he thought it would be a good idea if others like himself could receive words of encouragement from 'Intrepid Fellows' whilst in the target area. He considered his idea had rebounded somewhat when, with Squadron Leader S.P. (Pat) Daniels a noted bomber pilot, Anderson's crew on 83 P.F.F. squadron was selected to be the intrepid encouraging enthusiasts for the attack on Frankfurt on 2/3 December 1942. Weather won that battle and despite Anderson wearing his 'best bombing spectacles' nothing of the target area was identified. The only lesson learned was that unless flares could be dropped that would illuminate the aiming point, the Master Bomber could achieve very little.

115 Middlebrook, The Peenemünde Raid, App.1
117 Anderson, Pathfinders, p.57
118 Ibid., p.58
A primary requirement for the successful employment of a Master Bomber was the provision of adequate communication facilities aircraft to aircraft. At the beginning of the war this could only be done, painfully slowly, by wireless telegraphy (W.T.) using morse. Radio telephony (R/T) employing high frequencies (H.F.) was in use by 1943 but it was not satisfactory. What was required was Very High Frequency (V.H.F.) R/T which possessed the advantages of reduced atmospheric interference, less interference from other stations because of the greater frequency separation possible and, finally, clearer speech. Bennett had requested V.H.F. equipment for the P.F.F. but his request had initially been declined. However, 617 Squadron, part of 5 Group under Cochrane had no difficulty in having V.H.F. fitted for the Dams Raid in May 1943. The P.F.F. Monthly Summary for November 1943\(^{119}\) gave an indication of the slow progress being made with the supply and installation of V.H.F. Oakington had temporary ground V.H.F. equipment; Graveley was having permanent V.H.F. transmitters and receivers installed and Upwood was having temporary V.H.F. fitted in the Watch Officer (early form of Control Tower) to provide R/T for landing control. Even in the P.F.F., to quote Anderson again, 'getting special equipment is like making love to an elephant. It's a very difficult thing to do, you are liable to get sat on heavily, and it takes about a year before anything happens'.\(^{120}\)

The Master Bomber tactic had been employed by 5 Group and the P.F.F. in a small scale precision attack against a factory target located at Friedrichshafen on 20/21 June 1943. The P.F.F. marked the target but in the second part of the attack the 5 Group Lancasters flew on a timed run from a marked point on the shore line to the estimated position of the factory but hidden by smoke.

Searby also flew as Master Bomber in an attack on Turin on 12/13 July 1943. With him, as a passenger, was Group Captain C.D.C. Boyce, Bennett's Senior Air Staff Officer who no doubt was there to assess Searby's suitability for leading the Peenemünde attack. Searby also flew as Master Bomber against Turin on 7/8 August 1943 as a dress rehearsal for Peenemünde but he had not been greatly impressed as to its potential usefulness. He believed that the 'main value of the exercise lay in practising the use of the new V.H.F. air-to-air communication'.\(^{121}\)

\(^{119}\) AIR 25/156, November 1943, p.16

\(^{120}\) Anderson, Pathfinders, p.59

Peenemünde's location determined that the attack should be from the north because it was agreed that in the good weather conditions required for the raid the islands of Rügen and Ruden would provide excellent navigational and bomb-run check points either visually or on the H₂S equipment. Normally bombing raids were planned so that the direction of attack was down wind. This meant that smoke from ground fires obscured neither the target nor the approaches to the target. The original Operation Order had clearly anticipated the surface wind for the attack as having a mainly southerly component as the targets were to be bombed in order from the north. Although this would have meant smoke drifting back along the bombers' approach paths the succeeding aiming points would have been in the clear.

When the final Operations Order was issued on 17 August 1943, because it was forecast for the surface wind to have a northerly component, the target order had to be changed. Aiming points would now be attacked from south to north with the residential area the first to be struck.¹²²

Marking plans for Operation Hydra were that Red Spot Fires would be placed by Blind Marker crews on the northern edge of Ruden Island approximately seven miles out from the first aiming point the housing estate. These were to be supplemented as the raid progressed. From Zero hour minus four minutes to the Zero hour the same Blind Markers were to continue their run and each drop three red T.Is and sixteen illuminating flares on the first aiming point. The red T.Is were to be a guide to, and the flares provide illumination for, the Visual Markers. From Zero -2 to Zero +2 six visual Markers were to mark the first aiming point each with four yellow T.Is.¹²³ Backers-up, with green T.Is, were to place their loads on the yellows.

The Main Force attack against the housing area was planned to last from Zero +15 to Zero +30 with the aiming point then being shifted to the production works. This target was then to be bombed from Zero +31 until Zero +42 when the final shift to the experimental works was to take place. These were to be attacked from Zero +43 to Zero +55.

New techniques were also employed by the P.F.P. on this raid for aiming point shifting. It had been calculated that if an aircraft flew at 12,000 feet, but had its bomb sight set to 5,000 feet, then any bombs released would undershoot (fall short of) the target by one mile. The distance between the housing area and the production works was one mile. Six Shifters were to be employed to mark the new aiming point. With a false altitude setting on their bomb sights, they were to drop their red T.Is by aiming at the green T.Is placed on the original aiming point by the Backers-up.

¹²² Middlebrook, The Peenemünde Raid, p.67
¹²³ Ibid., p.113
Allied Air Operations, 17 and 18 August 1943

Luftwaffe Night-fighter Airfields
- Twin-engined
- Single-engined

[Map showing airfields and routes, with annotations and symbols]

The Planned Bombing Areas

The three targets were later allocated to Bomber Command groups as follows:

- Experimental Works — Nos 5 & 6 Groups
- Production Works — No. 1 Group
- Housing Estate, etc. — Nos 3 & 4 Groups

Radar theory was disproved at the commencement of the attack on Peenemünde when the island of Ruden failed to appear on the H.S screens. As a result the majority of Blind Marker crews (six out of eight) dropped their Red Spot Fires on the northern extremity of the Peenemünde Peninsula. This two mile error was then perpetuated when their T.Is were placed two miles south of the correct aiming point. Only one load of T.Is was accurately placed on the housing area. The six Visual Markers retrieved the situation somewhat by placing three of their loads on the exact aiming point. Backers-up, with guidance from Searby, confirmed the correct aiming point but not before Main Force crews had spent almost three minutes attacking the incorrectly placed markers. Unfortunately for many, two miles south of the correct aiming point lay a camp for foreign workers employed at Peenemünde. The large fires created in this area continued to attract some Main Force crews throughout the attack.

Initially, the German defences were fairly slow to react. Flak at first was slight, only one searchlight was evident and no German fighters were in the area. A spoof raid on Berlin had been highly effective in drawing off the Luftwaffe fighters. But the inactivity was short-lived and light Flak, which could normally be ignored, soon began to take its toll. Smoke from bombing fires and German defensive screens added to the difficulties.

The aiming point shifting also did not go particularly well. Although the green T.Is at which the highly experienced Shifter crews aimed were accurately placed, only one load of red T.Is dropped by the Shifters was on the second aiming point. Fortunately the Master Bomber realised what had happened and was able to identify the correctly placed load of red T.Is for the guidance of Main Force crews. Another problem identified at this time by the Master Bomber was the tendency for the bombing to be affected by a cross-wind. Too many of the bombs were falling in the sea. Exhortations by the Master Bomber to compensate for the cross-wind effect appeared to have only limited success. To add to the problems, towards the end of the second phase of the attack, Luftwaffe fighters began to arrive at the scene.

Aiming point shifting was no better at the second attempt. The problems created by smoke, drift of bombing to the east and increasing German fighter activity had prevented Searby and his crew from detecting the misplacement of markers. Overshoots began to predominate.

There was, however, an exception in this the third phase of the attack. Unbeknown to Searby, 5 Group had resurrected the time and distance bombing method attempted by Mahaddie much earlier in the war. The system required good visibility and a series of identifiable check points on a straight
approach to the target. The exact time was noted when the first check point was crossed and a heading determined to maintain track to the second check point. On crossing the second check point the time was again noted. The ground speed achieved between the first and second check points was then calculated. Knowing the distance between a third check point and the target meant that a time could then be calculated for releasing the bomb load. The Peenemünde use of this tactic is illustrated in Fig. 32 on Page 373.

Bennett claimed that 'The Commander in Chief and the A.O.C. of No. 5 Group had much excitement and amusement by laying on some of the Main Force bombers from 5 Group to check the reliability and accuracy of the Path Finder Force, by doing a timed run from a landmark outside the target area. The run-in to Peenemünde provided a great opportunity for navigators and bomb-aimers to cross check their progress. Those who neglected to do so displayed poor airmanship. Perhaps it was just coincidence but the P.F.F. Monthly Summary for September 1943 contained a foreword by Bennett stressing the need for team work in bombing and navigation 'including habitual cross-checking ... crew members should co-operate with information, directions and checking ... to overcome our greatest difficulty - the unreliability of the human element ... it is just common sense'.

Briefing instructions to 5 Group crews in the third wave were that their time and distance system was only to be employed if there were no P.F.F. markers visible or if the Master Bomber advised that the T.Is were seriously misplaced. The interesting fact about this arrangement was that Searby was unaware that it might be employed by bomber crews under his command. Middlebrook, an admitted admirer of Cochrane, thought that 'this brilliant commander should have been given his head much earlier and on a wider scale.' Harris, however, was still playing Cochrane off against Bennett at a time when unity, and not splintering, was essential. It is inviting disaster to give control of an operation to a particular individual while at the same time approving actions by some of those, ostensibly under his command, of which he had no knowledge.

Forty bombers failed to return from the Peenemünde operation but the R.A.F. was not called upon to attack the same target again so for that reason alone the attack must be considered successful.

124 Bennett, op.cit., p.171
125 AIR 25/156, September 1943, p.2
126 Middlebrook, The Peenemünde Raid, p.227
Time-and-distance Bombing

Approach Run—
Checking Time and Heading

Final Calculations Made

Timed Bomb-run

Bennett, even in September 1943, was still seriously concerned at the situation of the P.F.F. The attacks against Hanover in September 1943 provided him with sufficient reason. In the first major raid against the city for more than two years, on 22/23 September 1943, 711 bombers had been detailed to attack. If the raid was launched to confirm the efficacy of Newhaven tactics against inland cities then it was a miserable failure. Weather conditions, of course, were vital elements in determining success or failure for Newhavens but on this occasion the forecast had been good. Visibility in the target area at the start of the raid was excellent and there was no cloud. The Main Force bombing, however, was very wide of the aiming point. Various authorities differ remarkably in their assessment of this particular raid. Webster and Frankland did not mention it in their work despite the fact that it was the first time that a spoof attack was specifically arranged. Harris neither mentioned it in his book nor in his post-war Despatch. Musgrove, however, claimed that 'From the practical point of view the attack was a resounding success ... and 56 factories had been hit'.\textsuperscript{127} Another authority claimed that the 'main weight of the attack ... fell two to five miles south-east of the aiming point and spread up to nine miles .... The main factory area was on the north-west and west of the town, and was little affected'.\textsuperscript{128} Middlebrook and Everitt considered that it was 'unlikely serious damage was caused'.\textsuperscript{129}

The P.F.F. Monthly Summary for September 1943 stated that on 22/23 September 1943, when the main target had been Hanover, that 'The main attack went badly astray to the S.E. thanks largely, it must be admitted, to the Path Finder Force'.\textsuperscript{130} Stronger winds than those forecast were apportioned some of the blame. The P.F.F. made a timed run from the Steinhuder Meer (a technique evidently not confined to 5 Group) but with actual winds some 25 miles per hour stronger than forecast, Blind Marker Illuminators and Backers-up overshot the aiming point by at least two miles. Visual Markers did better and their T.I.s were well placed but unfortunately they were ignored by the Main Force. Similar problems reoccurred at Hanover on 27/28 September 1943, again in good weather conditions. Although Musgrove claimed on both occasions that the bombing was heavy and concentrated (even if not in the right place) he still commented that nobody dared whisper the word Hanover within 25 miles of P.F.F. H.Q. at Huntingdon'.\textsuperscript{131}

\textsuperscript{127} Musgrove, \textit{Pathfinder Force}, p.75
\textsuperscript{128} Panter, \textit{op.cit.}, Vol.5, p.113
\textsuperscript{129} Middlebrook & Everitt, \textit{op.cit.}, p.432
\textsuperscript{130} AIR 25/156, September 1943, p.3
\textsuperscript{131} Musgrove, \textit{Pathfinder Force}, p.76
Harris on 25 September 1943, confirmed 'the failure of the raid on Hanover' and considered it advisable 'to do "a stock-taking" of the state of the Path Finder Force'.

It was made very clear in this letter from Bennett that he considered that the terms under which the P.F.F. had been established and the manner in which it was to be maintained had not been confirmed in practice. The aim had originally been 'nothing but the best' but Bennett argued that this had not been achieved to any great extent. He then listed four main causes of concern. The first was that the P.F.F. was not receiving the very best of the crews available in the supporting Groups. Secondly, he rue'd the fact that no less than one third of the crews being posted to the P.F.F. had no operational experience. They came direct from the training environment. Thirdly, he pointed out that as a consequence of the strength of the P.F.F. in relation to its task, opportunities for training were considerably less than in Main Force squadrons. Finally, he regretted that the P.F.F. had been accorded no priority in either the development or the supply of special equipment. They simply joined the queue proceeding through the 'usual channels' so much so that 'the policy of development rests more with the higher formations than with the P.F.F. itself'.

Bennett then expanded on the deficiencies. He agreed with the S.A.S.O. of one of the Main Force Groups who claimed that he could produce twelve crews who could do a better job of backing-up than the P.F.F. backers-up. However, Bennett's suggestion that those crews should have been in the P.F.F. had been greeted with distinct surprise. It was clear to Bennett that too many in high places had not understood the first principle of path finding, that only the best would do. Bennett made clear 'that failures of the human element (and the human element was the failing actor at Hanover) are a direct reflection on their selection of crews for the Path Finder Force'. Bennett then voiced his concern that casualties were diluting the efficiency of the P.F.F. While, in February 1943, the average experience of P.F.F. captains had been 32 sorties; by September 1943 the average had reduced to only 20 sorties.

Training was always a significant burden to the P.F.F. and Bennett next suggested to Harris that the one third direct entry from O.C.Us and H.C.Us should only be second tour crews returning to operations. Crews lacking operational experience took up too much invaluable training time. Conversion of squadrons from one aircraft type to another, with the P.F.F. gradually moving to Lancasters, was also a

\[\text{\textsuperscript{132}}\text{AIR 14/2701, 25 September 1943, para.1}\]

\[\text{\textsuperscript{133}}\text{Ibid., para.2}\]

\[\text{\textsuperscript{134}}\text{Ibid., para.3}\]
problem. Main Force squadrons, when required to convert to new aircraft types, were removed from the front-line for weeks at a time. The P.F.F. on the other hand, with limited numbers and heavy commitments, had been forced to convert 'without going non-operational for a single night'.  

It is clear from this letter of Bennett's that even if Harris had not written to him expressing his concern at the failures at Hanover, he had certainly been in contact on the telephone. Bennett, in afterthought it would appear, was roused by an implied slur, given by Harris, on the capabilities of the P.F.F. 'On the telephone yesterday' wrote Bennett, 'you made the statement that H₂S results were on the average worse than without H₂S. The comparison, I feel sure, must have been against the P.F.F. visual-illumination method and not in relation to pre P.F.F. days. The failure at Hanover was undoubtedly a paragon of success compared to the farcical raids which I can assure you from personal experience were carried out before P.F.F.'.  

Bennett agreed with Harris that H₂S results had not been good but argued that, had visual methods been employed, the results would have been 'appalling'. The human element was one area where improvements could be made, continued Bennett, but if the equipment (improved H₂S and stabilised scanner), on demand for over a year, could be supplied, 'the results would be far better very soon'.  

Other reasons were provided by Bennett which all, he believed, contributed to the shambles at Hanover. An eight day stand-down from operations coupled with a wide-ranging briefing to cover the first official spoof raid, plus late take-offs because of incomplete bomb loading, all contributed. Finally, Bennett lamented that 'Our Pyrotechnics are still not what we want either in quantity or type. Hooded flares, vitally important in a Newhaven attack, are still months overdue ... [and] our armament fraternity are only able to produce three colours of pyrotechnics'. To compound the difficulties at Hanover 'many incendiaries were dropped by the Main Force before the allotted time of Z+2'. After such a litany of deficiencies and short comings, what were the prospects for a successful, P.F.F.-led offensive against Berlin during the coming winter months?

135 AIR 14/2701, 25 September 1943, para.5
136 Ibid., para.6
137 Ibid., para.6
138 Ibid., para.6
139 Ibid., para.9
140 Ibid., para.9
Despite the emphasis given in the Pointblank Directive of 10 June 1943 that the priority objective for the bombing offensive was to achieve a reduction in the Luftwaffe fighter strength, the requirement continued to be largely ignored by Harris. Inspiration for the Directive had been provided by the increasing losses being experienced both by the R.A.F. and the U.S.A.A.F. in their night and day strategic bombing offensives. The growing Luftwaffe fighter strength threatened to make it impossible for the bomber forces to carry out their allotted tasks. But Harris had been allowed an escape path. The primary object, as distinct from the priority objective, remained 'the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened'. In Harris's opinion if Berlin could be devastated as Hamburg had been, then what was previously only a shattering blow may, in the case of the German capital, become a decisive one. The prospects blinded Harris to the difficulties his bomber crews would face and the impossibilities of the task they were given.

Perhaps he still had in mind the Casablanca Directive of 21 January 1943 which had said 'other objectives of great importance either from the political or military point of view must be attacked ... Berlin, which should be attacked when conditions are suitable for the attainment of specially valuable results unfavourable to the morale of the enemy or favourable to that of Russia'.

Politically and industrially, as well as from a morale point of view, Berlin was an attractive target. It was, without doubt, the most important industrial and manufacturing city in Europe. Important elements of the German aircraft industry were located in Berlin as well as numerous other electrical and engineering firms. Portal recognised its importance as a target. He commented, on 19 August 1943, 'In present war situation attacks on Berlin on anything like Hamburg scale must have enormous effect on Germany as a whole'.

Churchill, for his part, always blew hot and cold with regard to the bomber offensive. However, the recognition by Stalin early in 1943 that Russia was appreciative of the R.A.F. bombing of Berlin, must have given the Prime Minister encouragement to continue the build-up of the bomber forces in the United Kingdom. Churchill, with his oft repeated personal messages to Stalin concerning the raids against Berlin listing bomb tonnages, damage created, and aircraft lost, almost sought the gratitude of the Russian leader.

141 Webster & Frankland, _op. cit._, Vol.4, p.158
142 _Ibid._, Vol.4, p.154
143 Panter, _op. cit._, Vol.5, p.121
Harris, in a memorandum to Churchill on 3 November 1943, described the damage that had already been created in 38 German cities. Berlin, he argued, should now be accorded the highest priority. In its destruction Harris saw final victory. To achieve this, however, Harris admitted at this time that Bomber Command would require the assistance of the U.S.A.A.F. Provided they would 'wade in in greater force ... and avoid such disastrous diversions as Ploesti ... We can wreck Berlin from end to end if the U.S.A.A.F. will come in on it. It will cost between us 400-500 aircraft. It will cost Germany the war'.

For their part the Air Staff were not unanimous in their attitude to Harris's claim. Some supported it on the grounds that immediate and aggressive offensive action could bring victory. Others believed that any failure to curb the growth of the Luftwaffe fighter force could have long-term, disastrous implications. Should, for any reason, the offensive against Berlin fail, then seriously weakened British and American bomber forces would be forced to attempt to overcome a strengthened Luftwaffe. The final consensus, reached on 13 November 1943, was that while Harris should not commit Bomber Command to a 'sustained and costly series of assaults' he should seize 'suitable occasions when weather and other tactical conditions should give him the most favourable chances'. It was the green light for Harris and the Battle of Berlin commenced on 18/19 November 1943. Optimism was the keynote in November 1943 but it was to prove a winter of suffering for Bomber Command not made glorious by any summer of victory.

Success for Bomber Command in the Battle of Berlin always hinged on two intangibles - had the German ground and air defences overcome the problems introduced by Window, and, could the P.F.F. locate and adequately mark precise aiming points in a distant, inland, widely-spread and heavily defended city? Berlin was well beyond normal Oboe range and investigations into the possibility of using repeater aircraft to extend its range had been discontinued in October 1943. Hope rested on an improved version of H2S to solve the problem of target marking on a cloud-covered large city.

H2S MK.III was available for the Battle of Berlin but only in numbers sufficient to partially fit a portion of the P.F.F. Unfortunately the aid, on which high hopes rested for better target definition, had been rushed into service. This meant inadequate training for the set operators and high levels of equipment unserviceability on operations. In

144 Messenger, op.cit., p.142

145 Panter, op.cit., Vol.5, p.122
November 1943 the P.F.F. Monthly Summary remarked that 'The navigators who have been lucky enough to fly with that rare thing, a serviceable Mark 3, like it very much ... [but] ... the Mark 3 is too often the cause of "early return"'. In March 1944 the P.F.F. were still experiencing a failure of the H/S MK.III equipment on every 3.7 sorties flown. Human failings were of considerable concern, and while 'Radar unserviceability in general for March was below expectations ... nearly 50% were not traceable to any technical fault in the equipment.'

By this time also it was known that suitably equipped German night fighters could home onto bombers that were using their H/S equipment. Luftwaffe tactics had forced Bomber Command to attempt even greater concentration of their force in any attack but the use of H/S and route markers plus the dropping of Window were positional 'give-aways' enabling the movements of the bomber stream to be closely monitored. Radar, and the 'running commentary' provided by the German controllers, enabled the German fighters to overcome the darkness and locate many of the vulnerable bombers.

Berlin provided a difficult target for the P.F.F. but it is clear that the problems to be overcome were grossly underestimated. Attacks on the city required deep penetrations of German air space which gave their air defences the time to organise their forces. Increasingly the Luftwaffe, after their experiences at Hamburg with Window, turned to free night fighting. German fighter controllers attempted to assess the target that would be attacked and to position their fighters to intercept the bomber stream as early as possible and continue their efforts as long as they had fuel and ammunition.

