DF-4IR1B5 BISTATIC INFRARED TARGET

The DF-4IR1B5 target is identical in principle and operation to the DF-4IR1A target described in the preceding paragraph, except for its radar reflector. The DF-4IR1B5 target incorporates a reflector designed specifically for beam attacks by the GAR I missile by Ohio State University. (Simple RADOP targets with this reflector are currently in use at Eglin Air Force Base as Air Force Model MC-5). This Air Force approved radar reflector is an eight corner, distorted angle, bistatic reflector designed to have sufficient monostatic capability for satisfactory target acquisition and bistatic capability for beam attack flight paths.

D-200 SCORER

GENERAL

The Del Mar D-200 Radar-Optical Scorer is designed to provide miss distance indication for Falcon type missiles as well as 2.75 FFAR and similar rockets. It is suitable for use in training by operational units and for evaluation by testing agencies. In test agency usage, it may be employed to yield large amounts of information other than simple miss distance, including dispersion and ballistics data under conditions which make it now difficult or impossible to obtain such data.

DISCUSSION

The radar optical principle of scoring, as such, has been successfully applied previously to 2.75 rockets and Falcon missiles. This method consists of obtaining two of the required three spatial positions of target and missile from a photographic recording, normally a motion picture strike camera. The third coordinate is obtained

from radar tracking of the missile, normally presented as a range-only display recorded photographically along with the strike record. For miss distance measurements, it is necessary to determine the time of coincidence of the missile and target photographic planes which is accomplished by determining superposition of rocket and target returns on the radar presentation.

For scoring of Falcon class missiles, a long focal length lens is required. Previous systems have utilized a fixed camera with a long focal length lens and a large film format to give reasonable angular coverage since the scoring aircraft must track the target at least until coincidence has occurred. This camera is synchronized in time to oscillographic records from one or more other cameras. While this arrangement has been successful, it is unduly complex because of the requirement for synchronization of several cameras and associated equipment. Data assessment is also complex because of the necessity for evaluating two or more photographic film records. Probably the most serious deficiency of all arises through the use of the stationary strike camera which therefore requires rather precise aircraft control under difficult conditions. The Del Mar D-200 eliminates these shortcomings by utilizing a single 35 mm camera whose optical system is slaved to the radar antenna. With this arrangement it is only necessary for the pilot to fly the airplane within an envelope whose angular dimensions are controlled only by the limit stops on the radar antenna. The camera will always remain aimed at the radar aiming point; that is, the target.

At the longer ranges, even a long focal length lens does not provide a target image size of sufficient resolution for determining distance by comparing it to target dimensions. For this reason, it is imperative that absolute target range be presented on the scope so that miss distance determinations may be computed from optical parameters. The flare target described in the preceding paragraphs provides visual radiation as well as infrared radiation and the target is therefore recorded on film with sufficient intensity for accurate measurements to be made.

INSTALLATION

The Del Mar D-200 Scorer is designed for mounting in F-89H aircraft with only a small external protuberance which houses the movable strike optics. The scorer proper is mounted beneath, and permanently attached to, the top access panel just forward of the front pressure bulkhead. Installation of this equipment will not impair accessibility of other aircraft accessories. Weighing less than 30 pounds, the scorer is arranged on a single chassis designed for quick installation and removal. The sketch on the following page depicts a scorer installation in an F-89H airplane. It derives camera power from the aircraft supply and electronic voltages from the Fire Control System. Other aircraft electrical connections are for trigger, video, and antenna position voltages, all of which are obtainable from externally accessible test points of the fire control system. No weapon system performance compromise is entailed.

