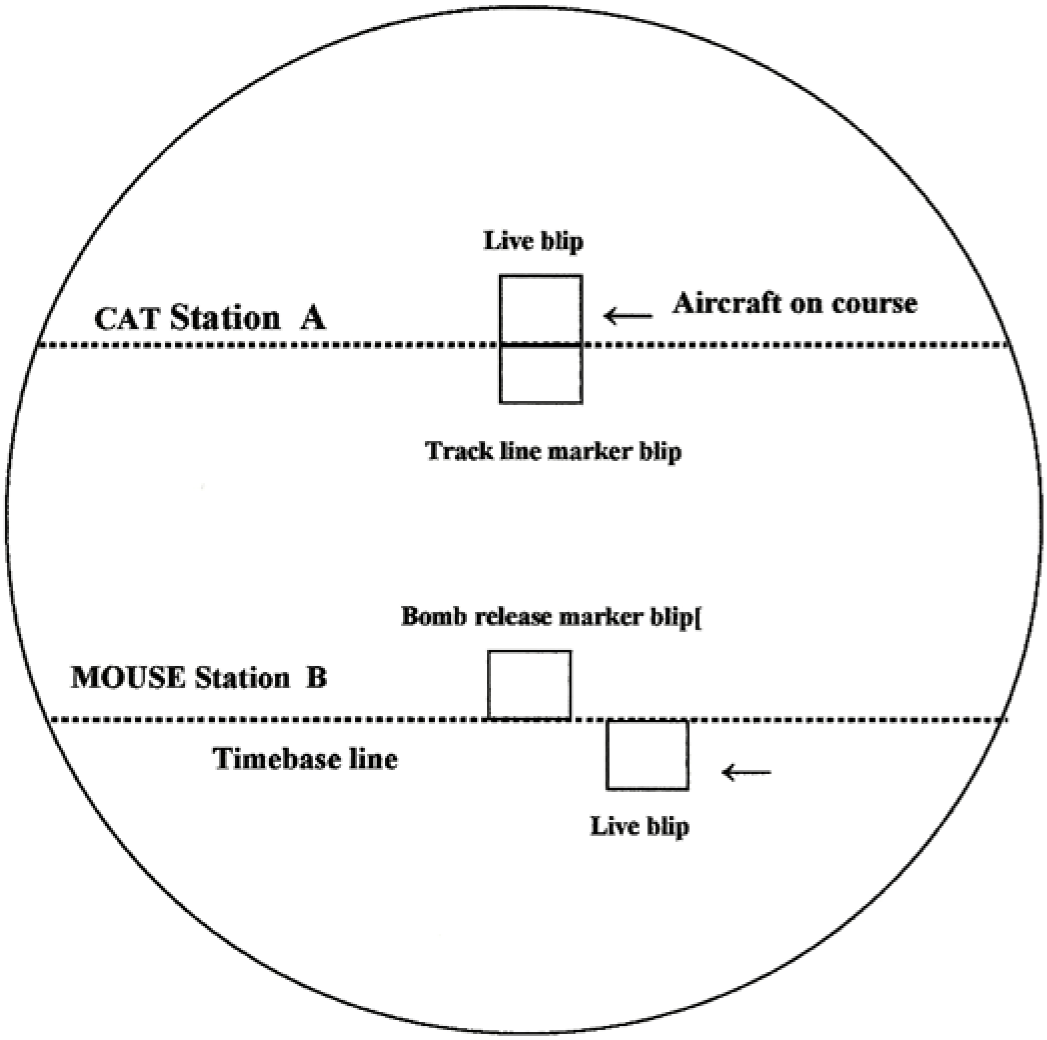
GEE-H and OBOE, Through the Cloud Bombing

By John Howland



GEE H MODE Cathode Ray Tube screen showing aircraft on track course (CAT station) with the live blip of the MOUSE station approaching the bomb release point. The live blip positions were reversed. The CAT station live blip was above the line while the MOUSE station live blip was below the line