In an attempt to divert the German fighter forces another radio counter-measure was introduced in October 1943. Code-named Corona, German speakers at a radio station in Kent would issue fake instructions on the Luftwaffe fighter frequency. Exchanges between the controllers in Germany and those in England became heated at times as each tried to convince the pilots as to the authenticity of their orders. Music was even tried by the Germans with different tunes indicating various instructions to Wilde Sau night fighters.

146 AIR 25/156, P.F.F. Monthly Summary, November 1943, p.17

147 AIR 25/156, P.F.F. Monthly Summary, March 1944, p.14

148 Ibid., pp.14-5
Bomber Command also made greater efforts to concentrate the bomber stream and reduce the duration of a particular raid. This was not always successful because of the flying conditions experienced in European winters which caused forecasts and navigational timings often to be wildly astray.

A further effort to reduce the bomber casualties was made by refining the feints and spoof operations mounted by Bomber Command. Small formations, and even single aircraft, were employed dropping Window in an attempt to mislead the German controllers as to where the main attack would fall. These operations became increasingly complicated as the war progressed until they reached a point where so much effort was employed on spoofing and diversions that the main assaults had to be reduced in strength. On 23 July 1944 while 600 bombers attacked Kiel another 100 Halifaxes and Lancasters were raiding oil storage facilities near St. Nazairs; flying bomb sites received the attentions of 102 Halifaxes; 27 Mosquitoes went to Berlin each with a 4,000 pound bomb; five Oboe equipped Mosquitoes attacked Duren and eight aircraft were 'gardening' near both Brest and Kiel. Additionally, 180 crews made a diversionary sweep as if on the way to a German target while other O.T.U. crews dropped leaflets over France. Finally, 36 aircraft of various types were airborne operating a variety of electronic counter measures.\(^{1+1}\)

Not all these measures were available during the Battle of Berlin and the shortage of Mosquitoes at this period was particularly noticeable. This extremely versatile aircraft did not require to be part of a bomber stream in order to receive a measure of protection. Its performance - high speed at high altitude - meant losses were few. Although the value of the Mosquito at this period of the war bore no relationship to the number available, additions to the front line strength were very slow. The average number of Mosquitoes available in November 1943 was 50 but this figure had only increased to 58 by March 1944.\(^{1+0}\)

Perhaps at this stage it is relevant to discuss the standard evasive action employed by many crews during their operations with Bomber Command. 'Many' is used deliberately because some crews, often called 'George into the target boys',\(^{1+1}\) saw no advantage in punctuating their flight with violent, energy sapping maneuvres, without apparent justification. Evasive action required that the bomber

\(^{1+9}\) Middlebrook & Everitt, *op.cit.*, pp.548/9

\(^{1+0}\) Webster & Frankland, *op.cit.*, Vol.2, p.201

\(^{1+1}\) Tape recording by John Searby, Peenemünde. In Author's possession.
Comparative Tactics during the Battle of Berlin

23/24 August 1943
- R.A.F. losses
- Luftwaffe losses

changed its altitude by either climbing or descending combined with a definite turn. Slight evasive action was the recommended procedure for avoiding Flak. Should a bomber be 'coned' by searchlights or come under attack by fighters then of course immediate and violent evasive action was essential. Rapid climbs or descents combined with major turns when in the bomber stream increased the changes of collision so crews were warned to be particularly alert. However, when an aircraft was picked out by a 'master' searchlight and other searchlights joined, visibility outside the bomber was reduced to nil so crews reacted and hoped. Evasive action complicated the plotting problem for the navigator because he was responsible for keeping an air plot record of the headings being flown by his aircraft and the true air speed being maintained. Evasive action also delayed the aircraft's arrival at its target. When slight evasive action was maintained for 30 minutes then it was necessary to add one minute to the estimated time of arrival (E.T.A.) at the next turning point or target. However, when heavy evasive action was required for 30 minutes then it was necessary to add twelve minutes to the E.T.A.\textsuperscript{153} Evasive action offered one way of attempting to avoid disaster but, as John Searby said, there was 'no formula for survival in a bomber at night save constant vigilance'.\textsuperscript{153}

The optimism expressed by Harris as to the possible outcome of the Battle of Berlin was not well founded. Up to the time when the preliminary raids of the Battle of Berlin were launched no new significant tactical or technical advances had been made to bolster either the confidence of the bomber crews or their commander. Optimism was however not an unknown quantity in the R.A.F. It had been expressed in 1938 when the Air Staff claimed that 144 Whitleys 'could bring German war-making capability to a standstill'.\textsuperscript{154} And surely some of the optimism expressed by Portal in 1941 and 1942 were but reverberations of the pre-war theory of the 'knock-out' blow? The provision of Gee in 1942, Oboe in the Battle of the Ruhr a year later and then Window, H₂S, and the special geographic situation of Hamburg in July/August 1943, were not reflected for the opening of the Battle of Berlin. Admittedly Bomber Command was now able to deploy an increasing number of

\textsuperscript{152} Path Finder Force Instructions, \textit{op.cit.}, p.18

\textsuperscript{153} Tape recording by John Searby, \textit{The Ruhr}. In Author's possession.

Lancasters but Stirlings and Halifaxes with inferior performance still made up some of the numbers in the front-line squadrons in the early raids. Additionally, the increased all-up-weight of 65,000 pounds announced for the Lancaster in November 1943— which meant carrying a greater bomb load - not only reduced the aircraft’s performance but also lowered the confidence of many of the crews.

Because of the distances involved - 1,200 miles round trip - and the need for operations to be conducted in darkness, Berlin, in late 1943 and early 1944, was a target that could only be attacked in winter. That meant flying in conditions that were physically demanding and psychologically damaging. Low temperatures, which contributed significantly to reduce performance, and cloud, which could be both an enemy and an ally, provided the main meteorological hazards. Cloud, in winter, meant icing which could destroy an aircraft either by cancelling lift or causing engine failures should penetration be attempted. To avoid cloud was to risk leaving the bomber stream and thus render aircraft and crews vulnerable to Flak or German fighters. Efforts to fly beneath the cloud merely increased the risk from radar - predicted light Flak. Finally, there was always the hazard of weather conditions on return to base. Operations were normally only conducted when the meteorological forecasters were able to affirm that flying conditions at base or a suitable and reachable diversion on the return would permit safe landings. Unfortunately the forecasters were not always correct in their assessment of a particular meteorological situation. On 16/17 December 1943 97 crews from the P.F.F. were involved in an operation against Berlin. Six aircraft were lost on the raid, which was a high enough casualty rate, but with conditions deteriorating back at the bomber bases worse was to follow. No less than ten P.F.F. aircraft crashed attempting to land (with 53 crew killed) while another two were abandoned in the air by their crews. The highest losses for this night on the P.F.F. were suffered by 97 Squadron which lost one aircraft on operations, five in crashes in the United Kingdom plus two others from which the crews parachuted to safety. The problem on that particular night was extremely low cloud.

FIDO (Fog Investigation and Dispersal Operation) was available by December 1943 at selected airfields but it had no effect on the very low and heavy cloud. The system of oil burners alongside the runway and the approaches was developed during 1943 at a time when the frequency of crashes in fog was

156 Musgrove, Pathfinder Force, p.94
157 Middlebrook. The Berlin Raids, p.184
becoming a matter of considerable concern to the R.A.F. Prior to 1939 it was realised that there were only two ways of dealing with the problem of landing an aircraft in fog. Either the airspace around the aerodrome had to be cleared or, electronic guidance had to be developed which would make it unnecessary for the pilot to see the ground during landing. Most attention, up to 1942, had been focused on the latter alternative but even then no instrumentation was available capable of providing precise guidance to the touch-down point in conditions of thick fog. Much, therefore, had to be done in a short time in order that runways, clear of fog, could be provided for stressed aircrew returning from operations over Germany. Churchill, again, was a prime mover. On 26 September 1942 he wrote that 'It is of great importance to find means to disperse fog at aerodromes so that aircraft can land safely. Let full experiments to this end be put in hand by the Petroleum Warfare Department with all expedition. They should be given every support.'

Four methods offered possible solutions; mechanical, by providing air currents; electrical, by high voltage discharges and either chemically or thermally. Only the latter two were considered seriously. The chemical solution using calcium chloride to remove the water vapour present in the atmosphere to the point where the remaining water vapour could be retained without super saturation (i.e. fog), was abandoned early. Thermal removal of fog, by heating the air and moisture until evaporation of the fog droplets occurred, was accepted as offering the best prospects for success. Thermal removal required the application of heat to the atmosphere from a line source at the edges of the area to be cleared. In the case of an aerodrome the pilot had to be able to see his touch down point at the beginning of the runway. This required the clearance, or lifting of the fog, on the approaches. For the trial installation at Graveley (a P.P.F. aerodrome) it was decided to fit burners at the edge of a rectangle measuring 150 yards wide (50 yards beyond both edges of the runway) by 1,000 yards long. The 1,000 yard length covered the last 500 yards of the approach and the first 500 yards of the runway. The burner system in this rectangle was designed to lift the base of the fog to 100 feet.

The first trial landing using FIDO was made by Bennett on 18 February 1943. Although the visibility was much reduced for this test the conditions were not foggy. On 17 July 1943 Bennett, again, landed in a fog where the actual fog visibility of 100-200 yards had been increased to 1,300 yards by the use of FIDO. The first operational landings using the equipment were made on 19 November 1943. FIDO was later fitted on other airfields, its length along the runway extended and it was used for take offs as well as landings.

Much needed relief for the hard pressed Allied forces at the Battle of the Bulge in December 1944 and January 1945 was only possible because FIDO was available for both take offs and landings. FIDO was very expensive to run but as well as making take offs and landings possible it provided another benefit. The pall of smoke which filtered through the fog when fuel was being burned for FIDO made it very easy for crews, flying in the clear above, to locate the aerodrome position. Leaking valves also provided invaluable fuel for private motor cars. By May 1945 about 2,500 operational landings had been completed using FIDO.

During the Battle of Berlin which commenced on 18/19 November 1943 and ended on 24/25 March 1944 there were 16 major raids on the German capital. In total, 9,161 R.A.F. bombers were launched against Berlin in these attacks of which 7,913 dropped 29,798 tons of bombs. Losses averaged 5.5 per cent or a total of 500 aircraft. These figures indicate that much was asked of the P.F.F. and Bomber Command during this period but in fact it was only half the picture. The Battle of Berlin was but one facet of the on-going strategic bombing offensive. During the same time span another 11,240 sorties were flown by the bomber force for the loss of a further 565 bombers.\textsuperscript{189} It is not proposed to deal with each of the raids on Berlin in detail but rather to cite examples to illustrate a particular point regarding the difficulties faced by the P.F.P.

Weather, as always, proved to be a major enemy during the winter of 1943/44 particularly in attacks launched against an inland, long-range target such as Berlin. Only on rare occasions was the city seen by crews so that target marking by the P.F.P. was, all too frequently, a compromise - the best that could be done under the circumstances.

For the raid on Berlin on 29/30 December 1943 the planned tactic was the Berlin Method - mixed Wanganui and Parramatta - with both sky and ground markers being dropped. At Zero Hour minus two minutes (Zero -2) fifteen primary Blind Markers, using their \( \text{H}_{58} \)S, were to mark a release point with flares emitting red and green stars and the aiming point with red T.Is. Three Lancasters fitted with the new \( \text{H}_{58} \)S MK.III and nineteen other Blind Markers were to maintain the primary marking from Zero Hour to Zero +18 with green T.Is and Wanganui flares. Twenty Backers-up were to aim their green T.Is at the centre of the reds, if visible, otherwise at the centre of the green T.Is with a 2 second overshoot. If the Backers-up could see no T.Is, either red or green, they were briefed not to drop their own greens but to release their bombs using either \( \text{H}_{58} \)S or by aiming at the centre of the Wanganui flare pattern. From Zero -2 to Zero +18 forty

\textsuperscript{189} Figures derived from Middlebrook & Everitt, \textit{Bomber Command War Diaries}, pp.446-488
The Operational Squadrons of Bomber Command—30 March 1944

- Airfields
- Mosquito Squadron
- Heavy bomber Squadron
- Bomber Command H.Q.
- Group H.Q.

1. Middlebrook
2. Croft
3. Leeming
4. Skipton
5. York
6. Thirsk
7. York
8. Kilvington
9. Oakham
10. Alford
11. Louth
12. Boston
13. Grimsby
14. Hull
15. Doncaster
16. Manchester
17. Liverpool
18. Chester
19. Blackburn
20. Manchester
21. Woodhall Spa
22. Waddington
23. Melton Mowbray
24. Bedford
25. Aldershot
26. Amersham
27. Stevenage
28. Watford
29. Hemel Hempstead
30. Welwyn
31. St Albans
32. Hertford
33. London

H.Q. BOMBER COMMAND

London

Martin Middlebrook, The Nuremberg Raid

Supporters, flying on a heading of 035°, were to bomb using the same technique - aiming at the green T.Is if visible, otherwise aiming at the sky marker flares.\(^{160}\)

With target marking plans of such complexity (the norm for Berlin) it was essential that all crews were comprehensively briefed. Therefore it is surprising to read reminders to crews in the P.F.P. of the necessity of being fully aware of the target marking methods and colours that could be anticipated on any particular raid. The P.F.P. Monthly Summary for November 1943 said that 'It has been noticed that some crews are still not too sure as to what Methods of Marking the target they are expected to see. This must be fully explained at Briefings so that Bomb Aimers thoroughly understand what colour T.Is or sky marking flares are being used'.\(^{161}\)

Admittedly this reminder to crews was given prior to the December attack detailed above but it must be remembered that this was a briefing for qualified and experienced crews who should not have required prompting. Further admonitions on the necessity for cross-checks on navigation, accurate track keeping and ETA, and care in manipulation of the H.S. were given in December. In January 1944 navigators of the P.F.P. were again reminded of the need for 'timing and precision'. Strong defences, bad weather, and heavy casualties among P.F.P. crews no doubt all contributed to reduced performances.

In the navigation section of this work it was pointed out that the determination of the wind velocity was a primary requirement for an aircraft navigator. Cockpit instrumentation - compass, air speed indicator, altimeter and outside air temperature gauge - enabled the navigator to determine the aircraft heading and true air speed. Once the actual position of the aircraft was known, either by visual, astronomical, radio or radar means, then it was possible to calculate the wind velocity that had been affecting the aircraft. Meteorological forecasts were a guide, an educated guess, at expected wind and weather conditions. The navigator was the man on the spot and it was his responsibility to determine the actual wind affecting his aircraft. In the Summary for November 1943 it was pointed out to Pathfinder crews that marking for the attack on Berlin on 26/27 November had been 'a shambles. This result has once more been placed at the met. man's door whereas it should really have been the navigators. The met. forecast is purely an indication of what is expected - the navigator is put in the aircraft to find out what the true conditions are'.\(^ {162}\)

\(^{160}\) Panter, *op. cit.*, Vol.5, p.123


\(^{162}\) Ibid., p.6
Nothing would appear to have changed when Berlin was again the target on 2/3 December 1943. The forecast wind for that raid was 270/20 (from the west at 20 m.p.h.) but in fact that actual wind was 340/50. The P.F.F. Summary admitted that this raid went 'sadly astray to the South, mainly due to a large wind change ... Everyone was blown well South of track, some immediately got back on to track, the majority carried on not believing what data they had'.

The final raid on Berlin, on 24/25 March 1944, became known among Bomber Command aircrew as the 'Night of the Big Winds'. Forecast winds had been 340/20, gradually veering to 358/44 as the Danish coast was approached. Further increases in wind speed were forecast as the bombers continued eastward on their outbound track to Berlin. Determination of the wind direction was not a problem on this raid. However, most navigators found it difficult to accept that they were experiencing winds in excess of 100 miles per hour and even harder to convince their captains. Crews involved in wind finding for the Main Force, Zephyrs, scaled their winds down before transmitting the figures to their Group H.Q. Staff at Group H.Q. probably did the same before the average winds were passed on to Bomber Command. Thus crews received so-called actual winds considerably lower in speed than what they were actually experiencing. As a result the bomber stream was never concentrated and most aircraft flew tracks well to the south of the planned route on a frontage of at least 70 miles on the approach to Berlin.

Those crews prepared to acknowledge that they had flown past Berlin, but still wished to bomb the city, turned back towards the north. With head winds of over a 100 m.p.h. it took one crew 20 minutes to cross the heavily defended area and into what remained of the bomber stream - a highly fraught manoeuvre.

'Zephyrs' did not always solve the problem of wind finding for navigators because frequently the number of useable winds received at Bomber Command were far below the number expected. On the disastrous raid on Nuremberg on 30/31 March 1944 only 28 per cent of the expected Zephyrs were received. The spread of these winds averaged 33 m.p.h. and 40 degrees.

According to the standards defined by Harris that Berlin could be wrecked and that its destruction would cost Germany the war, the Official History considered that 'the Battle of

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163 AIR 25/156, P.F.F. Monthly Summary, November 1943, p.6

164 Ibid., December 1943, p.6

165 Ibid., March 1944, p.6, and Middlebrook, The Nuremberg Raid, p.127
Berlin had been a failure ... Moreover, in the operational sense ... It was a defeat ... measures of evasion and deception had ... [not] ... been able to prevent ... the mastery of the night fighter over the night bomber'\textsuperscript{166} Harris, for his part, would only admit that 'by the standards of our attacks on Hamburg, the Battle of Berlin did not appear to be an overwhelming success'.\textsuperscript{167} Bennett, as head of the P.F.F., took the extreme view that in the Battle of Berlin 'Bomber Command achieved a very great victory, and achieved it by sheer hard fighting in bad weather, and against the strongest defences which the enemy could muster'.\textsuperscript{168}

Where then does the truth lie regarding the Battle of Berlin? Harris, in his post-war Despatch, called the period which included the Battle of Berlin, the 'Main Offensive'. In reality it was the test of the capacity of Bomber Command to deliver the 'knock-out' blow which had featured so prominently, up to 1938, in airpower discussions. How much support was there for Harris's claim that Berlin could be wrecked from end to end? Was he believed when, in a letter to Portal on 7 December 1943, he argued that 'the Lancaster force alone should be sufficient but only just sufficient, to produce in Germany by April 1st 1944, a state of devastation in which surrender is inevitable'?\textsuperscript{169}

Churchill had always wavered over his support for the strategic bombing offensive. The Combined Chiefs of Staff were in no doubt that land offensives in Europe would be necessary to achieve final victory - their only arguments were how, where and when. The Casablanca Conference in January 1943 had identified strategic bombing not as a war-winning offensive but simply as part of the necessary softening-up process prior to a land campaign by Allied forces. Portal in Casablanca admitted that 'air bombardment, though essential on a heavy scale' would not be sufficient in itself'.\textsuperscript{170}

Was, in fact, a victory possible in the Battle of Berlin that would have brought about the surrender of Germany? Middlebrook believed the answer hinged on one condition. He argued that the Main Force bombers had shown by their results in the Ruhr with Oboe and again at Hamburg with Harris that they had the capacity to destroy Berlin. Their success, he believed, depended on the P.F.F. being able to 'place their

\textsuperscript{166} Webster & Frankland, \textit{op.cit.}, Vol.2, p.193

\textsuperscript{167} Harris, \textit{Bomber Offensive}, p.187

\textsuperscript{168} Bennett, \textit{Pathfinder}, p.175

\textsuperscript{169} Webster & Frankland, \textit{op.cit.}, Vol.2, p.56

\textsuperscript{170} Richards, \textit{op.cit.}, p.258
Accurate marking in the Battle of Berlin depended almost entirely on the equipment, skills, and experience of the H\textsubscript{2}S operators in the P.F.F. In the sixteen major raids on Berlin between November 1943 and March 1944 the city was only sighted visually on two occasions. Although T.Is were dropped in the hope that perhaps they may be visible through the cloud, in reality the only useable marking was provided by lightweight, parachute sky-markers. Unfortunately, even in the best conditions, sky markers were the least satisfactory technique employed by the P.F.F. to attempt to bring about concentrated bombing. With cloud tops often at 18,000 feet and frequent strong winds, sky markers either rapidly disappeared in cloud or were equally rapidly displaced from the marked aiming point. With timings of the P.F.F. and the Main Force sometimes astray due to weather or enemy action, gaps appeared in the marking which reduced the chances of achieving reasonable bombing concentration.

Was the performance of H\textsubscript{2}S a significant element in the failure to 'wreck Berlin' in the Winter of 1943/44? To examine this question it is necessary to go back to mid-August 1943. At this time H\textsubscript{2}S Mark.II was being fitted in some aircraft of the Main Force squadrons. Although H\textsubscript{2}S was considered a blind bombing device as well as a navigational aid, at Bennett's insistence, Main Force crews were required to aim at P.F.F. markers rather than bomb on their individual H\textsubscript{2}S indications. There were no exceptions to this ruling. Even small targets hidden beneath ten tenths cloud were only to be bombed by Main Force crews aiming at P.F.F. sky markers. At least that was the theory and those were the orders issued. In reality, and under the stress of combat, too many Main Force crews were content to aim at transient evidence of ground fires. On too many occasions they were German decoys.

As a bombing device H\textsubscript{2}S had shown its worth at Hamburg but in particular circumstances. Hamburg offered an identifiable target near the main coast-line and was situated on a broad river. Against inland targets H\textsubscript{2}S had proved to be much less accurate. Small, isolated towns provided reasonable targets but the definition of specific built-up areas within an industrial complex had been poor. Large cities, although readily identified, provided even greater difficulties for the H\textsubscript{2}S operator because of the difficulty of identifying the specific aiming point. Even parks, lakes or forests within the built-up area were submerged by returns from buildings so that the P.P.I. was a mass of overlapping bright responses.

171 Middlebrook, The Berlin Raids, p.4
During August and September 1943 three attacks were carried out on Berlin to attempt to find a satisfactory technique for the use of H₂S against the city. On the first two raids the P.P.F. Marker crews attempted to fix their position using H₂S and then fly a short distance to what they believed would provide a prominent feature on their P.P.I.s. The city promontory selected was a built up area on the northern outskirts projecting outwards in the shape of a hook. What these raids showed was that the H₂S MK.II equipment then fitted in the P.P.F. aircraft was unsuited for either marking or area attacks on the 'Big-City'. Another lesson learned was that the P.P.I presentation depended very largely on the direction of approach of the bomber aircraft. Slight directional variations radically transformed radar presentations. If H₂S was going to be of significant value higher degrees of discrimination were essential.

This, it was hoped, would be provided by the new H₂S, 3-centimetre radar (which the R.A.F. called H₂S Mark III) that was being hastily readied for operations in the no-moon, 1943/44 winter bombing season. After the three raids on Berlin in August and September 1943 Harris ordered a cessation until the new equipment became available. By 18/19 November 1943 six Lancasters of the P.P.F. had been fitted with H₂S Mark III and two of these aircraft took part in the raid on Berlin on the same date. Operators were lavish in their praise of the new H₂S equipment but it must be remembered that they were hand-picked, very experienced specialists. The new equipment had also been sought by Coastal Command for use in their anti-U-boat campaign but the Air Staff was given priority for H₂S Mark III to be provided for the P.P.F. Crash fitment programmes however rarely proceed smoothly and H₂S Mark III was no exception. Many of the units constructed were declared as being below an acceptable standard while others suffered from a low power output. Despite the priority, by 12 February 1944, only 35 Lancasters of the P.P.F. had received the new equipment and several of these had already been lost on operations together with their experienced crews.

However, these figures in isolation do not provide an accurate guide as to the availability of the new marking aid during the Battle of Berlin. Equipment serviceability was a major problem as evidenced in the P.P.F. Monthly Summaries during the Battle. In March 1944 it was stated that 'Radar serviceability in general ... was below expectations and, with few exceptions, Squadrons have reason to take a new hold on the old problems'.

172 Berlin
173 Air Ministry, Signals Vol.3 Aircraft Radio, p.78
174 AIR 25/156, P.P.F. Monthly Summary, March 1944, p.14
Berlin, 23/24 August 1943

- Planned bomber route
- Actual route of most bombers
- Shot-down R.A.F. bombers
- Shot-down German fighters

The 'hook' of the city boundary to be used by Pathfinder Blind Markers

Main bombing area

Unserviceability of the limited number of aircraft fitted with H₂S Mark III was an extra problem during the Battle of Berlin. Actual losses during the Battle were very heavy but in addition there were those aircraft that returned damaged either by Flak or the attentions of cannon-equipped German fighters. Still others were damaged in landing or other forms of pure aircraft accidents.

Another contributory factor to the failure 'to wreck Berlin' was the heavy casualties among P.F.F. crews. Statistics provided by the P.F.F. Monthly Summaries from November 1943 to March 1944 reveal that the original P.F.F. Squadrons 7, 35, 83, 156 and 109 lost, respectively, 36, 24, 19, 42 and 3 aircraft and crews during the period of the Battle. These figures do not include aircraft and crews lost in crashes in the United Kingdom. These are startling statistics because they meant, in effect, that in five months squadrons could have had a complete change of personnel. Of course some crews survived this tragic period but it is obvious that extensive operational experience was becoming a commodity in desperately short supply. Such losses required that during the Battle of Berlin the P.F.F. had to recruit and train to marking standard no less than 50 completely new crews each and every month.

If Bennett could complain, in September 1943, of the need for nothing but the best for the P.F.F. than the problem by March 1944 had become acute because his complaints had not been addressed. The P.F.F. had commenced the Battle of Berlin with a comparatively low level of recent operational experience and heavy losses meant a further reduction. There were some very experienced and capable H₂S operators in the P.F.F. who survived the Battle of Berlin but they were never available in sufficient numbers to turn the tide despite their best efforts.

A casualty rate of 5 per cent meant that the average crew could expect to survive for 20 operations. In January 1944 7 Squadron's operational losses were 6.3 per cent, 83 Squadron 11.3 per cent and 156 Squadron 11.2 per cent.¹⁷⁵ No wonder there was some reluctance shown by crews to volunteer for extended P.F.F. tours.

Bennett, in later correspondence with the Air Ministry concerning the Battle of Berlin, admitted a reduction in enthusiasm by both Pathfinder and Main Force crews at that time. For some, the requirement to be expected to press on in difficult weather conditions night after night, against long range strongly defended targets, suffering heavy losses for no measurable success, became too much. Discussing Main Force efforts he considered that 'a very large number of crews failed to carry out their attacks during the Battle of Berlin in their customary determined manner ... the amount of bombing on the markers ... was negligible ... many bombs were wasted

¹⁷⁵ AIR 25/156, P.F.F. Monthly Summary, January 1944, p.4
en route in an effort to increase aircraft performance ... Great damage was undoubtedly done in Berlin', Bennett admitted, 'but, the effect of each individual raid decreased as time went on'.

This last statement requires further consideration because in the Battle of Berlin it was a pertinent element. Attacks on Berlin suffered from the law of diminishing returns. That is, after a certain amount of bomb damage has been created in a city the amount of new damage in subsequent raids is reduced unless the weight of attack is considerably increased. If 50 per cent of a city could be destroyed in a raid then on the next raid it must be anticipated that there would be a 50 per cent wastage of effort even when the same weight of bombs again hit the target. The wastage of effort bears a direct relationship to the amount of damage already created. The problem with the area bombing of Berlin was that until the Spring of 1944 there was practically no evidence either of the damage created or the main areas affected. Bombing photographs taken during the Battle usually showed only cloud. There was also the fact that the Battle of Berlin was an extended campaign and not compressed as in the case of Hamburg. This gave the German authorities time to effect repairs or provide clear areas to act as fire breaks. As the number of raids on Berlin increased so did the requirement for improved bombing accuracy. This was not possible in the Battle of Berlin.

Harris embarked on his area bombing programme on the assumption that the destruction of German cities would not only significantly reduce war production but would also lower the morale of the populace to a point where the German Government would be unable to resist their insistence on surrender. He also assumed that Bomber Command was capable of the expansion necessary to create the desired destruction. The Battle of Berlin was fought by Bomber Command with these assumptions by Harris still very much to the fore.

Both assumptions were in error. The Report issued by the British Bombing Survey Unit suggested that the British perhaps fell greater victims to Nazi propaganda than the Germans themselves. It said that 'However totalitarian may have been the political and military aspects of German life, the fact is that the German war economy and the organisation of production in Germany, were less totalitarian than either their British or American counterparts ... Almost to the end ... German war production still possessed great reserves of capacity'. On the subject of morale, the Report continued, 'we were equally wrong in our beliefs in the frailty of the German civilian in the face of air attack'.

176 Webster & Frankland, op.cit., Vol.2, p.196

177 Air Ministry, Report of the British Bombing Survey Unit, pp.67-8
The Battle of Berlin, under the terms espoused by Harris and given the equipment and the numbers of bombers available in 1943/44, was a battle that could not have been won. A bomber force quadrupled in size, or the possession of an atomic bomb, may have sufficed, but at the time neither was available. But then neither was it a battle that was lost. Tremendous damage was created in Berlin by British bombers that winter although, strangely, the United States Strategic Bombing Survey, conducted minutely after the war on many German cities, is noticeably reticent on the subject of damage in that particular city.

Win, lose, or draw, the Battle of Berlin had to be terminated in the early Spring of 1944 because the hours of darkness were reducing and long range attacks could not be considered without its protection. There was also the requirement to initiate the strategic offensive that was a prerequisite to Operation 'Overlord' the forthcoming invasion of mainland Europe.

Morale may have sagged in Bomber Command during the Battle but the crews continued to 'press on regardless'. There is the story of one squadron commander, a popular figure with a light touch and little regard for the rules. At the height of the Battle he faced up to the fact that no crew on his squadron had ever finished a tour of duty. Casualties were too heavy. At briefing for the 'Big-City' his young officers and N.C.O.s sat facing the dais, faces dead-pan and resigned, as he wound up the briefing.

Something more than the customary good wishes for their safety was needed. He thought about it and he got it right. This is what he said:

'There is a story going round this squadron that no one ever finishes a tour. Is that so?'

A stony silence. Then a growl from the back of the room, 'Too bloody right they don't!'

He knew the voice. 'Flight-Sergeant Brown, how many sorties have you done?'

'Twenty-eight, Sir.'

'Right. You're finished. You can fall out, take your crew and go on leave. It's time somebody finished a tour and you're the lucky one.'

The spell was broken. The fortunate Brown, grinning broadly, stuck this thumb up and left with his men.'

178 Tape recording by John Searby, Berlin. In Author's possession.
Immediately after the Battle of Berlin the P.F.P. suffered a severe blow not merely to its pride but more importantly to its operational efficiency. On 15 April 1944 Harris ordered the transfer of No.627 Mosquito Squadron on 'temporary detachment' to 5 Group. Worse was to follow. On 18 April 1944 Nos. 83 and 97 Lancaster Squadrons were also removed from No.8 P.F.F. Group and returned, on the same conditions, to 5 Group. There are many who would argue that the transfers indicated not only a loss of faith in the P.F.F. by Harris but also severely disadvantaged Bomber Command in the long term. Bennett, as usual, was very forthright in his condemnation of the undermining of his Force. He attributed the transfers to spite on Harris's part.

Bennett's assessment was that the three squadrons had been transferred because he had refused to employ low flying Mosquitoes for aiming point location and marking in the Battle of Berlin. Cochrane, again, had convinced Harris that the tactic offered possibilities. Bennett argued that at high speed, low level, over a densely built-up heavily defended area at night, the method was not practicable. In the case of Berlin, even if T.Is could be accurately placed, they would rarely be visible through the persistent cloud cover. Bennett claimed that he thought 'that the method was excellent for other than densely built-up areas, but not for Berlin'.

Within thirty minutes of his rejection of the Cochrane/Harris plan Bennett was summoned to report directly to the C-in-C Bomber Command. Bennett wrote that he was 'received with a frigid and formal notification that I was immediately to send 83 and 97 Squadrons (Lancasters) back to their parent group, 5 Group, together with one Mosquito Squadron, and that in future 5 Group would adopt the method which I had refused to accept - namely the low-level marking method - and would then mark a large number of their own targets themselves'.

These transfers reduced the available Lancaster strength, which had grown to seven squadrons in March 1944 and then eight squadrons in April 1944, back to only six squadrons. This was a 25 per cent reduction at a time when increased demands were being made on the Force. Furthermore, 8 Group were still expected to provide the equipment for the squadrons on detachment as well as continue to train their replacement crews in Pathfinder techniques. Despite the problems the transferred squadrons retained a considerable measure of loyalty to 8 Group. When they arrived at their new station 97 Squadron crews were given a stern lecture by the Station Commander. They were told to forget about their former methods because now they would be required to employ those.

179 Bennett, op.cit., p.176

180 Ibid., p.176
devised by 5 Group. 'We are fighting the Germans, Sir', a voice called out, 'not 5 Group'.\(^{181}\)

Some viewed the transfer of three P.F.F. Squadrons to 5 Group as indicative of a step toward Group individuality. Until Higher Command had decided otherwise in August 1942 this had been Harris's original intention. With the transfer it became clear that marking would not be the sole prerogative of the P.F.F. Individual Groups would employ their own Pathfinders. The transfer marked a major step backwards, to the pre-P.F.F. era, and suggested the possibility of the exercise of greater restraints over the marker force. One writer stated that it was Harris's intention to use 5 Group, under Cochrane, as a 'separate force against targets in Germany in conjunction with Main Force attacks'.\(^{182}\)

Although the detached squadrons retained their P.F.F. status and were still required to complete Pathfinder tours, operationally and administratively they were under the control of 5 Group. This particular Group was selected by Harris for what he considered would be a 'thoroughly sound' experiment\(^{183}\) for two specific reasons. It was the largest operational Group and therefore capable of providing two effective bomber forces for combined attacks when necessary. It had also had recent experience of marking and bombing precision targets in France. Perhaps there was another more subtle reason. Harris had been Cochrane's commanding officer in Mesopotamia in 1922 and he regarded him as a 'most brilliant, enthusiastic, and hard working leader of men'.\(^{184}\) Cochrane agreed with Harris that each Individual Group should have its own target marking force. Harris claimed the move was a trial and 'even if it failed the Pathfinder squadrons could revert to No.8 Group within 48 hours'.\(^{185}\)

As a result of the transfer of P.F.F. Squadrons to 5 Group Harris could justifiably have claimed to have at least partially overturned the decision thrust upon him of having to form a corps d'élite. He was at last getting what he had long sought. Did he consider the views he had originally held as being vindicated? In the Despatch he is unequivocal. He

\(^{181}\) Jackson, *op.cit.*, p.88

\(^{182}\) G.R.M. Hartcup, *The R.A.F. in the Bombing Offensive against Germany* (London: Air Ministry, undated), Vol.6, p.34

\(^{183}\) Ibid., p.34

\(^{184}\) Harris, *Bomber Offensive*, p.158

\(^{185}\) Hartcup, *op.cit.*, p.34
wrote, 'In the outcome the Pathfinder Force, although it did the most excellent work, nevertheless displayed all the handicaps and shortcomings which I had anticipated ... while in the latter part of the war my contention that each Group should find and maintain its own Pathfinding Force was proved infinitely the superior method when tried out in No.5 Group'.

Harris delivered a somewhat kinder valedictory to the P.F.F. in his book written two years after the Despatch. With longer hindsight he wrote of the advantages that Bomber Command had gained by having 5 Group and 1 Group develop marking techniques 'suitable for a variety of targets or conditions of weather. But I do not mean in any way to suggest that the Pathfinder Force, as the force which was mainly responsible for identifying the target, had in any way been superseded or lost its commanding position; on the contrary, I continued to entrust the Pathfinder Force with the identification of the target in nearly all our principal attacks until the end of the war, and ... the force did brilliant work and continually improved its tactics'.

Cochrane and Bennett were mutually antipathetic. While Bennett criticised Cochrane for his lack of operational experience, many believe Cochrane opposed Bennett simply because he did not want to be seen to be in agreement with a person he regarded as a 'young upstart'. In an interview in 1983 Harris was remarkably revealing in his response to Bennett's claim that Harris regularly supported Cochrane no matter the strengths of other's arguments. Bennett had claimed that 'Cochran [sic]' could do anything, and the C.-in-C. would always support him, any attempts to convince the C.-in-C. that Cochrane could ever be wrong were inevitably doomed to failure'.

When asked if he accepted the substance of Bennett's claim Harris responded that 'I think he ... is being a little bit fictitiously sensitive. But it is quite true that nine times out of ten I would support Cochran over anybody ... I had complete confidence in Cochran, but mind you, any difference of opinion I might have had with Don Bennett in the Cochran/Bennett time was, I think, that I knew Cochran very well and I had long experience of his abilities. Bennett was...

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186 Harris, Despatch on War Operations, p.11
187 Harris, Bomber Offensive, p.203
188 Bramson, op.cit., p.90
189 Bennett in Pathfinder and Bramson in Master Airman both consistently spelt Cochrane incorrectly
190 Bennett, op.cit., p.177
a brand new boy come up from "the wild and woollies" from Australia - and he wore an odd uniform and wasn't in the same service!\textsuperscript{191}

The subject of Bennett in his relationship with Cochrane cannot be terminated without consideration of a draft letter from Bennett's files presumably intended for Harris. It illustrated a depth of ill-feeling which surely was counter-productive to the cooperation so desperately needed if Bomber Command was to play its fullest part in the strategic bombing offensive.

Cochrane, in a letter to Headquarters Bomber Command on 5 August 1944, claimed that the technique developed by the three Pathfinder Squadrons attached to 5 Group was not 'suitable for the normal conditions encountered over Germany during autumn and winter.'\textsuperscript{192} To enable the Mosquitoes of No.627 Squadron to continue marking at low level in conditions of haze and poor visibility when visual marking using flares was not practicable, Cochrane requested that a low level, forward-looking H,S that was under development be made available to 5 Group 'at the earliest possible date'.\textsuperscript{193}

This letter was handled by Dudley Saward who was Radar Liaison Officer at Bomber Command Headquarters. He advised Bennett of the letter by telephone and then, on 8 August 1944, forwarded Bennett a copy.

Bennett was apparently incensed. His unsigned and undated draft, obviously intended for Harris, makes clear his antipathy towards a fellow Group Commander. He called for the priority accorded the P.F.F. in the introduction and development of 'items particularly applicable to its work'\textsuperscript{194} to be maintained. Bennett continued that all developmental work had been done in close agreement with the radar technical staff at Bomber Command Headquarters. Now, he said, it 'appears that the A.O.C. of 5 Group has decided that he also wishes to take part in this development ... His extensive knowledge of H,S having been acquired during the course of a single visit to T.R.E., it is not surprising that his proposals are even more-than-usually unacceptable'.\textsuperscript{195}

\textsuperscript{191} Bramson, \textit{op.cit.}, p.91

\textsuperscript{192} Letter, Cochrane to H.Q. Bomber Command, 5 August 1944, Ref. 5G/91/8 Air
(In author's possession)

\textsuperscript{193} Ibid.

\textsuperscript{194} Draft of a letter from Bennett's personal papers. In Author's possession.

\textsuperscript{195} Ibid.
Bennett then wrote of the 'territorial ambitions ' [of this] particular officer who ... is endeavouring to cause confusion in the development work of H.S [and who] has already done so much damage and it would appear is potentially liable to do in the future even more damage that I feel that there is no alternative but to approach the problem from the somewhat unusual and certainly undesirable angle of the personality concerned. Air Vice Marshal Cochrane came to this Command in 1943 and within a few months ... demonstrated adequately that he would from time to time effect the Command in some plausible but expensive way every few months'.  

According to Bennett Cochrane's insistence on training while in 3 Group had reduced their daily availability from 180 aircraft down to 40 or 50. When Cochrane moved to 5 Group he became 'aggressive' and called upon his air gunners to shoot first and identify later. This policy was only abandoned when, in a B.B.C. interview, a gunner admitted that he had shot down an aircraft without having identified it. According to Bennett Cochrane's policy, freely admitted, was 'getting what he wants by shouting the loudest'.

The attack continued. Cochrane, Bennett claimed, 'went on criticising the Path Finders and declaring that they should do low level marking until finally you [Harris] gave way and permitted him to weaken the Path Finder Force numerically and from a prestige point of view and he has since then endeavoured to apply his method. I realise 'continued Bennett, 'that the incompatibility of his particular personality and his inability to work with others made such a move desirable'. Cochrane was described as being 'wily' and exerting a 'catastrophic influence', so much so that 'chaos will result' in the attempt to develop H.S if his 'activities were permitted to interfere'.

In the conclusion to his attack on Cochrane, Bennett provided the semblance of an apology for having invoked the question of personality in his arguments. But, he wrote, I am 'firmly convinced that his activities were really disastrous towards the particular piece of our war effort which he effects. The question is ... one of principal as to whether the personal ambitions of a self-centred man are to be appeased at the expense of the rest of the Command merely because of his super Gobellian propensities'.

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196 Draft of a letter from Bennett's personal file. In Author's possession.
197 Ibid.
198 Ibid.
199 Ibid.
One of Bennett's perennial complaints was that the P.F. F. was not receiving the best men available from the various Groups. Undoubtedly he was correct. It is only necessary to consider a few names from 617 Squadron, Guy Gibson, 'Mickey' Martin, Dave Shannon, John Munro (N.Z.), 'Willie' Tait, 'Terry' Kearns (N.Z.) and Geoffrey Leonard Cheshire, to appreciate the truth of his oft-repeated assertion. Yet, it must be said, there were occasions when perhaps Bennett himself had been responsible for the rejection of candidates who should have been in the P.F.F.

Cheshire, of course, provides the classic example. Rejected by Bennett as the Commanding Officer of 35 Squadron when the P.F.F. was formed, Cheshire's application at the time of the controversy over low level marking, was also declined. Mahaddie observed that 'I have never quite understood why 'Chesh' as we called him at the time, was the only person I selected for training with the Force that my Master [Bennett] vetoed; my Master also vetoed the selection of Leonard to command No.35 Squadron in the early days of the Pathfinder Force and I was never able to establish why'.

Two stories are current over the rejection of Cheshire at the time of the low-level marking controversy. In October 1943 Cheshire was a Group Captain and Station Commander at R.A.F. Marston Moor near York but growing ever more anxious to return to operational flying. The P.F.F. appeared to offer his last hope. Bennett happened to be at Marston Moor and Cheshire approached him directly. Bennett's response was that 'he would be accepted if he could prove his flying to be of the required standard'. This, to an officer prepared to accept a step down in rank and who had already completed three operational tours. Cheshire felt rebuffed and turned to Cochrane and 5 Group and was appointed C.O. of 617 Squadron.

Another picture is painted in Cheshire's biography. There it is stated that Bennett 'knew nothing about any application from Cheshire. If I had, and if he'd been free to move, we'd have snapped him up at once'. Cheshire, of course, under Cochrane in 5 Group became the greatest exponent of low level marking in the R.A.F. and ended the war with a V.C., triple D.S.O. and D.F.C. The P.F.F. to the end of the war rejected low-level marking.

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200 Mahaddie, op.cit., p.69
201 Jackson, op.cit., p.89
Perhaps the last word on the subjects of the transfer of three squadrons from the P.F.F. to 5 Group and the quality of crews posted to the P.F.F. should be left to Mahaddie. He considered the move unnecessary as 5 Group already had the men available who were more than capable exponents of low-level marking. Mahaddie, however, considered that the technique was only suited to a lightly defended or an undefended target. He did admit one benefit from having attached a Pathfinder element to 5 Group - it put an end to inferior crews being moved from 5 Group to the P.F.F. - most of whom were returned as unsuitable. 'But' wrote Mahaddie, 'I got excellent crews from the very day that it had its own Pathfinder element. I then forgot about even interviewing crews that came from 5 Group, they were outstanding and I reflect now on why, oh why, could that not have been the normal practice on previous occasions?'