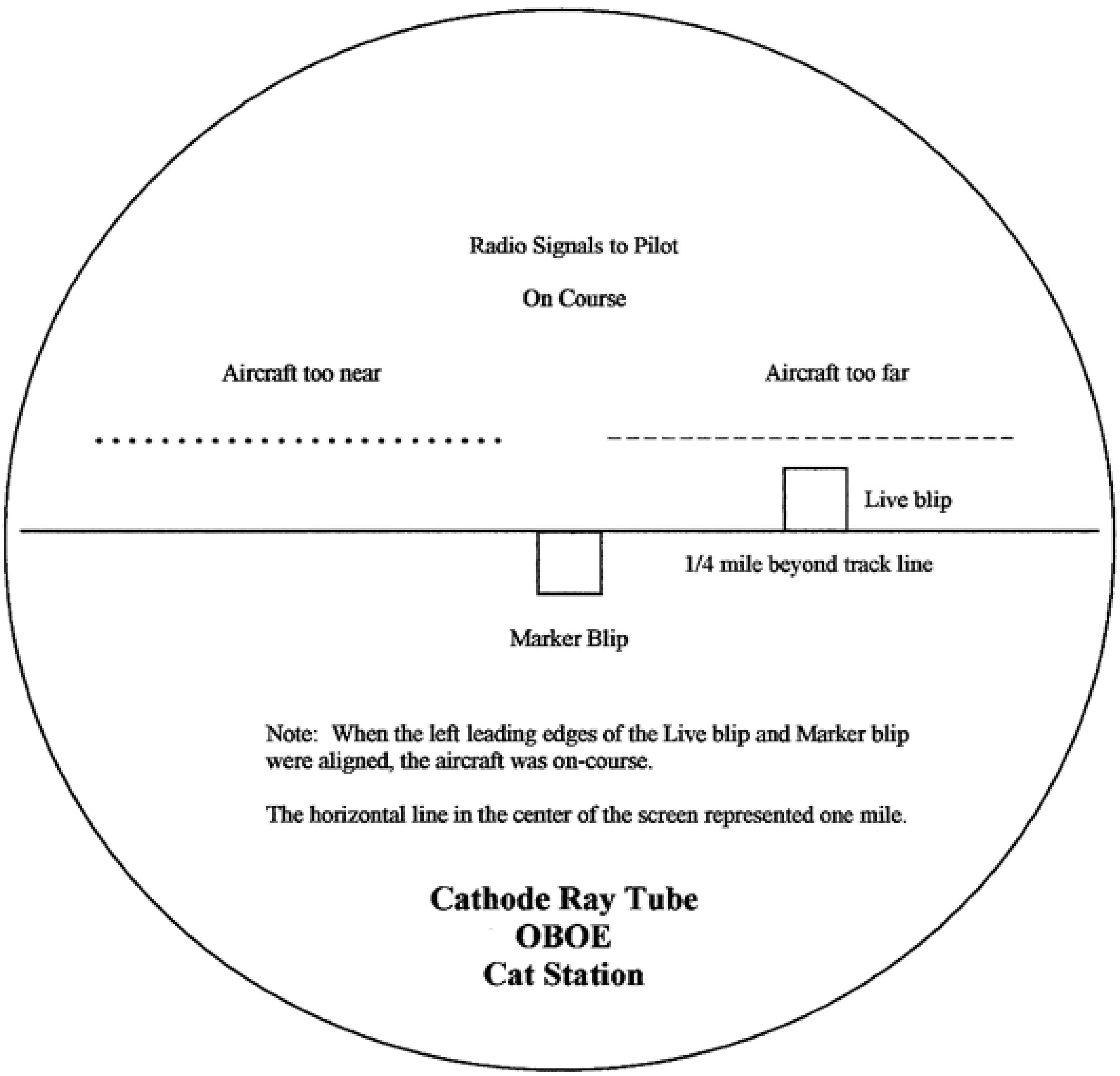
In times of stress, people rise to new heights to meet the challenges. Robert Watson-Watt started four years before the war started. However, the radar shield he and his team of scientists put together was largely responsible for the victory achieved in the Battle of Britain in 1941. In 1937, R. J. Dippy was stimulated to develop an entirely new concept of navigation consisting of a grid system of hyperbolic curves known as GEE. This novel concept opened a Pandora's box of new aids to navigation utilizing hyperbolic curves generated by radio waves. These involved systems known as Loran A, Loran C, Decca, Omega, and a German system known as Hyperbol.