Although it has not been possible to determine the precise reason, the disagreements between Harris and the Air Ministry over the formation of the P.F.F. were again raised in April 1944. Perhaps it was related to the decision to return 83 and 97 Lancaster Squadrons to 5 Group under Cochrane. There certainly was a rapid exchange of correspondence between Harris and Portal in April 1944 which is now held with the Portal Papers at Christ Church, Oxford. The first available letter from Portal to Harris on 12 April 1944 began, 'As I promised to do yesterday, I have looked up the correspondence of April to June, 1942, about the formation of the Pathfinder Force'. It would appear that Harris had claimed that his only opposition to the formation of the P.F.F. was on the grounds that it would be premature. This claim Portal rejected bluntly. He continued that 'I cannot find anything to substantiate your contention that the only opposition in your Headquarters to the formation of the P.F.F. was that this would be premature'.

Perhaps the subject had re-arisen over who was to receive credit for the establishment of the P.F.F. and its subsequent achievements. Was it to be the Commander who had not wanted the Force on Air Ministry terms, or the Air Ministry staff who had insisted on its formation? Portal admitted that Oboe had been a prime source of much of the success but added that he saw 'no reason at all to modify my opinion as to where the credit lies for the Air Ministry share in what has been achieved'. Had Harris tried to block S.O. Bufton, now Director of Bomber Ops (D.B.Ops), from receiving any credit?

203 Mahaddie, op. cit., p.122
204 Portal Papers, File 10, 1944, Item 15, 12 April 1944
205 Ibid.
206 Ibid.
Harris replied, at length, on 14 April 1944. He expressed his concern that when discussing such matters with Portal he was 'often unable to make myself either clear or even understood'. But, he continued, 'I certainly never said or intended to infer to you that the only opposition ... to the formation of the P.F.F. as (sic) that this would be premature'.207 As near as Harris could recall in the conversation he had held with Portal immediately prior to 12 April 1944 he believed that he had made two points. Firstly, that the formation of the P.F.F. had been premature and only the use of Oboe and other aids had made it of value. Secondly, that he remained unconvinced that the establishment of the P.F.F. as a separate entity was either 'the right or the best solution. My alternative' wrote Harris, 'was then, has always been, and still is to form a Pathfinder element in each Group'. Harris continued that he had always accepted Pathfinder as being essential, and had used them in 5 Group, but he did not want 'the obvious disadvantages of a corps d'elite creaming off the entire Command for one formation'.208

Pathfinder tactics, in the same letter, became Harris's next argument. He claimed that the methods employed in April 1944 would not necessarily work in the future. If the German defences were to be overcome then it was necessary for Bomber Command to attack multiple targets and, as well, possibly use split routes. For deep penetration German targets this meant providing four lots of Pathfinders. In addition 8 Group would be expected to provide H2S leaders for mining operations as well as Oboe Pathfinders for both French and short-range German targets. 'In these circumstances' wrote Harris, 'the load on Bennett is becoming insupportable, and with Overlord it will become impossible for him or any one Commander to keep pace with ad hoc demands. Furthermore, in Bennett as an individual, we have already far too many eggs in one basket'.209

According to Harris this problem 'has for some time been my major worry. After examining it at length with my staff, with Bennett and with Cochrane,'210 he had decided to return two Lancaster squadrons and a non-Oboe Mosquito squadron, on detachment, to 5 Group, their parent. Bennett made no mention of 'lengthy examinations' of the return of squadrons to their parent Group but wrote that he received only 'frigid and formal notification'211 of the transfer.

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207 Portal Papers, File 10, 1944, Item 15a, 14 April 1944
208 Ibid.
209 Ibid.
210 Ibid.
211 Bennett, Pathfinder, p.176
Harris concluded this letter with the claim that he liked Bufton, had high regard for his 'ability and honesty of purpose' but that he could not 'stand his methods'. Harris expressed the wish to get the matter cleared up 'regardless of personalities or personal traits' but made clear that he was not prepared to make 'purely unilateral concessions amounting to Bufton running my show regardless of the opinions of my Command'.

This letter by Harris is important not only because it renewed the arguments about Bufton but also because of the enigmatic statement on Bennett by his Commanding Officer. What did Harris mean when he wrote that 'in Bennett as an individual, we have already far too many eggs in one basket'? Was Harris beginning to doubt Bennett's abilities? When Bennett was selected to lead the Pathfinders Harris had considered him eminently suitable because of his professionalism, experience and all-round knowledge. Or, had Harris chosen Bennett simply to thwart the Air Ministry? They had forced the P.F.P. on Harris and doubtless had in mind the person who was to become its leader. It certainly would not have been Bennett. Remember, Harris refused to accept the name Target Finding Force because that was Air Ministry inspired. Perhaps the selection of Bennett was to prevent some in Air Ministry from being able to claim that with regard to the Pathfinders they had been able to dominate Harris.

Surely Harris did not view Bennett as a rival? Portal, despite provocation, never gave any indication that he had considered replacing Harris. Furthermore, when Harris offered to resign, in January 1945, the suggestion was rejected gracefully by Portal. Yet, even in early 1944, there was growing concern in some high places that battle-experienced Group Captains and Air Commodores were having further promotion prevented by a plethora of aged senior officers. Many of these had been compulsorily retired before the war, were then recalled to help avoid chaos during the rapid expansion, but who then remained in the Service. One such officer aged 60 was, in 1944, appointed to a new command. An editorial in an aviation magazine cited 'a small band of senior officers holding high appointments that has for some years enjoyed a game of general post. Its members have gone from one important appointment to another and now might well make way for younger blood'.

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212 Portal Papers, File 10, 1944, Item 15a, 14 April 1944
213 Webster & Frankland, op.cit., Vol.3, p.93
This same article, as well as deploring promotion blocks, attacked the order banning senior R.A.F. officers from flying on operations. The instruction was compared, unfavourably, with the American policy which encouraged senior officers to gain personal experience. The article concluded that 'We do not favour change for the sake of change, but flying conditions on active service to-day are very different from those of the last war, or even from those of three years ago. New strategies can perhaps be devised from an armchair, or an office table ... First-hand knowledge may not be considered essential but it is highly desirable'.

Perhaps the transfer of three squadrons from the P.F.F. to 5 Group had little to do with reducing Bennett's power but rather more to Harris achieving what had always been his declared aim — a Pathfinder element in each Group. Harris knew that public opinion was very largely on his side because his Command was seen to be 'dishing it out to the Hun'. Pathfinders of course were a part of Bomber Command but they operated very much in secret and shunned publicity. Internal differences of opinion were thus of minimal public concern or knowledge. Harris was also fully conscious of the fact that he had the ear of Churchill.

With those asides concluded it is necessary to return to the April 1944 correspondence between Harris and Portal. Portal's letter, on 16 April 1944, claimed that he had only delved into past history in order to justify Borton and in an effort to establish good relations between Bomber Command Headquarters and the Air Staff. Portal pointed out that he expected Borton to keep in close touch with the needs, thoughts and practices of Bomber Command and to use this knowledge to improve its efficiency. Furthermore, it was D.B. Ops' task to advise the C.A.S. of his responsibilities in relation to the supervision of the activities of Bomber Command. Portal made clear that he expected his staff to put their own knowledge and opinions at his disposal. When Portal and Harris disagreed such expressions of opinion should not 'be regarded as improper and ... [they] should not poison relations between your Headquarters and the Air Ministry'.

Portal ended this letter with a reference to the revised structure of the P.F.F. 'Naturally', he wrote, 'I should not wish to interfere in any way over this, particularly as I have for some time been wondering whether some change of this kind would not be forced upon us'.

Editorial, 'Fresh Blood'

Portal Papers, File 10, 1944, Item 15b, 16 April 1944

Ibid.
Harris, on 18 April 1944, to close this particular correspondence mounted what appeared to be another attack on Bufton's methods. Harris claimed that Bufton 'short circuited Command Headquarters ... giving the impression that his real aim was not so much to ... assist the Command as to exercise detailed control over it from the Air Ministry'.

Next Harris railed against Bufton for making judgements on Bomber Command's requirements 'without reference to this Headquarters'. He claimed that Bufton gave at least the impression that he knew better than Harris how Bomber Command should operate, the objectives that should be attacked and the tactics needed to be employed. Harris, in closing, said that he agreed with Portal's definition of Bufton's responsibilities provided Bufton collaborated closely with Bomber Command Headquarters and avoided 'pressing his own theories on our organisation, operations and requirements without consulting us on their merits'.

Until April 1944 Harris employed his bomber force largely as he saw fit. The support of Churchill, loosely worded Directives and lack of restraints imposed by Portal, all contributed to his virtual freedom of action. Harris sought to end the war by destroying German cities and the morale of the German people. To a large extent, however, he had been working in isolation for at Casablanca in January 1943 the broad outlines of future Allied strategy had been laid down. Under the code-names Neptune and Overlord a full scale invasion of Europe was to be executed leading to a military campaign to bring Germany's land forces to defeat. With such momentous plans in being it should have been clear that Bomber Command was going to be required to render every assistance prior to, and subsequent upon, the invasion. Further conferences, at Quebec in August 1943 and Cairo and Teheran in November and December 1943, should have confirmed that Bomber Command's role was about to change. Pointblank priorities were going to have to be replaced by those applicable to an invasion and subsequent land operations in Europe. As had been decided at Teheran the strategic and tactical bomber forces of Britain and the United States were expected to contribute directly. Although no dates had been determined the Chiefs of Staff agreed that 'In the preparatory stage immediately preceding the invasion, the whole of the available air power in the United Kingdom, tactical and strategic, will be employed in a concerted effort to create the conditions essential to assault'.

218 Portal Papers, File 10, 1944, Item 15c, 18 April 1944
219 Ibid. (underlining in the original)
220 Ibid.
221 Hartcup, op.cit., p.4
This statement of intent, in fact, went very little further than the paragraph included in the Casablanca Directive which must have been well-known to Harris. Issued on 21 January 1943, it had said that, 'Whenever Allied Armies re-enter the Continent, you will afford all possible support in the manner most effective'.222 Because dates and intentions remained unconfirmed Harris, on 27 December 1943, requested clarification of the future role of Bomber Command. Portal advised him that although offensive operations against German targets would not necessarily have to be curtailed 'the criterion by which they are judged will then be the extent to which they assist "Overlord" and not as at present the extent to which they weaken Germany's general power to make war'.223

This response prompted Harris, on 13 January 1944, to prepare a paper entitled 'The Employment of the Night Bomber Force in Connection with the Invasion of the Continent from the U.K.' wherein he argued that the greatest contribution Bomber Command could make would be the continuation of area attacks on German cities. His opening sentence was very illuminating. '"Overlord" must now presumably be regarded as an inescapable commitment'224 revealed how unwilling he had been to accept that the strategic bombing offensive had failed in its primary aim. In this paper Harris made a final attempt to resist change. He argued that the methods of night operations, the limitations of the navigation and bombing aids, the restrictions imposed by weather and the tactical considerations, precluded effective use of Bomber Command in assisting either an invasion or subsequent land operations.

In the light of subsequent events it is perhaps a little surprising to read in this paper of the importance Harris attached to the P.F.F. He admitted that even with Oboe and H2S it was still necessary for targets to be marked by the Pathfinders. Successful marking, he said, 'demands a high standard of experience from the Pathfinder crews'.225 Because they could not be replaced quickly Harris also said that specialised crews should never be put in a situation 'in which they would be subject to any undue casualty rates'.226

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222 Webster & Frankland, op.cit., Vol.4, p.154
223 Hartcup, op.cit., p.4
224 Ibid., Appendix 1, p.1
225 A.T. Harris, 'The Employment of the Night Bomber Force in Connection with the Invasion of the Continent from the U.K.' in Hartcup, op.cit., Appendix 1, para.8
226 Ibid.
Harris also admitted the numerical weakness of the P.F.P. when he said that 'it is not possible to use the Pathfinder Force in strength for more than two nights running without greatly impairing its effectiveness'.\textsuperscript{227} Yet in April 1944 with operational requirements expanding and P.F.P. elements continuing to lead, in the place of greatest danger, Harris had reduced the Lancaster strength of the P.F.P. by twenty five per cent.

Harris, in this paper, argued against the use of the heavy bomber force in any attempt to disrupt railway networks. Such attacks, he claimed, would be 'unlikely to achieve sufficient accuracy to be of any material use ... and the impossibility of maintaining the requisite continuity of action in the prevailing weather conditions ... [probably render them] ... 'impracticable with any type of bomber force'.\textsuperscript{228} Harris claimed that the best assistance the bomber forces could give the army would be to increase the weight of attacks on selected industrial centres. If, instead, Bomber Command was diverted from this intention by being required to attack 'gun emplacements, beach defences, communications or dumps in occupied territory we shall commit the irremediable error of diverting our best weapons ... to tasks which it cannot effectively carry out ... It would lead directly to disaster'.\textsuperscript{229}

This particular work cannot deal in detail with the political and military wrangles that took place during the next few weeks and months over the structure, command, responsibilities, and employment of the bomber forces, before, during, and after, the planned invasion of Europe. There is sufficient material there for several books to be written on the subject.\textsuperscript{230} At the same time it is essential that a basic understanding is attained of the changes that occurred.

When it was first issued the Pointblank Directive did have a positive objective but, as the months went by, it

\textsuperscript{227} Harris, 'The Employment of the Night Bomber Force in Connection with the Invasion of the Continent from the U.K.' \textit{para.11}

\textsuperscript{228} Ibid., \textit{para.17}

\textsuperscript{229} Ibid., \textit{para.22}

\textsuperscript{230} Those interested will find relevant sections in both the following volumes from the History of the Second World War published by H.M.S.O. L.F. Ellis, \textit{Victory in the West} (London: H.M.S.O., 1962), Vol.1 and, Webster & Frankland, \textit{op.cit.}, Vol.3
became increasingly irrelevant. As the necessity for an invasion followed by a European land campaign became ever more obvious so did Pointblank conflict more and more with the requirements of Overlord. The appointment of General Eisenhower, in December 1943, as Supreme Allied Commander confirmed the already widely accepted view that Pointblank was only one of the steps towards final victory but would not itself provide that victory. With confirmation that an invasion would take place the attainment of air superiority became even more pressing. Up to this time Bomber Command had virtually been conducting a private strategic bombing war; now it was clear that it would have to become an interlocking and effective part of a war to be conducted on land, sea and in the air. Bomber Command would have to subordinate both its individuality and its freedom of action. Who was to control its operations?

After confused wrangling between Churchill, the British Chiefs of Staff and the Combined Chiefs of Staff it was agreed, on 13 March 1944, that once the air programme had been determined then 'the responsibility for the supervision of air operations out of England of all forces engaged in the programme including United States Strategic and British Bomber Command, together with any other Air Forces that might be available, should pass to the Supreme Command'. The word 'supervision' in this statement was rejected by the Combined Chiefs of Staff who offered 'command'. Finally, it was agreed the word 'direction' should be used.

Confirmation of the air programme also required protracted negotiations. Air Marshal Sir Trafford Leigh-Mallory who had been appointed leader of the Allied Expeditionary Air Force (A.E.A.F.), responsible for providing tactical air support for Overlord, had prepared a plan. This was presented on 3 March 1944 and involved the attainment of air superiority and a massive assault on communications - road, rail and water - in Belgium, Northern France and Western Germany. Clearly it required support from the strategic bomber forces. General Spaatz, Commanding General United States Strategic Air Forces Europe (C.G.U.S.S.A.F.E.), and Harris, were united in their opposition to Leigh-Mallory's plan. Spaatz, because he wished to retain the independence of his command and Harris, for the reasons he had enunciated on 13 January 1944. Spaatz did not deny the capability of his force but he wanted to be certain that the plan finally adopted would provide for air superiority at invasion time. As an expression of the individuality of his command he sought approval for a bombing campaign against German oil targets - particularly those concerned with the production of petrol.

Hartcup, op.cit., p.21
Before plans for the use of the strategic bomber forces could be drawn up it was obviously necessary that these differences should be resolved. Portal, by early 1944, was coming to believe that Harris was allowing his appreciation of Bomber Command's operational capabilities to be over-influenced by his strategic aims. He therefore suggested to the Air Staff that experimental raids be carried out on selected targets to determine, if possible, exactly what Bomber Command could and could not do. This review of Pointblank targets, issued as a Directive to Harris on 4 March 1944, was expressly for the purpose of obtaining 'experience of the effects of night attack of airfields, communication centres and ammunition dumps, before operation "Overlord"'. In other words it was to test the veracity of the claim made by Harris that his force was incapable of carrying out worthwhile attacks by night on precision targets. Six railway objectives were nominated as well as one airfield and one ammunition dump.

Trappes, on 5/6 March 1944, was the first railway target attacked. These marshalling yards, sixteen miles west-southwest of Paris, were selected for the test not because of their importance but because they were in generally flat terrain and relatively clear of civilian housing. P.F.F. marking for the raid was Musical Parramatta and, in good conditions, the first Oboe Mosquito dropped its red T.Is 70 yards and 140 yards south of the first aiming point. Main Force bombing was from about 13,000 feet and a very successful attack developed. Subsequent photographic reconnaissance confirmed that considerable damage had been created. The P.F.F. Monthly Summary for March 1944 did not specify Trappes but it did mention that the two Oboe Mosquito squadrons had, on seven nights, marked marshalling yards in France for attacks by quite 'sizeable forces of heavies ... the effects of the blows ... will, no doubt, have far reaching effects'.

This summation was particularly accurate for the raid had confirmed that Bomber Command was very capable of playing a significant part in Overlord contrary to the original beliefs of its leader. It also reduced the influence that Harris could exert on the future employment of his Command. Ostensibly, the employment of Bomber Command and the strategic element of the U.S.A.A.F. now depended on the resolution of the expressed differences between Leigh-Mallory and Spaatz.

232 Webster & Frankland, op. cit., Vol.4, pp.165-6
233 Lionel Lacey-Johnson, Point Blank and Beyond (Shrewsbury: Airlife Publishing Ltd., 1991), p.59
234 AIR 25/156, P.F.F. Monthly Summary, March 1944, p.4
There is a strange incongruity to be noted here that both these leaders had gained their major experience with fighter forces. Fortunately, Tedder, as Deputy Supreme Commander was in the position to ensure that the 'search for a common object in the pursuit of which all arms could be deployed'\textsuperscript{23}\textsuperscript{25} did not go unrewarded.

Tedder rejected Spaatz's oil plan. He acknowledged its merits but at the same time pointed out that it only offered long-term prospects. Although rejected it was not forgotten. Tedder was a supporter of what by now was called the Transportation Plan - attacks on rail targets in particular and their supporting industrial organisations. Such attacks, he believed, by delaying and disorganising the movement of German troops would provide direct and valuable support to the Allied armies both during the invasion and in subsequent land operations. Leigh-Mallory's plans for attacks on the interior, overland German communication lines, only covered short-term objectives; Tedder, with his Mediterranean experience, believed that a long-sustained assault was required not only against key points in the rail network but also against elements in the repair and maintenance organisation.

Decision time came at a meeting, chaired by Portal, on 25 March 1944. In attendance were Eisenhower, Tedder, Spaatz, Harris, Leigh-Mallory and various representatives from the War Office, Joint Intelligence Service and the Ministry of Economic Warfare. At this meeting it was made clear that the oil plan proposed by Spaatz was unacceptable. Its benefits were long-term and what was required were advantages at the time of the invasion scheduled for early June 1944. Equally, support for the Transportation Plan was only luke-warm. What swung the meeting was Eisenhower's declaration that the Transportation Plan was acceptable provided it would cause some reduction in German military traffic and provided there was no other alternative. Nothing really decisive had either been offered, or said, and it would appear that the Transportation Plan was reluctantly accepted \textit{faute de mieux}. Nobody, however, could gainsay that massive bombing attacks on German and French railway systems would not cause 'some reduction, however small'\textsuperscript{23}\textsuperscript{26} in German military traffic at a crucial time.

Churchill provided the last stumbling block. Perhaps he was now considering post-war political situations. He had been enthusiastic when insisting on Bomber Command attacks on U-boat installations in French ports but now he jibbed at the prospect of French casualties if the Transportation Plan was implemented. Eisenhower, however, was adamant that military

\textsuperscript{23}\textsuperscript{25} Webster & Frankland, \textit{op.cit.}, Vol.3, p.29

\textsuperscript{23}\textsuperscript{26} Ibid., p.33
necessity must not be subordinated to political desirability and in this attitude he was supported by Roosevelt. Churchill, belatedly and reluctantly, accepted the possibility of 10,000 French civilian deaths.

On 27 March 1944 the Transportation Plan became accepted policy and the British Combined Chiefs of Staff confirmed that Eisenhower be given control of the strategic bomber forces. On 14 April 1944 the transfer of control took place and Tedder was delegated the authority to coordinate all of the bomber forces in north-west Europe. Eisenhower's first directive to the strategic bomber forces was issued on 17 April 1944. Addressing Bomber Command specifically, the Directive stated that it 'will continue to be employed in accordance with their main aim of disorganising German industry'.

Although this wording allowed Harris plenty of scope to justifiably continue his area offensive, to his credit, he threw his energies and his bomber force wholeheartedly into implementing the Transportation Plan. Bomber Command had been allocated 37 of the 80 listed targets in the Transportation Plan and, by D-Day on 6 June 1944, all had been attacked. Twenty two of the targets by then were listed as Category A - that is no further attacks were considered necessary. Thirteen were Category B which meant that further attacks were required, while only two had received little or no damage and were listed as Category C. German counter-invasion plans were largely based on the movement of large forces held in reserve areas until the Schwerpunkt had been identified. The German authorities failed to move their reserves rapidly to the Normandy area but whether it was because of the bomb damage, or because they continued to believe that the main invasion would take place in the Pas de Calais area, is arguable.

Saundby, the Deputy Commander-in-Chief, Bomber Command, was in no doubt. He quoted in support the German General Staff Officer responsible, under von Rundstedt, for communications in the West. In this German officer's view, said Saundby, 'our air offensive against the railways made a greater contribution to the defeat of the Wehrmacht in France than any other single factor'.

When Harris, on 13 January 1944, produced his 'Memorandum for the Employment of Night Bombers in Connection with the Invasion of the Continent from the U.K.' in paragraphs four to seven he had stated how it was always necessary to use some

237 Webster & Frankland, op.cit., Vol.4, p.169

238 Lacey-Johnson, op.cit., p.163

239 Point of main effort.

form of Pathfinder technique in bombing but that the aids that were available to the crews all had limitations. The A.E.A.F response to this was that the statement appeared to have been written in respect of deep-penetration German targets. Given good weather and moonlight, French targets would be much more vulnerable. Additionally, Oboe could be expected to give increased accuracy against short range French targets.

The immediate Air Staff reaction to Harris's paper was that it was too sweeping in down-playing the accuracy of either H$_2$S or Oboe and that H$_2$S could be expected to give good results when water features were available. The Air Staff also rejected the notion that Pathfinders were always necessary. In coastal areas with moonlight, they claimed it should be possible for the bomber force, using visual methods, to achieve accurate bombing.  

In the light of events before and after D-Day the Air Staff reconsidered the earlier claims made by Harris. On 28 June 1944 they confirmed that they believed Harris had been wrong concerning the accuracy to be expected from the navigational and bombing aids available to the bomber force. They argued that Pathfinders were essential but not necessarily using either Oboe or H$_2$S. They claimed that the results obtained by 'the technique of visual marking with the aid of flares ... have been in many cases comparable to those achieved with the aid of 'Oboe'.'

Harris agreed with this finding. In his summing up of Bomber Command's efforts in the Transportation Plan he admitted that 'I myself did not anticipate that we should be able to bomb the French railways with anything like the precision that was achieved'.

As far as the P.F.F. were concerned their most important development in implementing the Transportation Plan was the refinement of the Oboe target marking tactic by combining it with the Master Bomber technique. Oboe-equipped Mosquitoes would drop T.Is in the target area; P.F.F. Lancasters would then drop flares to illuminate the marked area and, finally, low-flying Mosquitoes would mark the precise target. In command of the whole operation was a Master Bomber and his Deputy. As Bennett had argued, the method was only suitable against lightly defended, precision targets, in good weather.

241 Hartcup, *op.cit.*, Appendix 2, p.2
247 Lacey-Johnson, *op.cit.*, p.241
243 Harris, *Bomber Offensive*, p.266
The attack on Mailly le Camp on 3/4 May 1944 provided a good example of the tactics employed and the difficulties that could be encountered. Mailly le Camp was the site of a German military depot midway between Troyes and Chalons sur Marne, approximately 80 miles E.S.E. of Paris. Two Oboe-equipped Mosquitoes were to open the attack at 2358 hours by releasing green T.Is as target proximity markers. Lancasters of 83 and 97 squadrons (P.F.P. squadrons attached to 5 Group) were then to drop illuminating flares aimed at the proximity markers. Using these flares, Cheshire of 617 Squadron in a Mosquito at 1,500 feet, was to identify and mark the target with Red Spot Fires. All went well up to the aiming point marking by Cheshire. Always a perfectionist, he considered his Red Spot Fires were not quite precise enough. Cheshire advised the Master Bomber circling above there would be a slight delay and that he was to hold off the Main Force until he (Cheshire) was satisfied the marking was accurate. By this time the first wave of the Main Force, 173 Lancasters of 5 Group, were circling a yellow datum point marker near Chalons sur Marne about 20 miles to the north. Cheshire then called in 'Dave' Shannon, an original 'Dam Buster', to re-mark the aiming point. At approximately 0006 Cheshire advised the Master Bomber that the aiming point was marked and that the attack could commence.

Although the attack was now fractionally late in starting, nothing really serious had gone wrong. Unfortunately, when the Master Bomber tried to call in 5 Group on his V.H.F. radio his transmissions were unreadable. They were being blotted out by what was later considered to have been sophisticated German jamming. Attempts to use W.T. also failed because of a technical problem with the Master Bomber's transmitter. Some crews, however, had heard the order to attack and they were only too pleased to cooperate. Others, well aware of the dangers involved when loitering in the target area, also decided to initiate attacks. By this time the German controllers had decided that Mailly le Camp was the target and were directing their fighters to the area. Orbiting Lancasters, seeing some bombing taking place and also seeing Lancasters being shot down, broke radio silence (contrary to orders) to enquire as to what was happening. Their frantic transmissions further clogged up the V.H.F. in use.

The Deputy Master Bomber had heard the garbled order given by the Master Bomber to commence the attack but was also aware of the increasing concerns being vividly expressed by the circling Lancaster crews. However, his orders were only to take over if the Master Bomber was shot down or, if he had been ordered to do so. Neither had happened so he was in somewhat of an invidious position.

Lacey-Johnson, op.cit., pp.112-121
Cheshire, meantime, was also well aware of what was happening and he made unavailing attempts to order the bombing to commence. Because disaster threatened Cheshire, unsuccessfully, tried to have the attack cancelled. Then, despite the bombs falling from Lancasters above, Cheshire called on two other Mosquito markers from 617 Squadron, one flown by New Zealander 'Terry' Kearns, to mark the second aiming point for the second wave of Lancasters from 1 Group. This was done accurately and these Red Spot Fires were supplemented by additional T.Is from a 97 Squadron Lancaster. At this stage, aware that a critical situation had developed, the Deputy Master Bomber issued the clearly heard order that all crews were to go ahead and bomb. The last bomb release photograph was timed at 0037, twelve minutes after the attack should have ended.

This raid, despite the problems, was both concentrated and successful but to illustrate the dangers of having to linger in the target area 42 Lancasters were lost, 11.2 per cent of the force involved. Lessons were learned at Mailly le Camp. Crews were urged to tighten up on their R/T (radio telephone) discipline and only break radio silence in exceptional circumstances. What the layman has to appreciate is that if an aircraft is transmitting on V.H.F. and another attempts to use the same frequency, neither can be understood. Bombing instructions were also revised for Main Force crews as a result of the experiences at Mailly le Camp. Provided they arrived at the target either at or after the zero hour they were to begin bombing on the markers without further orders. The only exception to this order was to be if the Master Bomber or his Deputy had issued orders to the contrary. In other words the Master Bomber could order bombing to cease and he could order a change of aiming point but, normally, he would not issue the order to commence bombing.

As a further appreciation of the difficulties which faced Master Bombers, 5 Group sought, and was given approval by the Air Ministry, to establish at Coningsby four Wing Commander posts for Master Bombers. It had been accepted that being a Master Bomber was a full-time job and could not be done in combination with those of either a Squadron or Flight Commander. Similar approval was neither sought nor accorded to 8 Group Squadrons. The Master Bomber, known at first as the Master of Ceremonies or Controller, carried a heavy and trying burden during an attack. Success or failure could depend upon his judgement and he remained in the target area throughout the attack. It was truly said that 'only men of proved ability, possessing the qualities of leadership, flexibility of outlook, clear judgement and capable of immediate reaction to changed circumstances, were selected for the job'.

Perhaps it was considered unnecessary to note that they required courage well beyond the norm.

Maurice A. Smith, 'Pathfinder Story' in Flight, 9 May 1946, p.6
Despite the enormous effort expended by Bomber Command on the Transportation Plan— from 9 February 1944 to 6 June 1944, 8,751 sorties were flown and 44,494 tons of bombs were dropped— it must be recognised that these attacks were only a portion of the total bombing programme. As well as railways and marshalling yards there were coastal defence positions, radar stations, airfields, ammunition and petrol dumps and, as we have seen, military depots. Then, in December 1943, with confirmation that the mystery 'ski' sites in the Cherbourg and Pas de Calais regions were launching ramps for a new German secret weapon, they had to be added to the lengthy target list. After the first flying bomb landed on England on 13 June 1944, 'ski' site attacks assumed a priority only behind that of support operations for Overlord. Also, after the D-Day landings, there was always the prospect that the strategic bomber forces could be summoned to provide tactical assistance to the armies in the field. Nor must it be forgotten that apart for a two month break in June/July 1944, Bomber Command was still carrying out major area attacks on German cities. Fortunately, although the area attacks on German cities still provided an uncomfortably high loss rate, overall, casualties were reducing so operational expertise was expanding.

During the first six months of 1944 several new marking techniques were employed. A popular one, Controlled Oboe, first used on 10/11 April 1944, was found to be most successful when used in attacks on marshalling yards. Oboe-equipped aircraft, either Lancasters or Mosquitoes, would drop their T.Is and their accuracy would be determined by a Master Bomber prior to the arrival of the Main Force. Using V.H.F., he would then instruct the Main Force crews as to which T.I. they were to use as an aiming point. If the Oboe T.Is were not considered sufficiently accurate then the Master Bomber would drop other T.Is of a distinctive colour and order the Main Force to use them as their aiming point.

Naturally these Controlled Oboe attacks could only take place when the Main Force was able to operate below the general cloud base. When the targets were covered by ten tenths cloud which the bombers could not get underneath, formation bombing was often employed in daylight operations.

This technique proved accurate against Crossbow targets (V-weapon launching sites) provided the formation was not too large. Normally six to sixteen Lancasters flying in pairs, line astern, and each pair stepped down below the pair in front were led to the target by an Oboe-equipped aircraft.247 All the formation released their bombs when bombs were seen to fall from the lead aircraft. If the formation was large (and remember that Bomber Command pilots received no training in

246 Lacey-Johnson, op.cit., p.163

247 AIR 25/156, P.P.F. Monthly Summary, July 1944, p.3
formation flying) then following crews waited two seconds before releasing their bombs. A variation of this attack was for the leader to fire a smoke puff and following crews would release their bombs as they came abreast.²⁴⁸

By night Crossbow targets were attacked using a Group Visual method or Musical Newhavens. Encouraged by Harris, individual Groups had devised their own marking techniques. 8 Group Visual meant that proximity markers would be dropped using Oboe. They were followed by flares to illuminate the target area and then T.Is to mark the aiming point. Number 5 Group Visual required that the target area be illuminated by flares and then the aiming point was marked by Red Spot Fires placed by low-flying Mosquitoes. Number 1 Group Visual was yet another variation. The target was marked visually by T.Is bursting on impact and then Red Spot Fires marked the aiming point. All Group Visual methods were controlled by a Master Bomber.²⁴⁹

The Allied strategic bomber forces were first used in the direct support of a ground offensive during the Battle of Cassino in Italy in February and March 1944. Although the Monastery was destroyed, the German defenders were able to take up strong defensive positions in the rubble, and their removal was both difficult and costly. The first major call upon Bomber Command made by General B.L. Montgomery came early in July 1944 during planning for the capture of Caen.

Since the D-Day landing, ground operations had gradually fallen behind schedule. Initial planning targets were not being met. Caen had proved to be a major stumbling block for the Allied forces. Its capture became essential so that the Americans could use it as a pivot to start their break-through eastward before looping right to isolate the Cherbourg Peninsula. Bomber Command was called upon to assist. Naturally there was concern about the accuracy that the bombers could be expected to achieve. For this attempt at inter-service cooperation the bomb-line was set at 6,000 yards - that is the target area was established at 6,000 yards from the nearest Allied ground forces.

The target for the bombing force was identified as a rectangle measuring 4,000 yards by 1,500 yards on the northern outskirts of Caen. The area was known to be behind the main line of the German defences but they were to be the targets for the British artillery. The major aims of the bombing were to destroy the German artillery and isolate their forward troops from the bases in the rear. Bombing was to take place on 8 July 1944 but, with bad weather forecast, the attack was brought forward to the previous evening with the ground assault to follow six and a half hours later.

²⁴⁸ Musgrove, *Pathfinder Force*, p.128
²⁴⁹ Hartcup, *op.cit.*, p.92
Even at this stage of the war the tactic of using Forward Air Controllers to control the bombing was not widely employed by the British so the attack planned was a Controlled Oboe under Master Bomber 'Fat' Daniels, an experienced Pathfinder. Although the bombing was concentrated and accurate few German defensive positions were destroyed and the heavy cratering severely hindered the infantry advance next morning. The lessons learned were that the bomb line had to be reduced and that the ground attacks had to begin immediately the bombing finished if advantage was to be taken of the shock induced in the defenders by the display of air power. These lessons were incorporated in Operation Goodwood on 18 July 1944. In a two hour period, 1,513 British and American bombers dropped 6,800 tons of explosives using a bomb line reduced to 300 yards and instantaneous fusing on the bombs to prevent cratering.\textsuperscript{250} The attack confirmed that the heavy bombers could play an effective part in ground operations.

Because this paper is primarily concerned with the operations and influence of the P.F.F. in the Second World War this is not the place to enter into arguments concerning Harris and his employment of Bomber Command after it was returned to his control in September 1944. Suffice it to say that for all his good intentions Harris, despite the high regard for him held by his crews, was not always right. He had underestimated the strength and resilience of German morale and he had overestimated Bomber Command's capabilities. In retrospect, his continued identification of oil and transportation targets as 'panaceas' was also wrong. Admittedly the tonnage of bombs dropped on oil targets increased dramatically in the last quarter of 1944 compared with all of 1943, but percentage-wise, area attacks on German cities continued to dominate the target lists. Oil installations provided 14 per cent of the targets attacked, transportation 15 per cent and cities 53 per cent.\textsuperscript{251} From January to April 1945 26 per cent of Bomber Command's efforts were directed against oil targets.\textsuperscript{252} This, it must be remembered, at a time when politics were becoming part of the war equation and the further destruction of German cities reduced the capacity of their people to fend for themselves in the post-war world.

\textsuperscript{250} J.R.C. de Normann, 'The Use of the Strategic Bomber Forces over Normandy. Success or Failure?' in British Army Review, No.96, December 1990, p.17

\textsuperscript{251} Musgrove, Pathfinder Force, p.155

\textsuperscript{257} Webster & Frankland, op.cit., Vol.3, p.199
Neither is this the place to consider morality in war particularly with regard to the attack on Dresden in February 1945. Indeed, it was as the result of no unilateral decision on Harris's part that the operation orders for that raid were issued. However, when the results became known others in the chain of command, from Churchill downwards, were quick to seek cover. Opprobrium became the consequence and Harris was both first and last man standing. But, as the Official Historians pointed out, 'operations against Dresden were, ... only a part of a concerted action and the Bomber Command attack was only an element in a combined Anglo-American assault'.

During the last year of the war Bomber Command and 8 Group increased in size. This was not as a result of expansion plans reaching fruition but was rather a consequence of reduced casualties. Statistics, however, can be used to convey a false impression. Expansion of the P.F.F. element of 8 Group lagged behind that of Bomber Command as a whole and, in addition, was irregular. When the P.F.F. was formed in August 1942 there were five squadrons equipped with four different types of aircraft. By August 1943 8 Group comprised one Halifax, four Mosquito, and five Lancaster squadrons. One year later 8 Group comprised six Lancaster and still only four Mosquito squadrons. At the end of the war, in May 1945, there were still only six Lancaster squadrons in 8 Group but the number of Mosquito squadrons had risen to ten.

It is important that the distinction between 8 Group and the P.F.F. element of 8 Group is recognised. The heavy bombers in 8 Group were always Pathfinders but of the Mosquito squadrons only three were Pathfinders, Numbers 105, 109 and 139. Other Mosquito Squadrons that joined 8 Group belonged to the Light Night Striking Force.

Cursory examination of the numbers of heavy bomber squadrons in the P.F.F. would tend to give the impression that its strength remained static. In fact it varied. In April 1944 two veteran P.F.F. Lancaster squadrons were detached to 5 Group and their replacements were newly formed squadrons. While the total number of heavy squadrons in the P.F.F. remained the same, operational experience had been diluted. Perhaps of even greater significance, the total number of heavy bombers available had been reduced. In March 1944 all the Lancaster squadrons in the P.F.F. were reduced to a two flight level. That is, instead of having three flights and totalling twenty four aircraft, squadrons were reduced to only sixteen aircraft.

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[254] Musgrove, Pathfinder Force, p.110
With the growth in size of all elements in Bomber Command came the enlargement of experience as increasing numbers of crews completed their operational tours. As the Allied armies continued their advance into Europe the German air defence system lost its early warning capability. With reducing fuel stocks German fighters were kept on the ground until the bombers' target was confirmed. The *Luftwaffe* fighter force suffered heavily in this period and, as losses mounted and training time for replacement pilots was reduced, overall effectiveness deteriorated. Both Bomber Command and the U.S.A.A.F. with heavy fighter escort operated in daylight, especially on short-range targets. By night the German fighters could still inflict losses but, fortunately, not with the consistency shown in the past. At the same time, by the use of mobile control stations, Oboe extended its coverage over a shrinking Germany.

Nor in these final months of the war did the development of bombing aids to improve the destructive capability of Bomber Command lose its impetus. The first operational use of Gee-H took place on 4 October 1944 although its first success was obtained when the system was used for an attack on Aachen three days later.

Gee-H was basically an aircraft navigation aid which provided accurate medium range fixes. When this navigation equipment was fitted with another item called a Gee-H Mouse it was then converted into an automatic blind bombing device. Despite the similarity of names and the fact that Gee and Gee-H information could be displayed on the same indicator unit, there were major differences between the two aids. With Gee the Master and Slave stations were interdependent while with Gee-H the ground stations worked in isolation. With Gee the user aircraft merely acted as a receiver; with Gee-H the user aircraft was required to transmit. When using Gee a Master and a Slave station provided a single position line; using Gee-H the interrogation of two ground stations provided a fix. Finally, Gee provided positional information for an unlimited number of aircraft but two Gee-H ground stations could only cope with 70 to 80 aircraft at any one time.

Basically Gee and Gee-H were very similar in that the principle employed was the measurement of time intervals between the reception of two radio pulses. With Gee the time interval measured was that between the reception of pulses from a Master and Slave ground stations. In the case of Gee-H the time interval measured was that between the initiation of a pulse from the aircraft and the reception of a pulse retransmitted (or 'transponded') by a ground station. With the speed of radio waves known (186,000 miles per second) there is a direct relationship between time and distance so that the time interval measured provided a distance from the
Gee H Lattice
Air Ministry, Radio Navigation Aids (AP 1234E)
(London: Air Ministry, no date), Sect.3, Chapt.2, Fig.2
ground station. Two time intervals in the case of Gee-H provided a fix. Positional information was obtained from a Gee-H lattice chart. Because over-lapping range circles would always cut in two places it was necessary to remove ambiguity of the fix by reference to the D.R. position of the aircraft.

Gee-H offered improved accuracy over Gee but at some expense to range. On 9 September 1942 it was decided by the Air Staff that the equipment would be installed in aircraft of the P.F.P. Trial installations were contemplated for the Lancasters, Halifaxes and Stirlings but Harris was asked to limit the fitting to only one aircraft type. Lancasters, with bomb doors modified to enable them to carry 8,000 pound bombs, could not be fitted with HaS so these were selected for Gee-H fitting. When it was appreciated that fitting Gee-H could only be done provided a reduction in range was accepted, it was decided to defer final decisions until trials were completed.\textsuperscript{255}

On 16 March 1943 it was suggested that Gee-H be fitted in Mosquitoes rather than Lancasters and thus reduce the chances of equipment falling into enemy hands. Oboe Mark I was being successfully used by the P.F.P. by this time but there was always the nagging doubt that enemy jamming could reduce its usefulness. Oboe Mark II was not expected to be available until August 1943 so Gee-H appeared to offer a stop-gap. This project came to a halt in June 1943 when it became apparent that fitting Gee-H in the earlier marks of Mosquito presented major difficulties.

Service trials of Gee-H fitted in a Lancaster commenced on 28 June 1943 and the Bomber Development Unit (B.D.U.) sang their praises of the accuracy they had obtained. They considered that '50 per cent of bombs [would be] within 610 yards of the aiming point'\textsuperscript{256} if the equipment was used against targets in the Ruhr. Bad weather, technical difficulties, and the onset of the winter bombing programme with Berlin the target, delayed the crucial operational testing. It was not until 3/4 November 1943 that Gee-H was employed by thirteen Lancasters of 3 Group and twenty-five Lancasters from 6 Group for an attack on Düsseldorf. Results were very encouraging. However, at this juncture, it was decided to remove the Gee-H from the Lancasters until the jamming of other aids made its employment necessary.

In the meantime, on 8 August 1943, the P.F.P. had requested that Gee-H be installed in the Mosquitoes of 139 Squadron. Trials were held in October 1943 against Aachen and Duren and a bombing photograph of the latter target was only 500 yards from the aiming point. Training was a problem for

\textsuperscript{255} Air Ministry, Signals Vol.3 Aircraft Radio, p.256

\textsuperscript{256} Ibid., p.258
the Mosquito navigators because, although Gee-H was easier to use than H2S, practical instruction was still essential. In the already cramped cockpit of the Mosquito it was simply impossible to carry a third person. Airspeed Oxfrds were requested by 139 Squadron for navigator training in the use of Gee-H and appeared on the unit establishment.

In Bomber Command Gee-H fitting was concentrated mainly in 3 Group and it was the only aid not distributed throughout the Command or allocated specifically to the P.F.P. However, it was widely used by the A.E.A.F. and the U.S.A.A.F. After the D-Day landings mobile units were based in France to extend its range and these were operative by the end of August 1944. At first the Gee-H equipped aircraft were used in daylight formation attacks on targets in the Ruhr and Rhineland. Box formations of six aircraft were employed led by a Gee-H equipped Lancaster identified by two horizontal yellow stripes on the tail. When the leader dropped his bombs the rest of the formation did likewise. Generally the accuracy achieved was very good and equalled that obtained in trials. Occasionally, however, random systematic errors saw good bombing concentrations but unfortunately displaced by as much as 1,000 yards from the aiming point. Such errors were naturally of concern when a Gee-H force was being used in support of ground operations.

Harris was pleased with the results obtained when using the equipment and said he believed that in Gee-H 'Bomber Command had ... an extremely valuable and efficient aid for precision bombing'.