GEE was highly effective and accurate as an aid to navigation, but it lacked the pin-point accuracy needed for a bombing attack on a selected target. A British scientist named Alec Reeves rose to the occasion and developed a through-the-clouds bombing technique known as OBOE. Although developed in spite of the earthy comments of doubting-Thomas detractors, OBOE proved to be the most successful of all such techniques developed during World War II. By mid-1944 the principle of OBOE was combined with GEE and a blind bombing technique known as GEE H was developed. Strikes upon difficult-to-hit targets were made by the RAF and the USAAF and Hitler's war machine was badly crippled by a lack of petroleum products and sorely needed replacements.

By modern standards, the technology associated with these novel bombing techniques is ancient history. However, the reader should recall that these techniques were on the cutting edge of the technology more than sixty years ago. We have attempted to describe the basic technology utilized in an effort to preserve the historical significance of these contributions.

The 8th Air Force did not use OBOE in their bombing attacks. OBOE guided RAF Pathfinder planes at night who dropped flares on targets designated by OBOE operators. The main RAF bomber stream followed and dropped their bombs on the flares lighting a designated target. The 8th AIR Force did use GEE H during the final year of the conflict. However, to describe GEE H, we must first describe OBOE because GEE H worked like OBOE, only in reverse.

OBOE

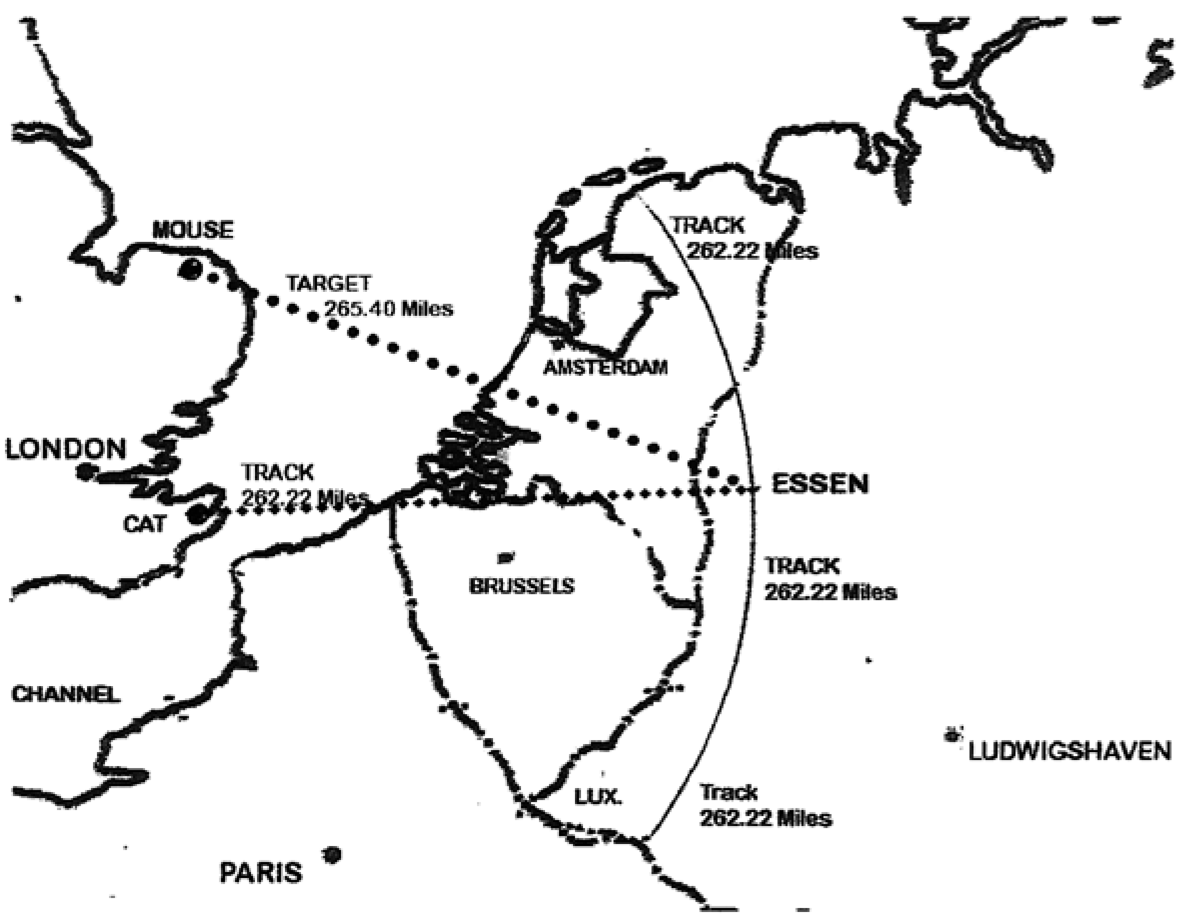


The through-the-clouds bombing technique called OBOE was developed by an Englishman named Alec Reeves. It was the most successful of all such systems produced during World War II. Directional control of the aircraft was in the hands of operators based at two radio stations in England. These stations were called the Cat and the Mouse stations. The Cat station was responsible for controlling the track of the aircraft on its bombing run. The Mouse station signaled when to release the bombs on a pre-selected target.

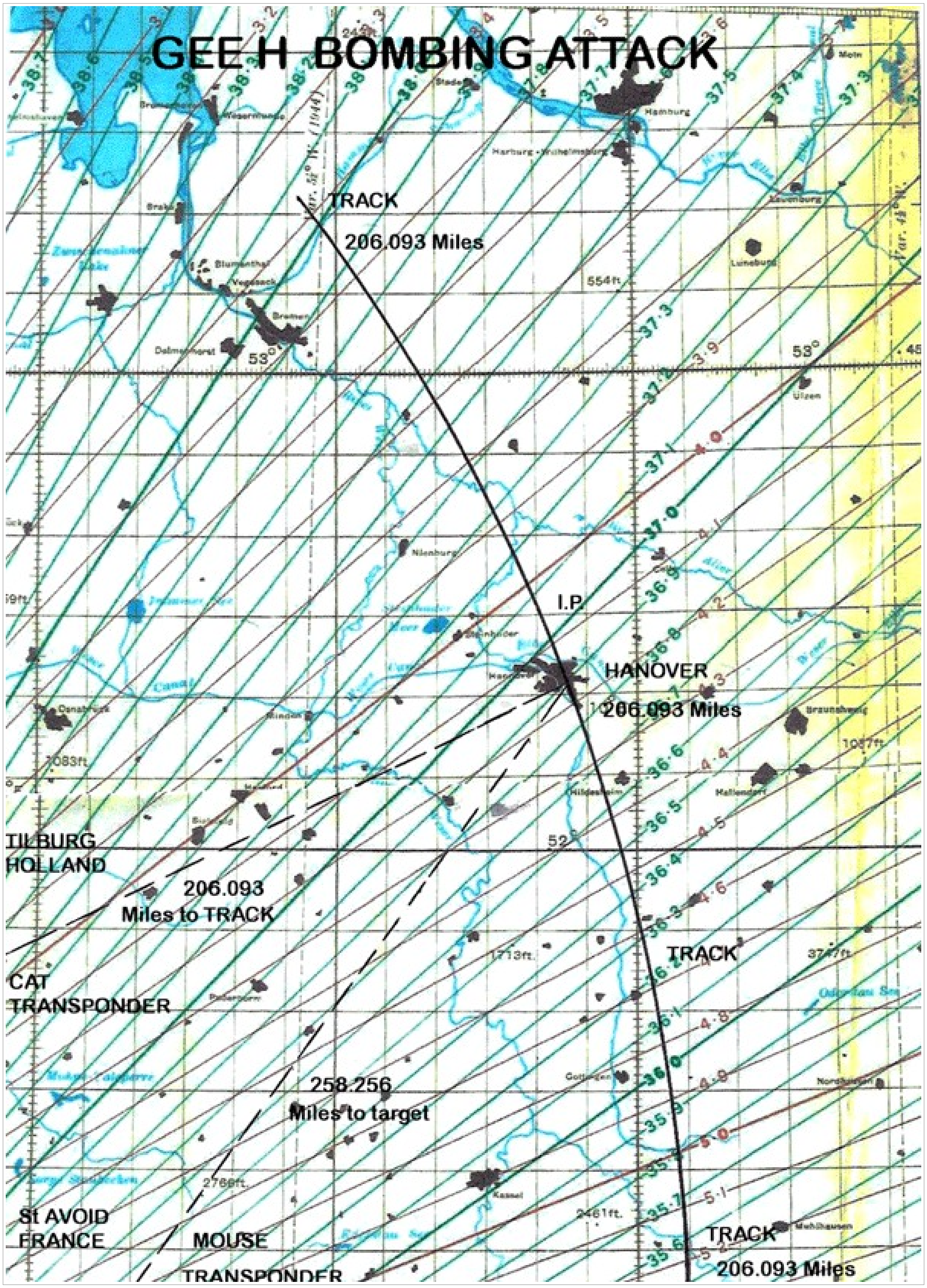
Prior to sending the aircraft on a mission, cartographers measured the distance from the Cat station to a selected target. Let us assume the target was Essen Germany and the measured distance from the CAT station was 262.22 miles. The pilot was ordered to fly into Germany well north of the target area until he reached the Track, an arc of a circle exactly 262.22 miles east of the Cat station.

The aircraft carried a transponder. This is an instrument that receives a radio signal and instantly transmits a signal back to the point of origin. The time lapse from the moment the signal was sent from the station and returned to the point of origin was measured on the oscilloscope of a cathode ray tube at the station. These measurements were in microseconds (uS). A microsecond (uS) equals one millionth of a second. Radio waves travel at a speed of, roughly, 1000 feet per uS. For example, if the Cat station sent a signal that required 2,769.04 uS to reach the aircraft and return, the one-way time required was half this amount or 1,384.52 uS. This meant the airplane was 1,384,520 feet distant from the station. Dividing by 5,280 feet per mile we find the distance was 262.22 miles.

Another set of audible radio signals were constantly transmitted to the pilot. Prior to reaching the track, all he heard was a series of dots like Morse code dots. When he reached the track line the dots turned into a solid tone and the pilot had to turn the aircraft south and follow that arc line and the solid tone. If he went beyond the track line the solid tone turned into a series of dashes like Morse code dashes. The pilot knew he was too far away (left) and had to correct back to the right. If he heard a series of dots, he knew he was too far to the right and had to correct to the left. With practice, pilots were able to follow the track quite easily until they reached the bomb release point. This point was controlled by the Mouse station.



The Mouse operators knew the aircraft was flying at a prescribed altitude. The bomb trajectory, distance-to target and release point, as well as distance to the Mouse station, were all pre-calculated. The Mouse station merely measured the distance to the aircraft using the same type of transponder signals as the Cat station and a similar Cathode Ray tube. Although the bombardier was actually 265.40 miles away in England, the bombs were dropped on his signal when the aircraft reached the release point. Accuracy was quite good, even through cloudy skies.



When the bomber reached the I.P. (Initial Point, approximately ten minutes prior to bomb release) the pilot stopped flying the arc of the Track circle. He was given a straight and level heading to the target that was followed until the bomb release order was issued by the Mouse operator. The precise nature of the entire operation is awesome. Of course, measurement of the pulse signals to a millionth of a second was a feat by itself. However, there were other considerations as well. For example, in the transponder there was a delay of perhaps 8 or ten microseconds between receipt of a signal and triggering of the reply signal that had to be allowed for. There was even an allowance of a few microseconds for normal human response delay after receiving the bomb release order.The main disadvantage of the OBOE system was that operators could deal with only one aircraft at a time. Subsequently, RAF Pathfinder crews were sent to a target area (always at night). Their bomb load consisted only of brilliant marker flares to light up the target. The main fleet of bombers followed and dropped their bomb loads on the brilliant flares. Nevertheless, OBOE was the most successful of all the wartime “Through-the-clouds” bombing techniques.Following the invasion, Cat and Mouse stations were established in France and Belgium that placed most of Germany within the 300 mile range of OBOE.GEE H