Another bombing aid provided mainly for the P.F.F. towards the end of the war was the Ground Position Indicator (G.P.I.). This unit, used in conjunction with the Air Position Indicator, projected a cross of light on to a precisely positioned chart and thus indicated the ground position of the aircraft. When the G.P.I. was to be used for bombing, a fix was obtained as late as possible on the way to the target. The G.P.I. was set to this fix (approximately ten miles from the target) and then the most accurate wind available was fed into the G.P.I. As the cross of light moved over the chart it indicated the ground position of the aircraft provided both the fix and the wind were accurate. If evasive action had to be taken it was easy for the navigator to regain track and proceed to the aiming point. The G.P.I. was considerably easier to operate on a bombing run than H2S and was used with much success for blind bombing and marking by the P.F.F. in the latter stages of the war.


258 Harris, Despatch on War Operations, p.70
The first mention of the G.P.I. in the P.F.F. Monthly Summaries appeared in July 1944 when crews were reminded that the accuracy of the G.P.I. method depended on the D.R. run from the fix, the accuracy of the fix, and the ability of the navigator to arrive at the aiming point on a specified heading. In October 1944 it was pointed out that G.P.I. methods were consistently less accurate than direct H.S.S runs. This was attributed to carelessness on the part of navigators. Because the G.P.I. bomb run was only about ten miles in length some navigators were inclined to be too little concerned as to the accuracy of the wind they set on the G.P.I. They were sharply reminded that on a ten mile bombing run 'a vector error of 10 knots gives a bombing error of half a mile'.

Before we turn to consider the operations of the Mosquito Light Night Striking Force which formed part of 8 Group, it is perhaps relevant to disabuse readers of some of the myths surrounding the war-time rivalry between 8 Group and 5 Group. From 28 February 1943 until 16 January 1945 5 Group was led by Air Vice-Marshall the Hon. R.A. Cochrane who had served under Harris from 1922 to 1924 in 45 Squadron based in Mesopotamia. The rivalry at the top between Cochrane and Bennett (it has been called 'enmity') set the tone for both their respective Groups. Because of the operational policy it pursued and the tactics it employed, 5 Group became known to the rest of Bomber Command as 'The Independent Air Force'. Unlike Bennett, Cochrane avidly sought and enjoyed publicity. He was prepared to accept, on behalf of his unknowing crews, tasks and tactics rejected by Bennett on the grounds that the potential cost made them militarily undesirable. But there is no denying, particularly from 1943 onwards, that 5 Group had among its personnel some of the outstanding bomber crews in the Royal Air Force. This does not reflect credit on either Harris or Cochrane because the understanding when the P.F.F. was established, in August 1942, was that only the best crews would be good enough for Pathfinders. It appeared that 5 Group was, and remained, reluctant to conform. This was confirmed in March 1943 when Wing Commander Guy Gibson in 5 Group was given the task of forming a new squadron, yet unnumbered, for a special and secret task. Gibson was given total authority and priority in the selection of men and material. Selected crews were to be either those who had completed at least one operational tour or were of outstanding ability and character. With those particular credentials it is surely pertinent to ask why were they never offered to the Pathfinder Force?

259 AIR 25/156, P.R.O. XC 08350, P.F.F. Monthly Summary, October 1944, p.8

260 Hastings, op.cit., p.283
This squadron, numbered 617 on 23 March 1943, remained out of the front-line until 16/17 May 1943 when 19 Lancasters set out to bomb the Möhre, Eder and Sorpe dams in the Ruhr Valley. Eight crews (56 men) and eight new Lancasters - averaging only 17 flying hours - were lost. The squadron did not fly again on operations until 15/16 July 1943. Nothing in this should be construed as either downplaying the bravery or the skill of the crews involved. The point to be made is that 8 Group was never in a position either to be so profligate with its crews or have such lengthy stand-down periods for squadron re-formation and recuperation. The Dams Raid has also been mentioned because many from 5 Group claim that it was on that occasion that the Master Bomber technique was pioneered. In fact it was first used by Pathfinders on 2/3 December 1942.\textsuperscript{261} Unfortunately their initial efforts were not successful because the aircraft were not fitted with V.H.F. radios and the flares available for illumination were unsatisfactory. With backing from Harris, 617 Squadron had been afforded priority for the Dams Raid and their V.H.F. provided excellent inter-aircraft communication.

Another 'first' often accredited to 5 Group was the use of 'off-set' marking. That is marking a position 300 or 400 yards removed from the aiming point in an area unlikely to be affected either by bombing or enemy decoy measures. Then, by applying a false wind vector to the bomb-sight and aiming at the off-set marker, the bombs should strike the correct aiming point. The Official History stated that 5 Group introduced the modified marking technique in May 1943.\textsuperscript{262} Musgrove disagreed. When discussing the Peenemünde raid and the technique employed of shifting the markers by applying a false wind to the bombsight, he said, 'Later, in 1944, 5 Group "invented" this method which became known as "off-set marking"'.\textsuperscript{263}

It would appear possible that a certain amount of confusion arose concerning off-set marking. Cochrane was called in to assist with the planning of the Peenemünde raid because it was believed 5 Group had used the technique on 20/21 June 1943 for a raid on Friedrichshafen.\textsuperscript{264} In fact on that occasion the tactic employed was the 'time and distance' method regularly used by the P.F.P. as a check on the bomb run. It was also the same tactic described by Mahaddie as having been tried as early as June 1940.\textsuperscript{265}

\textsuperscript{261} Bill Anderson, \textit{Pathfinders}, p.57
\textsuperscript{262} Webster & Frankland, \textit{op.cit.}, Vol.3, p.154
\textsuperscript{263} Musgrove, \textit{Pathfinder Force}, p.63
\textsuperscript{264} Messenger, \textit{op.cit.}, p.134
\textsuperscript{265} Mahaddie, \textit{op.cit.}, p.38
A modified form of 'off-set' bombing was still employed by the V-Force during the 1960s. The Navigation and Bombing System (N.B.S.) was centred around H2S Mk9A but even this sophisticated system did not always provide identifiable aiming points. A practice target in the London area was always attacked using one of the gasometers outside the Oval cricket ground as the off-set aiming point. Accurate measurements of the displacement of the gasometer from the aiming point were made and applied to the Navigation and Bombing Computer (N.B.C.). Bombing runs were then made and theoretical bombs aimed ostensibly at the gasometer would in fact have struck close to the required aiming point.

Where 5 Group can justifiably claim to have been the first was in their development of the low-level dive bombing marking technique. Lancasters were used initially but the Mosquito was subsequently found to be a better aircraft for that demanding role. Even the single-engined Mustang was used on occasions as a low-level marker. Bennett had rejected the low-level marking system for area attacks on deep penetration German targets and in doing so he was undoubtedly correct. The attack against Maillé le Camp on 3 May 1944, when Main Force crews were forced to orbit in the target area while marking was carried out, cost 42 aircraft from a force of 362. A week later 12 bombers were lost from a force of only 89 which had attacked marshalling yards at Lille - certainly not a distant target. Loss rates of 11.6 and 13.5 per cent were clearly not acceptable, even at this stage of the war, in the long term. As the Official History declared, some forms of off-set marking involved 'more danger than could generally be justified by the standard of bombing accuracy required against most German targets'.

Mosquitoes played a prominent role in 8 Group operations. By the end of the war in May 1945, they had been employed in the fighter, fighter-bomber, photographic reconnaissance, meteorological reconnaissance as well as the day and night bomber roles. Mosquitoes, fitted with a six pound anti-tank gun, also served with Coastal Command. Their task was to intercept U-boats returning to their ports in the Bay of Biscay after having completed Atlantic patrols. By the end of the war they had been credited with the destruction of ten U-boats. In addition, the Mosquito was used by the British Overseas Airways Corporation from 4 February 1943 to carry mail, freight, and occasionally a passenger comfortably equipped in the bomb-bay, between Scotland and Sweden. Versatility and adaptability allied with an excellent performance at high and low levels together with low loss rates were key notes of its operations.

266 Webster & Frankland, op.cit., Vol.3, p.190

267 Sharp & Bowyer, op.cit., p.422
The development of the Mosquito of course was surrounded by controversy. In 1935 the foundations of Bomber Command were laid and it was decided that in the long term the force would consist of four-engined aircraft. Mosquitoes were the resultant of the struggle between those who continued to argue for a light bomber against those who put their faith in the heavy. Harris, not unreasonably, pointed out that the number of pilots available was the critical factor. Both light and heavy bombers required at least one pilot. Unfortunately the training resources of the Empire were insufficient to produce enough pilots to fly the number of light bombers required to drop the equivalent bomb loads that could be carried by the heavy bombers. 269

Mosquitoes of 8 Group, from very small beginnings, were employed, by May 1945, as Oboe and H2S markers, bombers, and gatherers of meteorological information. When the P.F.F. was formed in August 1942 No.109 Squadron, equipped with Wellingsons and Mosquitoes, was one of the nucleus. Once their Mosquitoes were fitted with Oboe they formed an invaluable element of the Pathfinder Force. In June 1943 a second Oboe Mosquito squadron, No.105, joined the P.F.F. The transfer of 105 Squadron to 8 Group left only one Mosquito squadron, No.139, in Bomber Command. For administrative ease it was also transferred to 8 Group for general bombing duties. The posting was not a particularly happy one at the time because 139 Squadron had gained a reputation for individuality in 2 Group as day, low-level attackers. Now they were to be re-employed in a night, high level role as nuisance raiders. They were also given an additional role. Because Bomber Command lacked an active counter-measure Group at that time it was decided that 139 Squadron would also fly spoof raids-called 'spooks' by the squadron—in an attempt to draw enemy fighters away from the Main Force. On nights when no major raids were scheduled 139 Squadron was expected to undertake nuisance raids.

Concentration on at least maintaining the heavy bomber force, as well as production difficulties, meant that expansion of the Mosquito force proceeded very slowly. Although the value of the Mosquito had been early recognised, at least by Bennett, it was not until December 1943 that sufficient aircraft became available to form another squadron in 8 Group. This squadron, No.627, was detached to 5 Group in April 1944 for low-level marking. By that time two further squadrons, numbers 692 and 571, had also been formed in 8 Group so the Light Night Striking Force (L.N.S.F.) as it was called, was at least in the process of expansion. It was also extending its duties. By April 1944 Mosquitoes were able to carry out raids in considerable strength against Berlin and

269 Harris, *Bomber Offensive*, pp.100-101
other cities either when the Main Force did not operate or was employed against another target. In addition, Mosquitoes carried out spoof routing and windowing, early target windowing, pre-raid reconnaissances of targets, and later, even the mining of heavily defended German canal systems.

Initially, the Mosquito had been regarded as unlikely to provide a good bombing platform. It could only carry a two man crew and therefore the second crew member had to combine the duties of navigator, wireless operator, bomb aimer and flight engineer - quite a range of tasks. It flew at high speed but the cockpit was small and therefore it was difficult to install either navigation or bombing aids convenient for crew manipulation. As an additional disadvantage the first Mosquito bombers were only equipped with a Mark IXA bomb sight which was unsuitable for high level bombing.

This fact provided another example of the 'D.C.T.' method of getting results in the face of procrastination by officialdom. Aware of the limitations of the Mark IXA bomb sight, 8 Group fitted and tested a Mark XIV bomb sight in a Mosquito in eight days. Their findings and recommendations were forwarded to the Royal Aircraft Establishment (R.A.E.) early in 1944. When nothing had been heard from the R.A.E. for several months 8 Group simply went ahead with their own refitting programme. By August 1944 28 Mosquitoes out of 74 on strength had been fitted with workable MK XIV bomb sight.\textsuperscript{169} Bombing results improved noticeably.

In order that the L.N.S.F. could operate independent of the weather either \textit{en route} or in the target area 139 Squadron, in January 1944, were fitted with H.S. Gee-H had been tried but, in Bennett's opinion, been found wanting mainly due to its limited range. Also, in 1944, Mosquitoes became available which had been modified to carry a 4,000 pound bomb. This H.E. blast weapon (called a 'cookie' by the crews) provided an economical and productive form of attack. However, it required the enlargement of the Mosquito bomb-doors and, for long range targets, the addition of 50 gallon drop tanks under each wing because of the increased all-up-weight. Once again the versatility of the Mosquito had been put to the test and it did not fail.

During the pre-invasion period when Bomber Command and P.F.F. 'heavies' were generally fully occupied on other targets, it was only the efforts of the L.N.S.F. that kept the pressure on the German home front. Almost every night their Mosquitoes operated and despite the necessarily small numbers

\textsuperscript{269} Musgrove, \textit{Pathfinder Force}, p.207
employed, they created considerable damage both physical and mental. Although they had to contend with the entire German night fighter force, including its effective interception system, losses were very few. Between 1 April 1944 and 30 June 1944 the L.N.S.F. flew 3,798 sorties. Only ten aircraft failed to return from operations. A further fourteen were written off charge either as a result of battle damage or battle accidents (i.e. collisions).\textsuperscript{270}

Some other statistics concerning the Mosquito in relation to the effectiveness of other Bomber Command aircraft are equally revealing. Stirlings flew a total of 18,440 sorties during the war; dropped 27,821 tons of bombs and suffered the loss of 606 aircraft or 3.81 per cent. Wellingsons flew 47,409 sorties; dropped 41,823 tons of bombs and lost 1,332 aircraft or 2.8 per cent. Mosquito figures were 39,795; 26,867 and 254 or 0.63 per cent.\textsuperscript{271} The pity was that the Mosquito force was always small. According to the Bomber Command Review 1945 'The value of the Mosquito attacks as a supplement to the attacks by heavy aircraft (sic) is unquestioned and their contribution to the success of the combined bomber offensive was both significant and praiseworthy'.\textsuperscript{272}

The final marking tasks for the Oboe Mosquitoes were humanitarian operations - they guided the Lancasters to provide news and medical supplies to allied prisoner of war camps and food for the starving Dutch.

Finally, regarding the crews who flew the Mosquitos in \textsuperscript{8} Group, it must be pointed out that only those who qualified on either of the Oboe Squadrons 105 or 109, or who qualified on the H\textsubscript{2}S Squadron 139, were eligible for the award of the Pathfinder badge, the golden eagle. Crews who served on the L.N.S.F. even though employed in \textsuperscript{8} Group were ineligible. To gain the coveted badge they had to have trained as Marker crews, carried out the requisite number of Marker sorties and be certified as Pathfinders. It was not a badge lightly bestowed.

Operations by Bomber Command after October 1944 were conducted in comparative freedom. The term 'comparative' has been used deliberately because losses were still experienced due to the weather and accidents as well as flak and German fighter aircraft. To confirm the continuing hazardous nature

\textsuperscript{270} Sharp & Bowyer, \textit{op.cit.}, p.323
\textsuperscript{271} Ibid., p.324
\textsuperscript{272} Musgrove, \textit{Pathfinder Force}, p.215
of P.F.F. operations, even at this late stage of the war, two of the three Victoria Crosses won by members of the Force were awarded after 23 December 1944. On that date Squadron Leader R.A.M. Palmer, in an Oboe Lancaster and on his 110th operation, was awarded the supreme honour posthumously for his courage displayed during an attack on the Gremberg railway yards at Cologne. From a total force of only 30 aircraft on this daylight raid six were shot down and two others were lost after a collision over the North Sea outbound to the target. A witness to the collision of the two Lancasters described how the Lancaster which was closing to join formation 'came alongside and waggled his wings. Unfortunately he was too close and tipped the other Lanc's wing upwards and they crashed into each other'.

Parachutes were observed but there were no survivors from the collision as life expectancy is measured in brief minutes in a wintry North Sea. With a loss rate of 26.6 per cent on this attack it is only equitable to talk of 'comparative freedom'.

Flak defences continued to claim their victims because in their efforts to obtain greater accuracy both the P.F.F. and Main Force aircraft flew increasingly more often at medium altitudes. However the German defence organisation had, by this stage of the war, lost much of their ability to move their mobile Flak forces because of the damage created in their communications network. Likewise, Luftwaffe fighters were still available but usually only in reduced numbers and having suffered considerable dilution in their operational expertise. The German fighters were also disadvantaged by the sheer numbers of raids and spoofs being conducted both by night and day. As a consequence Bomber Command suffered fewer crew and aircraft losses so greater experience became available and bombing accuracy was improved markedly. The lesson learned when Bomber Command had operated under the direct authority of Eisenhower, was that the force was no longer simply a bludgeon - it could be used very effectively as a rapier. Harris, unfortunately, did not always fully utilise the effectiveness that his Command now possessed.

Shortly after Harris resumed full control of Bomber Command on 14 September 1944 he received his new Directive. Effective 25th September 1944, it listed the German petroleum industry as the first priority target. Second priority targets were rail and waterborne transportation systems, tank production plants and motor transport factories and depots.

Gordon Musgrove giving a personal memory in
Bill Lanning, By Oboe Victor to Cologne/Gremberg
(Wellingborough : Little Staughton Pathfinder Association, no date), page unnumbered.

Messenger, op.cit., p.169
Industrial areas were only to be attacked 'when weather or tactical conditions ... [were] ... unsuitable for operations against specific primary objectives'. Until mid-October 1944 Harris adhered reasonably closely to this Directive.

On 13 October 1944 Harris received a Directive giving details of Operations 'Hurricane I' and 'Hurricane II'. Hurricane I expressly ordered attacks on area targets in the Ruhr which were to be implemented 'on the first occasion when visual bombing conditions are favourable in that area but when they do not permit of visual bombing against the primary objectives (oil) elsewhere in Germany'.

Hurricane II ordered attacks by both the R.A.F. and the U.S.A.A.F. on precision targets - oil in particular - throughout Germany when weather conditions were deemed suitable. Although Harris was reminded that his Directive of 25 September 1944 remained in effect, he wasted no time in displaying his penchant for the area offensive. Hurricane I accorded area attacks legitimacy. Harris's hand written comments on a letter from Bottomley on 1 November 1944, which stressed the importance of the attacks on oil targets, exemplified his disdain for such panaceas. He wrote that 'Here we go round the Mulberry bush'.

It would appear that Harris had been forewarned regarding Hurricanes I and II. On 13/14 October 1944 57 Mosquitoes bombed Cologne. In the early morning of 14 October 1944 1,013 bombers, led by P.F.F. aircraft, launched Hurricane I against the city of Duisburg in the Ruhr. Ground marking for this raid was provided by Controlled Oboe - T. Is were dropped using Oboe with the raid under the authority of a Master Bomber and his Deputy. That same night Duisburg was again the target for another 1,005 bombers. This force attacked the city in two waves with unusually, a two hour gap in the middle. Both waves again employed Controlled Oboe tactics. At the same time as the Duisburg operation another 240 aircraft of 5 Group attacked Brunswick employing their own low level visual marking techniques. Four days later, to demonstrate the variety of attacks possible, 3 Group, who were essentially Gee-H equipped, attacked Bonn in their first independent operation. This raid by 128 Lancasters involved formation bombing - when the leader dropped his bombs the formation dropped theirs. This last raid was possibly by way of a trial because Bonn had received very little previous attention. Damage observed by P.R. aircraft provided a measure of the effectiveness of the new bombing aid. These raids showed the variety of tactics that could now be employed.

275 Webster & Frankland, op.cit., Vol.4, p.173
276 Ibid., p.175
277 Ibid., p.177
by Bomber Command and the comparative freedom in which they operated. They involved 2,386 aircraft and only 23 bombers were lost - a rate of only 0.96 per cent.

The last eight months of war confirmed the maturity of both the Pathfinder Force and Bomber Command. Precision and area targets were attacked by night and day, in good weather and in bad, and from the successes achieved it seemed to some that the bomber had achieved the omnipotence its supporters in the 1930s had forecast. The heavy bomber appeared to be the weapon supreme and new vistas were opened up for those who argued the importance of the strategic bombing offensive. War, however, is characterised by rapid technological and scientific developments. Most of those who foresaw a bright future for the bomber and the continuing importance of air power were, as yet, ignorant of the fact that another revolution was about to occur. They were at the dawn of the age of rocketry, the development of jet engines and the harnessing of nuclear energy in military weapons.

During the last months of the war there was, furthermore, not only a blurring of the distinctions between strategic and tactical bombing but also between area and precision targets. An area attack on a German city viewed as a strategic target could, of course, provide tactical benefits especially to the ground forces. Disrupted communications or destroyed fuel sources provided immediate tactical advantages. At this stage of the war tables which listed the bomb tonnages dropped against cities, oil facilities or communications systems, must always be viewed with caution. Area attacks could destroy precision targets and industrial plants as well as communication systems, or be responsible for the lowering of German morale. As an example, attacks against a German communication system late in the war normally had two aiming points. One would be the railway marshalling yards while the other would be in the city itself. Effective damage in the city meant that necessary repairs to the railway system were delayed. The Royal Air Force, certainly by late 1944, was able to give fullest expression to their use of air power. That is they were able to use the air space for either offensive or defensive purposes while at the same time virtually denying its use by the enemy.278

From January 1945 the Allied bomber offensive increased in intensity but with little significant change in either tactics or policy. There were some changes in armament,

perhaps most notably the development of the 22,000 pound 'Grand Slam' bomb. This weapon, officially described as a Bomb H.E., Aircraft, M.C. 22,000lb., was first used against viaduct targets in the German railway network on 15 March 1945. It was dropped from the specially modified and strengthened Lancasters fitted with up-rated engines (the Merlin 24) provided for only IX and 617 Squadrons. Only 41 Grand Slams were dropped in anger during the war but they proved particularly effective against capital ships, viaducts, bridges, canals and railway tunnels. However, the twenty-three feet of reinforced concrete covering the U-boat pens generally proved too much even for the Grand Slams. Had it been possible to drop them accurately from 40,000 feet, as Barnes Wallis their inventor desired, the results may have been different.

In the last months of the war, although there were changes in the upper echelons of Bomber Command Harris and Bennett retained their positions. With the end of the war in sight it was seen as desirable to replace some Group Commanders in order to provide wider experience for a broader spectrum of senior officers. The Groups affected were Numbers 1, 4 and 5.