The success of OBOE led to the development of a similar through-the-clouds bombing technique. It was called GEE H. It worked just like OBOE in reverse. The navigator of the aircraft became the operator, and the CAT and MOUSE stations were merely transponders. GEE H was introduced in the spring of 1944.

The entire operation was conducted from the aircraft and directed by the navigator.

In the first phase of the operation, the navigator used his GEE box in the normal way. He tuned to the two stations providing the GEE grid lines to guide his plane to the vicinity of the target. When he reached that area, the navigator switched his GEE box to the H mode of operation.

The aircraft then transmitted a pulse signal to the two ground station transponders. (CAT and MOUSE) The Navigator measured the time lapse between sending and receiving the signal with his on-board cathode ray tube (CRT). The track was the arc of a circle whose radius was the straight line pre-determined distance from a selected GH (CAT) transponder to the target.

The navigator set the A and B stations of his receiver to the two pre-calculated ranges.

He kept the pilot on course by voice commands and by keeping the left edge of the live (upper) blip for station A on the left edge of his timebase. In this position, the aircraft was flying on the arc of the curved track line .

Station B on the cathode ray tube was represented by an inverted blip on the scope of the CRT. As the aircraft flew towards its target this lower blip drifted across the timebase. When it lined up with the upper blip it showed the point at which the track line and the bomb release point intersected. Just before the two blips lined up, the pilot straightened his flight path and he, as well as all other planes in the formation, then dropped their bombs.

GEE H bombing through the clouds was highly accurate and played an important part in depriving Hitler of his much-needed reserves of oil and gasoline.

To my way of thinking, the merging of GEE and OBOE was a stroke of genius.

GEE was the first major addition to navigational procedures since the invention of the chronometer by John Harrison in 1764. OBOE and GEE H were extensions of this electronic wizardry and these systems were critically important to the final victory over the Nazis. Hats off to R. J. Dippy and Alec Reeves

CREDITS

I wish to express my thanks and deep appreciation to friends from overseas who contributed to this report. Walter Blanchard, an ex-RAF navigator, is also the past president of the prestigious Royal Navigation Institute. Walter generously furnished me

with many pages of solid technical data and descriptive comments about GEE H, OBOE and many other navigational aids and bombing systems used during WW-II. Norman Groom is curator of the Pitstone Navigation Museum in Pitstone, England. Anyone interested in WW-II navigational procedures should visit his Website.

Henry R. Black and I corresponded for several months via e-mail. He has published several articles on WW II navigation techniques and was a great help to me in my research efforts. Sadly, Henry passed away in August 2002. However, he contributed mightily to the historical record of Navigation techniques used by the RAF during WW-II. I must also give credit and thanks to my friend Doug Chiswell of New Zealand who gave me the inside scoop on rather exotic navigation equipment such as the astro-graph. Doug's forte was low-level pilotage navigation at night on missions dropping supplies to the resistance fighters. Doug couldn't see the ground from his compartment, so he fed the information from his pilotage chart to the bomb aimer by inter-com who actually spotted the turning points and guided the aircraft.

Thanks also to Richard Bettencourt, former navigator with the 381st BG, who furnished the WW-II GEE chart of central Germany used to illustrate a theoretical GEE H attack on Hanover. These are only a few of the many colleagues who have helped me in my quest for information. Few navigators realize that we have recently gone through the most revolutionary change in the art of navigation since John Harrison invented the chronometer in 1764 and opened the door to worldwide celestial navigation. GEE and LORAN brought in the electronic age of navigation and less than a half century later these systems were replaced by GPS. The US Air Force no longer teaches celestial navigation. However, we should take time to record the interim procedures that were developed during World War II.

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381st and 91st Bomb Groups