To round off this account of P.F.F. operations the raid on Dresden on 13/14 February 1945 provides a suitable finale. In August 1944 Portal had the Directorate of Bomber Operations draw up a plan (later to be called 'Thunderclap') for the destruction of a German city by the British and American bomber forces. Combined with other military events on Germany's eastern and western fronts such destruction might, it was assumed, be the means whereby a formal German surrender could be negotiated. The original plan to attack Berlin (and remember Bomber Command was under Eisenhower's command at this time) was not universally accepted. Some labelled it 'terroristic'. 'Thunderclap' was resurrected in January 1945 but on somewhat different terms. Now the officially proclaimed aim had become to provide assistance to the Russian armies by striking at the Dresden communications bottle-neck. Operation Thunderclap remained second priority to oil targets but actually ahead of communications and jet aircraft construction factories.

Churchill's minute to the Secretary of State for Air on 26 January 1945 was abrupt and unequivocal. He wanted something tangible to offer the Russians at the forthcoming Yalta Conference. No question was posed - nor was it simply a matter of 'harrying the German retreat'. He implicitly requested confirmation that 'Berlin, and no doubt other large

MacBean & Hogben, _op.cit._, p.157

cities in East Germany, should not now be considered especially attractive targets. Churchill allowed twenty-four hours for a reply. Thus the Dresden attack was organised with Portal as the initiator, Bottomley issued the orders, Churchill gave encouragement while the Combined Chiefs of Staff agreed. Bomber Command and the VIIIth US AAF were to carry out the action but only Bomber Command was to bear the blame.

Number 5 Group, with 627 Mosquito Squadron on temporary loan from the PFF in the van, opened the attack on Dresden at 'six and a half minutes past ten' in the evening of 13 February 1945. Low level marking was attempted for this first wave but cloud largely prevented accurate bombing. When the main bombing force arrived three hours later the cloud had mostly disappeared although haze and now smoke created some problems. The PFF Visual Markers were unable to identify the Aiming Point so the Blind Markers were called in by the Master Bomber to drop their T.Is. The Deputy Master Bomber, from low level, confirmed the accuracy of these T.Is and Main Force crews were instructed to bomb them with a 2-second overshoot. The resulting firestorm and heavy loss of life in Dresden has been the subject of continuing controversy ever since. But that, as they say, is another story.

What part then did Bomber Command, with the PFF as both leaders and markers, play in the Second World War? Speer, the German Armaments Minister, in an inscription of a book he presented to Harris, wrote that 'The strategic bombing of Germany was the greatest single battle for Germany of the whole of the war — greater than all their losses in all their retreats from Russia and in the surrender of their armies at Stalingrad'.

Field-Marshal Erwin Rommel shortly after D-Day advised Hitler that 'if you can't stop the bombing we cannot win and it's no good going on because all we get by going on is to lose another city every night'.

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281 Webster & Frankland, op.cit., Vol.3, p.103

282 Ibid.

Note: Martin Gilbert in Road to Victory, p.1161 stated that the words quoted arose in conversation between Churchill and Sinclair.


284 Musgrove, Pathfinder Force, p.171

RAF Bomber Command's
NIGHT ATTACKS on
DRESDEN,
13-14th February 1945

1 Zeiss Ikon factory
2 (5 miles to S.E.) Sachsenwerk factory
3 (9 miles to N.E.) Sachsenwerk factory
4 Siemens glass factory
5 Zeiss Ikon (Gochlewerk) factory
6 Industrial Estate
7 Arsenal
8 Infantry Barracks
9 Friedrichstadt Marshalling yards
10 S.S. Rock bunker
11 Military Transport park
12 Air Zone Command H.Q.
13 Crippling cigarette factory
14 Yenidze cigarette factory
15 Central Telegraph Office
16 Lobtau gasworks
17 Neustadt gasworks
18 Wettin power station
19 Johannstadt power station
20 Oil store
21 Oil store (Shell)
22 District heating plant
23 Seidel & Naumann factory

David Irving, The Destruction of Dresden
Field-Marshal Montgomery declared that 'he regarded the British bombers as having been the greatest of all in the destruction of the German armies as a whole'.

Eisenhower, after the German Ardennes' offensive had failed, sent a thank-you message to Harris for the tremendous assistance that Bomber Command had provided at a critical time. Harris acknowledged the signal and advised the Supreme Commander that the crews involved had received his message. Harris added, in his reply to Eisenhower, that 'You know by now you can always depend on my lads for anything short of the impossible'. Tedder later saw Harris's signal in Eisenhower's H.Q. and scrawled across it in Eisenhower's own handwriting were the words 'Goddamnit they've already achieved the impossible'.

Twenty five years after the war, when certain secrecy restrictions were lifted, one released paper revealed that Eisenhower 'had come to regard the British Bomber Command as one of the most effective parts of his entire organisation - always seeking and finding and using new ways for their particular type of aircraft to be of assistance in forwarding the progress of the armies on the ground'.

With these recommendations in mind it is obvious that the part played by Bomber Command and the VIIIth U.S.A.A.F. has, since the war, been vastly under-estimated. Agreed, they did not win the war. Without them the war would have been lost. Harris, in concluding his speech in 1977 said that 'whenever I think of what they [Bomber Command and the VIIIth U.S.A.A.F.] really achieved, I realise that you have never really been given adequate recognition of what you all did'. A fitting note on which to conclude the story of the preparation for war and the Pathfinder role in the bomber war.


288 Ibid.

289 Ibid.

290 Ibid.

291 Ibid.
15. Conclusions

The three dimensional nature of war was first acknowledged by British military authorities as early as October 1916. At that time No. 3 Wing, Royal Naval Air Service, was formed at Luxeuil for the express purpose of attacking industrial targets, particularly munition factories, situated in German cities well behind the established front lines. Army pressures forced the unit to disband in May 1917 because the aircraft and pilots were required for reconnaissance and military support operations. But the seeds of changed perceptions had been sown. The formation of 41 Wing in October 1917, although it was the consequence of public demands for retaliation after the Gotha raids on London and other targets in south-east England between May and August 1917, confirmed the acceptance of the altered structure of war. Further proof was provided, in June 1918, by the establishment of the Independent Force, Royal Air Force. Despite the fact that during its operations this bomber force only dropped 550 tons of bombs on German supply and production centres, it endorsed the British acceptance of the three dimensional concept of war.

During the 1930s there was yet another change in the public attitude to war. Fear of the bomber, and the concept of a knock-out blow, became widespread. British reactions to the German raids by Zeppelins and Gothas during the First World War had given rise to the widely held belief that extended wars were no longer possible. The third dimension of war, strategic bombing, rather than the three dimensional nature of war, became the dominant fear in most civilian (and some military) minds. It was accepted that modern war would admit many front lines, not least of which were the cities and civilian populations within the radius of action of a strategic bomber force. Mindful of the need for an effective deterrent, but still fearful of a knock-out blow, Britain's preparations for war, during the 1930s, focused largely on the need for a powerful strategic bomber force.

On the night of 24/25 March 1944 Bomber Command launched 577 Lancasters, 216 Halifaxes and 18 Mosquitoes for what was to prove to be the last major bombing assault by the R.A.F. on Berlin. A total of 72 bombers failed to return. This raid marked the end of the Battle of Berlin, begun by Harris in August 1943, and aimed at bringing about the defeat of Germany. But the German authorities made no tentative overtures for peace. Already, certainly well before March 1944, the passage of time had proved the falseness of the belief that only short-duration wars were possible. Thus, the failure of the strategic bombing assault against the German capital reconfirmed the three dimensional nature of war. With the force available it was clear that the war would not be won by bombing alone.
However, the myth of the 'knock-out' blow had been enduring. In June 1941 initial plans were made for a force of 4,000 heavy bombers to be available by the Spring of 1943. With such a force it was claimed, Germany's defeat would be swift and certain. This was simply an extension of the knock-out myth because such a target was never achievable without unacceptable restrictions on the development of both the Army and the Royal Navy and, indeed, other commands of the Royal Air Force. Air Vice-Marshall J.C. Slessor then Commanding 5 Group called it 'an opium-smoker's dream'.¹ Not all subscribed, however, to the theory that the war could be won by either a 'knock-out' blow or by any one of the three Services acting in isolation. In fact, until the German attack on Russia in June 1941 and the entry of the United States into the war in the following December, victory for an isolated Great Britain was a barely discernable prospect. A small but gradually increasing number were becoming aware that only collective, unified action would bring final victory. Four elements are identifiable as playing major parts in the defeat of Germany: the winning of air superiority over Western Europe; advance of the Allied armies across German-occupied territories and across Germany itself; collapse of German industry and, finally, the acute shortage of petroleum products experienced in Germany after September 1944.

Such a list may provide reason for some to claim that the R.A.F. and the U.S.A.A.F. must surely have played major parts in the defeat of Germany. Quite correct - but it is essential to appreciate that although they were 'major parts' they were not the be-all and end-all. Without the navy to move the invasion forces, without the armies to advance across Europe and without industry in England and America, final victory would not have been achieved. Those who would argue the greater importance of the R.A.F. over the Army would do well to recognise that the securing of air superiority was largely due to Allied armies over-running the well-established German early warning radar system which had proved so effective against Allied bomber fleets. Allied armies also made it possible to establish mobile Oboe and Gee-H units on continental Europe which extended the increasingly accurate reach of the strategic bombers.

At the same time the importance of 'Big Week' - 20-25 February 1944 - must not be overlooked.² Under the code name 'Argument', this was a series of attacks by the U.S.A.A.F. against German factories involved in the production of single

¹ Terraine, The Right of the Line, p.289
² Craven & Cate, (eds.), op.cit., Vol.3, pp.30-66
and twin-engined fighter aircraft. The aim was two fold. Firstly, it was to destroy the manufacturing and assembly plants. Secondly, it was to bring to action the Luftwaffe day fighter force, so that they could be destroyed by the American long-range fighter escorts. The widespread series of raids, from bases in England and Italy, must be counted as successes, but not solely from either the damage created in the factories, or the number of Luftwaffe fighters destroyed in the air. These attacks accelerated the hitherto disorganised dispersal of the German aircraft industry. It was thus rendered more vulnerable when transportation was identified as the primary target for Allied bombers later in the war. The German fighter forces were not swept from the skies as a consequence of 'Big Week' and, as well, German fighter production actually continued to increase until September 1944. The achievement of 'Big Week' was that, although the skies over Europe were too vast for the allies to claim that air supremacy by day had been won, the Luftwaffe, from then on, would only be able to attain an ephemeral and localised air superiority.

Total victory, however, was only won by the allied armed forces acting in combination - the aggregation of their individual parts, rather than the actions of any specific military formation. Thus we come to the question of what part did the Pathfinder Force play in that final victory?

Britain, by September 1939, had failed in its aim to build a bomber force, either sufficient in numbers or adequately trained and equipped to meet the demands of modern war. By mid-1942 Bomber Command was heading for disaster. Some were demanding that the enormous sums of money and vast industrial effort concentrated on the bomber force be reallocated. Bomber Command's actions were uncoordinated, it could not achieve concentration, and its effects physically against German industry, or morally against German civilians, were negligible. Admittedly it provided up-lift on the home front, thanks largely to a skilled propaganda machine, but the number of doubters were increasing. The first success for the P.P.F. was that it at least halted the downward spiral in which Bomber Command had appeared to be trapped.

Although no time had been allowed for training, and using only the same equipment as provided for the Main Force crews, the P.P.F. was able to bring about improved bombing concentration. The advent of the P.P.F. marked an end to individualism in Squadrons and in Groups. Now there were the leaders and those who were led and each recognised his position. Following the introduction of purpose-built T.Is in 1943, Main Force crews were no longer burdened with the
responsibility for target identification. Their task was simply to bomb the sky or ground markers provided by the P.F.F. Unfortunately, although target marking accuracy improved as new navigational and bombing aids were introduced, the same could not always be said for the Main Force bombing. Too many crews too often, failed to identify the M.P.I. of the T.Is, while too many others were content to aim their bombs at the largest visible fire centre. Quite laudable when the fire was the actual aiming point but, all too frequently, it was either a German decoy or a misplaced load of incendiaries. It must be allowed, however, that not all the blame for inaccurate bombing can be laid at the bomb sights of Main Force crews. Systematic errors, which were introduced when crews were expected to aim at the M.P.I. of T.Is rather than the aiming point itself, continued to provide frustration and inaccuracy to the end of the war. However, they were at least partially overcome by the introduction and use of Master Bombers on many raids.

Despite the claims of 5 Group and acknowledging Guy Gibson's efforts with 617 Squadron against the Ruhr Dams, it was the P.F.F. which, when given the equipment and the opportunities, was the first to use and develop the Master Bomber technique on full scale raids. Master Bombers, not necessarily the senior officer on a particular raid, arrived first in the target area and were usually among the last to leave. They provided both encouragement and direction. Gradually their duties were extended so that their advice and instructions enabled precision targets to be destroyed and invaluable close support to be provided for the Allied ground forces. The Master Bomber system worked because, appointment and not rank, determined who controlled a particular operation. It was the same in each individual bomber. The man in command, normally the pilot, was authorised to exercise his control for each and every flight that he and his crew undertook. Thus, a sergeant pilot, authorised as captain of an aircraft, could exercise his control over every other person in that aircraft, throughout the flight, regardless of rank. It has led to some interesting - and some tragic - situations. Master Bombers were appointed to lead and control specific raids because of their abilities, determination and knowledge, and they were the sole determinants. Their employment must count as a further plus for the P.F.F. Bomber Command's results improved as a direct result of the efforts they made and the risks that they were prepared to accept.

No one should claim of course that the P.F.F. was immediately able to convert a force of individuals into an effective instrument of war. Years of neglect, misapprehensions, and the failure to develop adequate navigational and bombing systems, were not to be overcome by the stroke of an administrative pen. For the Pathfinders it was also a learning experience. Press on regardless was their
unofficial motto and with this as a guiding precept, by trial and error, they attempted to achieve the excellence demanded by Bennett. Change was their constant routine. The question was always, will the tactic employed today, still work tomorrow? Or next week? Next year was always too far in the uncertain future to bear contemplation.

Naturally the P.F.F. experienced failures. All men have frailties and in a highly scientific war, where the physical elements of wind and weather could still play a part, there was no way that success could always attend their efforts. Bomber Command and the Pathfinders faced three enemies - darkness, weather, and increasingly sophisticated and enlarging German defences. In this regard the Meteorological flight established in 8 Group, and operating Mosquito aircraft performed an invaluable function not only for the Pathfinders but also for Bomber Command as a whole. The information obtained by the crews of 1409 Flight both by day and night largely determined not only the targets to be attacked but also the techniques to be employed. Another plus for 8 Group.

What must be considered as a tragedy for the P.F.F. was that they were not, for whatever reason, allowed the expansion necessary to keep pace with the growth of Bomber Command. Harris knew this, hence his admission that the P.F.F. could only operate against two targets each night and then only on two nights out of every three, but only for a limited period of twelve days. Did Harris accept this as a justification for expanding the Pathfinder Force? On the contrary, in April 1944, he used it as part excuse for further reducing its strength by detaching two of the long serving Lancaster Squadrons and one Mosquito squadron to 5 Group for Pathfinding duties. An examination of the Bomber Command Orders of Battle from 18 September 1942 to 8 May 1945 clearly revealed the most favoured treatment accorded 5 Group when compared with 8 Group.* If only the allocation of Lancasters is considered, then 5 Group was the most favoured Group in Bomber Command.

The Order of Battle for 8 Group on 18 September 1942 listed five different aircraft types and a total of 66 aircraft on unit charge, 19 of which were Lancasters. At the same time 5 Group had 143 Lancasters, 24 Manchesters and 2 Wellingsons. By 4 February 1943, although the P.F.F. still laboured under the handicap of five different types and only 36 Lancasters, 5 Group was now an all-Lancaster formation with 186 aircraft. The next all-Lancaster Group, No.1, did not appear on the Order of Battle until 1 June 1944.

* Hartcup, op.cit., Appendix 2, p.2

* Figures derived from Andrew, Panter & Hartcup, op.cit., Volumes 4, 5 & 6 of the Narrative History.
As far as Lancasters were concerned the peak for 8 Group was reached on 24 February 1944 when 136 were on unit strengths. At the same time 5 Group possessed 240 Lancasters. Consider the following table:

**BOMBER COMMAND ORDERS OF BATTLE**

<table>
<thead>
<tr>
<th>DATE</th>
<th>5 GROUP</th>
<th>8 GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 June 1944</td>
<td>Lancasters 310</td>
<td>Lancasters 119</td>
</tr>
<tr>
<td></td>
<td>Mosquitoes 22</td>
<td>Mosquitoes 110</td>
</tr>
<tr>
<td>28 December 1944</td>
<td>Lancasters 359</td>
<td>Lancasters 108</td>
</tr>
<tr>
<td></td>
<td>Mosquitoes 24</td>
<td>Mosquitoes 201</td>
</tr>
<tr>
<td>9 May 1945</td>
<td>Lancasters 380</td>
<td>Lancasters 134</td>
</tr>
<tr>
<td></td>
<td>Mosquitoes 28</td>
<td>Mosquitoes 223</td>
</tr>
</tbody>
</table>

These figures would indicate that 8 Group's Mosquito force expanded rapidly. It did, but the growth in the Pathfinder element of the Mosquito force was much less rapid. The Mosquito expansion that occurred in 8 Group was largely concerned with the Light Night Striking Force. There were 67 Mosquitoes in the P.F.F. on 19 August 1943 and 88 at the end of the war - hardly indicative of either extensive or rapid growth. Harris refused to permit expansion of the P.F.F. consistent with the needs of Bomber Command. This fact, coupled with the problem of recruiting the skilled crews available both in 5 Group, and elsewhere in Bomber Command, created difficulties for Bennett and prevented the Pathfinders from reaching their full potential.

It must also be remembered that by April 1944 5 Group, with three squadrons on detachment from the P.F.F. was also officially carrying out Pathfinding duties. The homogeneity of the P.F.F., wherein perhaps lay its greatest strength, was destroyed never to be rebuilt. During the last year of war, indicative of the value of the P.F.F. and the tactic of Pathfinding, leading exponents of the art were called upon increasingly often to display their talents against precision targets. That they were not found wanting is a further accolade for the Pathfinders.

For too long the P.F.F. laboured under the delusion, held by Harris, that Bomber Command in general was incapable of precision bombing. But while Cochrane and 5 Group were permitted the luxury of removing squadrons from the front line to train for specialist one-off precision attacks, 8 Group were never accorded either the luxury of numbers or the necessary approval for such diversions. Despite these
serious disadvantages 8 Group, in the attacks on communications and gun emplacements prior to D-Day and later at Caen and other army support operations, were able to show that Harris had been wrong in his assessments. Subsequently Harris admitted his misjudgment. The P.F.F., had it been allowed to expand, and had support for it been uncompromising and not circumscribed by a doubting Commander, possessed both the men and the capacity for all the tasks later carried out by 5 Group crews.

Despite Harris's assertion to Bennett that his support for the P.F.F. would be unstinting, sufficient evidence exists for serious doubts to be raised that total support was always forthcoming. In the provision of aircraft, equipment and men it was not always 8 Group, whose demands were answered first. Harris had other, older loyalties than the Pathfinders. As established, the P.F.F. was not what Harris had wanted and nor, it seemed, did Harris ever forget this fact. In at least partial confirmation we had his puzzling and intriguing statement, in April 1944 that 'in Bennett as an individual we have already far too many eggs in one basket' In that same month Harris confirmed his acceptance of the principle of Pathfinding because, although 8 Group suffered a severe setback, the tactic became broader-based among the rest of Bomber Command. Harris recognised the need for Pathfinders but still, in 1944, he wanted them only on his terms.

Bennett was also critical of the personal animosities that were allowed to persist at all levels in Bomber Command throughout the war. In a speech to the Royal Aeronautical Society Historical Group, delivered after the war, he claimed that the P.F.F. had enabled Bomber Command to produce results five hundred times better than they would have been had the Pathfinders not been established. Further improvements which could have taken place were prevented, Bennett stated, by jealousies, animosities and sniping from all sides. He did not paint a picture of Command unanimity. Yet there was truth in his assertion. With regard to Cochrane of 5 Group, we have Bennett's own words to show that he was equally guilty of that which he later accused others. A final judgment can only be that each thought at the time that he was doing his best for his particular Command and the war effort in general. That such a situation was allowed to persist reflects badly on the Commander in Chief no matter who was disadvantaged.

It would appear that no one was averse to attempting to circumvent the normal chain of command in order to have his wishes satisfied. Harris, on various occasions, expressed his dissatisfaction with the arrangements for the establishment of the P.F.F. Sometimes he blamed junior officers in the Air Ministry who wanted to run Bomber Command from the security of their lowly offices while bearing none of the ultimate

Portal Papers, File 10, 1944, 14 April 1944, Encl.15a
responsibility. But Harris, at least for much of the war, had the ear and support of Churchill. In a clear attempt to bypass normal Service channels he wrote to Churchill on 6 July 1942 and began, 'I ask your assistance'. This letter dealt with administrative details for the P.F.F. and should surely have been directed to the C.A.S. However, in this letter, Harris said that on the question of the formation of the P.F.F. he had been 'overborne by the C.A.S. and the Air Staff'. Clearly he was now looking to a higher authority than his own commanding officer. Churchill redirected this six page letter with but eight words. In a hand written annotation he appended, 'Chancellor of the Exchequer What can you do?' Initiators of such questionable tactics, it is hoped, saw them as being for the common good rather than for any personal gain.

Pathfinding tactics in World War Two were pioneered by the Luftwaffe in 1940. Therefore it is relevant to consider a German appreciation of the P.F.F. as at March 1944 issued by the Lufwaffenführungsstab Ic/Fremde Luftwaffen West. In the Preface to this paper, it was made clear that the success of any raid was always measured by the extent which the P.F.F. was able to overcome the dual hazards of weather and the German defences. The opening sentence provided a seal of approval when it observed that 'The success of a large-scale night raid by the RAF is in increasing measure dependent on the conscientious flying of the Pathfinder crews'. The paper also supported S.O. Bufton's claim when it said that 'The grouping of the Pathfinders into a Bomber Group of their own made it possible to standardise the equipment and the training, to put new ideas into operation and immediately to evaluate all experiences'.

This paper, which displayed an extensive knowledge of the P.F.F. and its tactics and equipment, concluded that despite the strong criticism at first levelled against the Force it had prevailed 'because of the successes achieved during the years 1943/44'. The author appreciated that operational

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6 Frem 3/79, P.R.O. XC 5349, 6 July 1942
7 Ibid.
8 Ibid.
9 German Air Force Operations Staff, Western Front, and quoted in Mahaddie, op.cit., pp.150-8
10 Ibid., p.150
11 Ibid., p.151
12 Ibid., p.158
tactics were continually being refined and asserted that increasing use would be made of Pathfinders as the war progressed. Overall it was an assessment of the P.P.F. in general, its leader and its men, equipment, and tactics, which could have been written by an officer at 8 Group Headquarters calling for expansion of the Force.

During the last five months of war one author claimed that the 'Pathfinder Force lost importance'. Undeniably he was correct. Indeed, the P.P.F. had lost a great deal of importance when it was forcibly emasculated in April 1944. But what must be noted is that the P.P.F. lost its importance then as the result of the wielding of an administrative pen and not because of any reduction in need for such a force. In point of fact the need had grown as is evidenced that other bomber Groups were actively encouraged to do their own Pathfinding. It would appear that the P.P.F. was not wanted under the terms on which it had been established. Harris had objected to its formation and, it would seem, took the first opportunity presented to re-establish it under terms more to his liking. Perhaps with the end of the war no longer in doubt, although the time-frame was still indeterminate, Portal saw no reason to continue what had been a purely internal struggle. He raised no objections to the changes made by Harris and Bennett, as the subordinate, had to accept the situation.

At the end of the war Bennett sent a signal addressed to the P.P.F. It said, in part, that 'The Path Finder Force has shouldered a grave responsibility. It has led Bomber Command, - the greatest striking force ever known. That we have been successful can be seen in the far-reaching results which the Bomber Offensive has achieved. That is the greatest reward the Path Finder Force ever hopes to receive, for those results have benefitted all law-abiding peoples'.

Harris signalled Bennett on 10 May 1945. He said 'The rubble that was Germany is the incontrovertible evidence that the path to the German cities was well and truly found. Your exacting task has been most magnificently accomplished. Congratulations and my warmest thanks'.

On 12 May 1945 Bennett was replaced as the Pathfinders' A.O.C. by Air Marshal J.R. Whitely. On 15 December 1945 No. 8 (P.P.F.) Group was officially disbanded. No further reason to 'Press on Regardless' existed.

13 Terraine, op.cit., p.679
14 Bennett File. H.Q. Path Finder Force, V.E. Day 1945
15 Bennett File. Signal A451, 101715B
Epitaph

Flight Sergeant Hugh Rowell Brodie, RAAF, from Victoria, Australia, was killed in action over Germany on June 2nd, 1944, flying with 400 Squadron. He was aged thirty. This devotional fragment, his only published poem, first appeared in the *War Service Record, 1939-45*, published by the Victoria Education Department.

"Almighty and all present Power, 
Shore is the prayer I make to Thee; 
I do not ask, in battle hour, 
For any shield to cover me. 
The vast unalterable way 
From which the stars do not depart 
May not be turned aside to stay 
The bullet flying to my heart. 
I ask no help to stifle my foe, 
I seek no petty victory here; 
The enemy I hate, I know 
To thee, O God, is also dear; 
But this I pray, be at my side 
Where death is drawing through the sky. 
Almighty God, who also died, 
Teach me the way that I should die."

Chaz Bowyer, *Path Finders at War* 
BIBLIOGRAPHY

1. UNPUBLISHED SOURCES:

   AIR 1/725/97/7, 26 November 1917, Trenchard H.T., Long Distance Bombing
   AIR 2/7649, P.R.O. XC 623
   AIR 8/688, P.R.O. 199152
   AIR 8/1015, P.R.O. 5346
   AIR 14/2701 P.R.O. 3859
   AIR 14/3523 P.R.O. XC 5349
   AIR 14/3548 P.R.O. XC 07380
   AIR 14/3548 P.R.O. XC 88806
   AIR 20/4809 P.R.O. XC 1312
   AIR 25/156 P.R.O. XC 08350
   AIR 41/42 P.R.O. XC 197366

   Air Ministry, The Strategic Air War against Germany
   (London: Air Ministry, no date)

   Andrew, C.R., The R.A.F. in the Bombing Offensive against Germany
   (London: Air Ministry, 1949), Vol.4 of Narrative History

* Bennett, Air Vice Marshal D.C.T., File
  (i) Bomber Command Quarterly Survey, No.10, July-September 1944
  (iii) P.F.F./S 49/AIR (Marking Techniques)
  (iv) Letter Bennett to Smith
  (v) Letter on Target Finding Force
  (vi) Signal to P.F.F. on V.E. Day
  (vii) Unsigned draft of a letter
  (viii) 50/91/8 AIR, 5 August 1944, Letter from Cochrane to H.Q. Bomber Command

* (The Bennett file was donated by Mrs Ly Bennett (widow of Air Vice-Marshal D.C.T. Bennett) to Mr Allan J. Vial of Broadbeach, Queensland. Allan is President of the Path Finder Force Association in Australia and he kindly provided me with access to this and other material held at his home.)
Frankland, Noble, *The Planning of the Bombing Offensive and its Contribution to German Collapse*  
(London: Air Ministry, 1951)

Harris, Air Chief Marshal Sir Arthur T., *Despatch on War Operations 23rd February 1942-8th May 1945*  
(London: Air Ministry, October 1945)

Hartcup, G.R.M., *The R.A.F. in the Bombing Offensive against Germany*  
(London: Air Ministry, no date), Vol.6 of Narrative History

Mackenzie-Wood, Wg.Cdr. *Aircrew Training 1934-1942*  
(London: Air Ministry, no date)

Parter, E.B., *The R.A.F. in the Bombing Offensive against Germany*  
(London: Air Ministry, no date), Vols. 2 and 5 of Narrative History

* Portal Papers, File 9, 1942, Items 3l, 3la, 32, 32c  
* Portal Papers, File 10, 1944, Items 15, 15a, 15b, 15c

* (The Portal Papers were kindly provided by H.J.R. Wing, Assistant Librarian, Christ Church, Oxford University)

PREM 3/29 P.R.O. XC 5349

Roberts, F.C., *The R.A.F. in the Bombing Offensive Against Germany*  
(London: Air Ministry, no date), Vol.3 of Narrative History

(London: Air Ministry, no date)

Wernham, R.B. & Frankland, A.N., *The R.A.F. in the Bombing Offensive against Germany*  
(London: Air Ministry, no date), Vol.1 of Narrative History
TAPE RECORDINGS:

1. Bennett, D.C.T., interviewed by Bruce Phillips 'early' in 1986


3. Mahaddie, Hamish, A Wing and a Prayer

4. P.F.P. Reminiscences, The Path to Victory

5. Searby, John, Peenemünde

6. Searby, John, The Berlin Raids

7. Searby, John, The Ruhr

(All the above tape recordings were kindly provided by Allan J. Vial)
2. **PUBLISHED SOURCES:**

Aders, Gebhard, *History of the German Night Fighter Force 1917-1945*  
(London: Jane's Publishing Company, 1979)

Air Ministry, *Air Navigation Vol. 2 Allied Subjects*  
(London: Air Ministry, 1952), A.P. 1234E

Air Ministry, *Air Navigation Vol. 5 Radio Navigation Aids*  
(London: Air Ministry, 1947), A.P. 1234E

Air Ministry, *Bombs & Bombing Equipment*  
(London: Air Ministry, 1952)

(London: Air Ministry, 1938), A.P. 1456

Air Ministry, *Signals Vol. 3 Aircraft Radio*  
(London: Air Ministry, 1956)

Air Ministry, *The Air Force List August 1935*  
(London: H.M.S.O., 1935)

Air Ministry, *The Origins & Development of Operational Research in the Royal Air Force*  
(London: H.M.S.O., 1963)

Air Ministry, *The Rise & Fall of the German Air Force*  
(London: Air Ministry, 1948)

Allen, H.R., *The Legacy of Lord Trenchard*  
(London: Cassell, 1972)

(London: Hollis & Carter, 1965)

Anderson, William, *Pathfinders*  
(London: Jarrolds, 1946)


Austen, R.L., *High Adventure*  
(Chichester: Barry Rose, 1989)
Barker, Ralph, *The Thousand Plan*  
(London: Chatto & Windus, 1965)

Barnett, Correlli, *The Audit of War*  
(London: Macmillan, 1986)

Baumbach, Werner, *Broken Swastika*  
(London: Robert Hale, 1986)

Bekker, Cajus, *The Luftwaffe War Diaries*  
(London: Macdonald, 1964)

Bennett, D.C.T., *Pathfinder*  
(London: Frederick Muller Ltd., 1958)

Bennett, D.C.T., *The Complete Air Navigator*  
(London: Sir Isaac Pitman & Sons Ltd., 1945)

Bennett, Tom, *617 Squadron*  
(Wellingborough: Patrick Stephens, 1986)

Bialer, Uri, 'Elite Opinion & Defence Policy: Air Power Advocacy & British Rearmament during the 1930's' in  
*British Journal of International Studies*, Vol.6, No.1, April 1980

Bialer, Uri, *The Shadow of the Bomber*  
(London: Royal Historical Society, 1980)

'Blue Force Staff Officer', 'Some Lessons of the Air Exercises 1930' in  

Bond, Brian & Murray, Williamson, 'The British Armed Forces, 1918-1939' in  
(Boston: Allen & Unwin, 1988)

Bottomley, Sir Norman, 'The Strategic Bomber Offensive against Germany' in  

Bowyer, Chaz, *Path Finders at War*  
(London: Ian Allen, 1977)

Bowyer, Michael J.F., *Bomber Barons*  
(London: William Kimber, 1983)

Bowyer, Michael J.F., *2 Group R.A.F.*  
(London: Faber & Faber, 1974)
Boyle, Andrew, Trenchard
(London: Collins, 1962)

Boyle, Andrew, No Passing Glory
(London: Collins, 1955)

Bramson, Alan, Master Airman
(Shrewsbury: Airlife Publishing Ltd., 1985)

Brookes, Andrew, V Force
(London: Jane's, 1982)

Brunswig, Hans, Feuersturm über Hamburg
(Stuttgart: Motorbuch Verlag, 1979)

Bullock, Alan, Hitler A Study in Tyranny
(London: Odhams Press Limited, 1952)
Chorley, W.R., *To See the Dawn Breaking*  
(Ottery St. Mary: W.R. Chorley, 1981)


Collier, Basil, *A History of Air Power*  
(London: Purnell Book Services Ltd., 1974)

Collier, Basil, *The Defence of the United Kingdom*  
(London: H.M.S.O., 1957)

Cocke, Ronald C. & Nesbitt, Roy Conyers, *Target: Hitler's Oil*  
(London: William Kimber, 1985)

Cooper, Alan, W., *Beyond the Dams to the Tirpitz*  

Cooper, Alan W., *Bombers over Berlin*  
(London: William Kimber, 1985)

Cooper, Malcolm, *The Birth of Independent Air Power*  

Cooper, Malcolm, 'The British Experience of Strategic Bombing' in  

Couling, Rupert, 'First Deliveries' in  
*Royal Air Force Yearbook*, 1986

Cox, Jafna L., 'A Splendid Training Ground: The Importance to the Royal Air Force of its Role in Iraq 1919-1932' in  

Craven, W.F. & Cate, J.L.(eds.), *The Army Air Forces in World War II*  
Vols. 1 & 2  
(Chicago: University of Chicago Press, 1964)

Cumming, Michael, *Pathfinder Cranswick*  

'Cyclops', 'Air Defence of Great Britain Command Exercise, 1933' in  
Dean, Sir Maurice, The Royal Air Force and Two World Wars  
(London: Cassell, 1979)

Divine, David, The Broken Wing  
(London: Hutchinson, 1966)

Douhet, Giulio, The Command of the Air  


(Brampton: R.A.F. Printing, 1977) (From A.J. Vial archives)


Ellis, L.F., Victory in the West Vol.1  
(London: H.M.S.O., 1962)


Frankland, Noble, *The Bombing Offensive against Germany* (London: Faber & Faber, 1965)


Gilbert, Martin, *Finest Hour* (London: Heinemann, 1983)

Gilbert, Martin, *Road to Victory* (London: Heinemann, 1985)


Greenaway, N. Dudley, *The Long Haul* (Warkworth: Private printing, no date)


Hall, Sam, 'Where Ignorance is not Bliss' in Marker, Spring 1990


Harris, Sir Arthur, Bomber Offensive
(London: Collins, 1947)

Harvey, Maurice, The Allied Bomber War 1939-1945
(Tunbridge Wells: Spellmount, 1992)

Hastings, Max, Bomber Command
(London: Michael Joseph, 1979)

Hecks, Karl, Bombing 1939-1945
(London: Robert Hale, 1990)

Herrington, John, Air Power over Europe 1944-1945
(Canberra: Australian War Memorial, 1963)

Herrman, Hajo, Eagle's Wings
(Shrewsbury: Airlife Publishing Ltd., 1991)


Hinsley, F.H. British Intelligence in the Second World War, Vol.2

Hyde, H. Montgomery, British Air Policy between the Wars 1918-1939
(London: Heinemann, 1976)
Irving, David, *Hitler's War*  
(London: Hodder & Stoughton, 1977)

Irving, David, *The Destruction of Dresden*  

Irving, David, *The Rise and Fall of the Luftwaffe*  
(London: Purnell Book Services Ltd., 1973)

Jackson, A.S., *Pathfinder Bennett*  
(Lavenham: Terence Dalton Limited, 1991)

James, Thustan, 'Getting Going at the Shadow Factories'  
in *Aeroplane*, November 3, 1937

(Oxford: Clarendon Press, 1937)

Jones, Neville, *The Beginnings of Strategic Air Power*  

Jones, Neville, *The Origins of Strategic Bombing*  

Jones, R.V., *Most Secret War*  

Jones, W.E., *Bomber Intelligence*  
(Leicester: Midland Counties Publications, 1983)


Knight, Michael, Strategic Offensive Air Operations (London: Brassey's [U.K.], 1985)


Lacey-Johnson, Lionel, *Point Blank and Beyond*  
(Shrewsbury: Airlife Publishing Ltd., 1991)

Lanning, Bill, *By Oboe Victor to Coloune/Gremberg*  
(Wellingborough: Little Staughton Pathfinder Association,  
no date) (From A.J. Vial archives)

Lawrence, W.J., *No. 5 Bomber Group R.A.F. 1939-1945*  
(London: Faber & Faber Ltd., 1951)

Lee, Asher, *Goering Air Leader*  
(London: Duckworth, 1972)

Lee, Asher, *The German Air Force*  
(London: Duckworth, 1946)

Lewis, Bruce, *Aircrew*  
(London: Leo Cooper, 1991)

Longmate, Norman, *The Bombers*  
(London: Hutchinson, 1983)
MacBean, John A. & Hogben, Arthur S., *Bombs Gone*  
(Wellingborough: Patrick Stephens Ltd., 1990)

MacMillan, Norman, *Sir Sefton Brancker*  
(London: Heinemann, 1935)

Mahaddie, T.G., *Hamish*  
(London: Ian Allan Ltd., 1989)

Mahan, A.T., *The Influence of Sea Power upon History 1660-1785*  
(London: Sampson Low, Marston & Co. Ltd., 1890)

Maitland, Andrew, *Through the Bomb Sight*  

Mason, Francis K., *The Avro Lancaster*  
(Bourne End: Aston Publications Limited, 1989)

Mason, T., *9 Squadron*  
(London: Beaumont Aviation Literature, 1965)

McKee, Alexander, *Dresden 1945: The Devil's Tinderbox*  

Merrick, K.A., *The Handley-Page Halifax*  
(Bourne End: Aston Publications Ltd., 1990)

Messenger, Charles, *'Bomber' Harris & the Strategic Bombing Offensive 1939-1945*  

Middlebrook, Martin & Everitt, Chris, *The Bomber Command War Diaries*  
(Harmondsworth: Penguin Books Ltd., 1985)

Middlebrook, Martin, *'Marshal of the Royal Air Force Sir Arthur Harris' in Carver, Sir Michael [ed.], The War Lords*  
(Boston: Little, Brow & Company, 1976)

Middlebrook, Martin, *The Battle of Hamburg*  
(London: Allen Lane, 1980)

Middlebrook, Martin, *The Berlin Raids*  
(London: Viking, 1988)

Middlebrook, Martin, *The Nuremberg Raid*  
(London: Allen Lane, 1978)
Middlebrook, Martin, *The Peenemünde Raid* 
(London: Allen Lane, 1982)

Middlemass, Keith & Barnes, John, *Baldwin* 

Moorehead, Alan, *African Trilogy* 
(London: Hamish Hamilton, 1945)

Murchie, Guy, *Song of the Sky* 
(London: Secker & Warburg, 1955)

Murray, Williamson, 'British Military Effectiveness in the Second World War' in 
(Boston: Allen & Unwin, 1988)

Musgrove, Gordon, *Operation Gomorrah* 
(London: Jane's, 1981)

Musgrove, Gordon, *Pathfinder Force* 
(London: Macdonald & Jane's, 1976)

Neilsen, Robert S., *With the Stars Above* 
(Olympia, Washington: The JENN Company, 1984)

Normann, J.R.C. de, 'The Use of the Strategic Bomber Forces over Normandy. Success or Failure'. in 
*British Army Review*, No. 96, December 1990


Overy, R.J., *Goering the 'Iron Man'* (London: Routledge & Kegan Paul Ltd., 1984)


Prins, Francois, 'Donald Bennett Pathfinder' in *Fly Past*, June 1987
Revie, Alistair, *The Lost Command*  
(London: Purnell Book Services Ltd., 1971)

Richards, Denis, *Portal of Hungerford*  
(London: Heinemann, 1978)

'Rod', 'Shuttle Run' in  
*Marker*, Summer 1991

Rodgers, Jack, *Navigator's Log*  
(Braunton [Devon]: Merlin Books Ltd., 1985)

Roskill, Stephen, 'The Ten Year Rule - The Historical Facts' in  

Rostow, W.W., *Pre-Invasion Bombing Strategy*  
(Austin: University of Texas Press, 1981)

Rumpf, Hans, *The Bombing of Germany*  
(London: Frederick Muller Ltd., 1963)


Saunders, Hilary St. George, Per Ardua (London: Oxford University Press, 1944)

Saward, Dudley, 'Bomber' Harris (London: Cassell, 1984)

Saward, Dudley, Victory Denied (London: Buchan & Enright, 1985)


Searby, John, The Bomber Battle for Berlin (Shrewsbury: Airlife Publishing Ltd., 1991)


Smith, Maurice, 'Pathfinder Story' in *Flight*, 9 May 1946


Stewart, Oliver, 'The War in the Air the Final Stage' in *J.R.U.S.I.*, Vol. LXXXII, No.528, November 1937

Streetly, Martin, *Confound and Destroy* (London: MacDonald & Jane's, 1978)
Tait, J.B., 'Accurate Bombing' in 
Royal Air Force Quarterly, Vol. XIX, No.2, April 1948

Taylor, A.J.P., English History 1914-1945

Taylor, Eric, Operation Millenium
(London: Robert Hale, 1987)

Tedder, Lord, With Prejudice
(London: Cassell, 1966)

Tedder, The Lord, Air Power in War
(London: Air Ministry, 1947), A.M.P. 235

Terraine, John, Business in Great Waters
(London: Leo Cooper, 1989)

Terraine, John, 'Theory and Practice of Air War: the R.A.F.' in
Boog, Horst (ed.), The Conduct of the Air War in the
Second World War

Terraine, John, The Right of the Line
(London: Hodder & Stoughton, 1985)

Thetford, Owen, Aircraft of the Royal Air Force Since 1918

Thorne, Alex, Lancaster at War 4: Pathfinder Squadron
(London: Ian Allen, 1990)

Trenchard, The Viscount, Air Power
(London: Air Ministry, December 1946)
Verrier, Anthony, The Bomber Offensive
(London: Batsford, 1968)

Wakefield, Kenneth, The First Pathfinders

Walker, E.G. & Fox, D.A., The Dispersal of Fog from Airfield Runways
(London: Ministry of Supply, 1946)

Warden, John A., The Air Campaign
(Washington: Pergamon - Brassey's, 1989)

Wark, Wesley K., The Ultimate Enemy

Watt, Donald Cameron, How War Came

Webster, Sir Charles & Frankland, Noble, The Strategic Air Offensive against Germany 1939 - 1945
(London: H.M.S.O., 1961), Vols. 1-4

Whitten, Geoff., 'What Survival Odds did you Beat' in Marker, Winter 1992


Windrow, Martin C. (ed.), Aircraft in Profile, Vol.6
(Windsor: Profile Publications Ltd., 1967)

Woolley, D.W., 'A Friend Remembered' in Marker, Spring 1987

Wragg, David, The Offensive Weapon
(London: Robert Hale, 1986)

Zuckerman, Solly, From Apes to Warlords 1904-1946
Use of the Gee Chart

Determine Position

Navigator selects appropriate Gee Chain and takes readings.

Readings: Red 12.25, Purple 53.4
Position: Exeter

Readings: Green 38.0, Purple 43.0
Position 51° 23' N 5 43' W

This position would then be transferred to a plotting chart to compare this ground position with the air position at the time of the Gee fix.

Using Purposes

1. Aircraft navigator somewhere just south of Swansea wants to proceed to Leicester.
2. Lowest lattice line is Purple 46.05
3. Navigator directs the aircraft towards this lattice homing line until the appropriate signal (Purple 46.05) is aligned with the Master signal.
4. By keeping the signals aligned (by adjusting the aircraft's heading) the aircraft will proceed towards Leicester.
5. The navigator watches for the second signal to appear on the time base - in this case Red 5.32.
6. Then both the signals are aligned with the Master then Leicester has been reached.

Of the Gee Screen

Master

Purple 46.05

Master