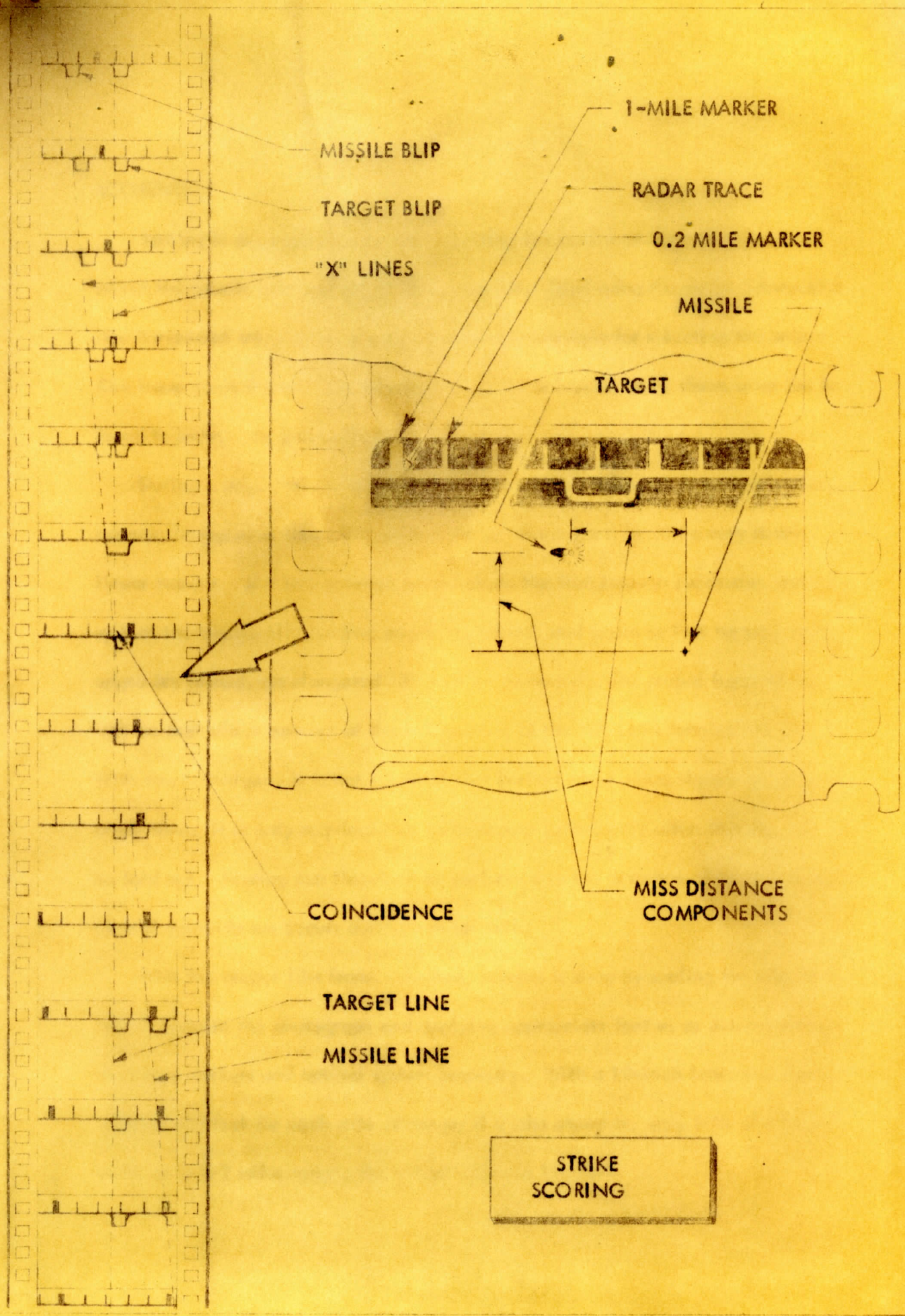
OPTICS

The optical system of the D-200 Scorer includes a 28 volt, 35 mm camera which will operate at 24 frames per second. The lens system consists of two independent optical trains to provide both strike and radar image on each frame. The radar scope recording system presents an "R" display across the full width of the top of each frame and occupies a masked area of approximately 20% of the frame height. Several different strike lenses may be used but a ten inch lens of f5.6 speed is considered optimum for most conditions. Reflective optical components, movable by a servo loop tied in with the radar antenna, insures that the camera and antenna aiming points are in synchronism. The scorer provides camera coverage with respect to aircraft axes as follows:

Azimuth = - 20° to - 20°
Elevation = - 20° to - 5°

RADAR DISPLAY

The radar trace is derived from two sources. Signals taken directly from the raw video output of the fire control system will put blips on the trace for both target and missile. The second part of the trace is derived from a time base generator which delivers an output pulse for every two-tenths mile of radar range. Every fifth pulse is emphasized so that even mile ranges are clearly distinguishable. The entire sweep pattern, video and timing, is delayed so that only a 1.5 mile zone, centered about the target, is shown. The scope presentation is shown on the sketch on the following page.



STRIKE SCORING

SCORING

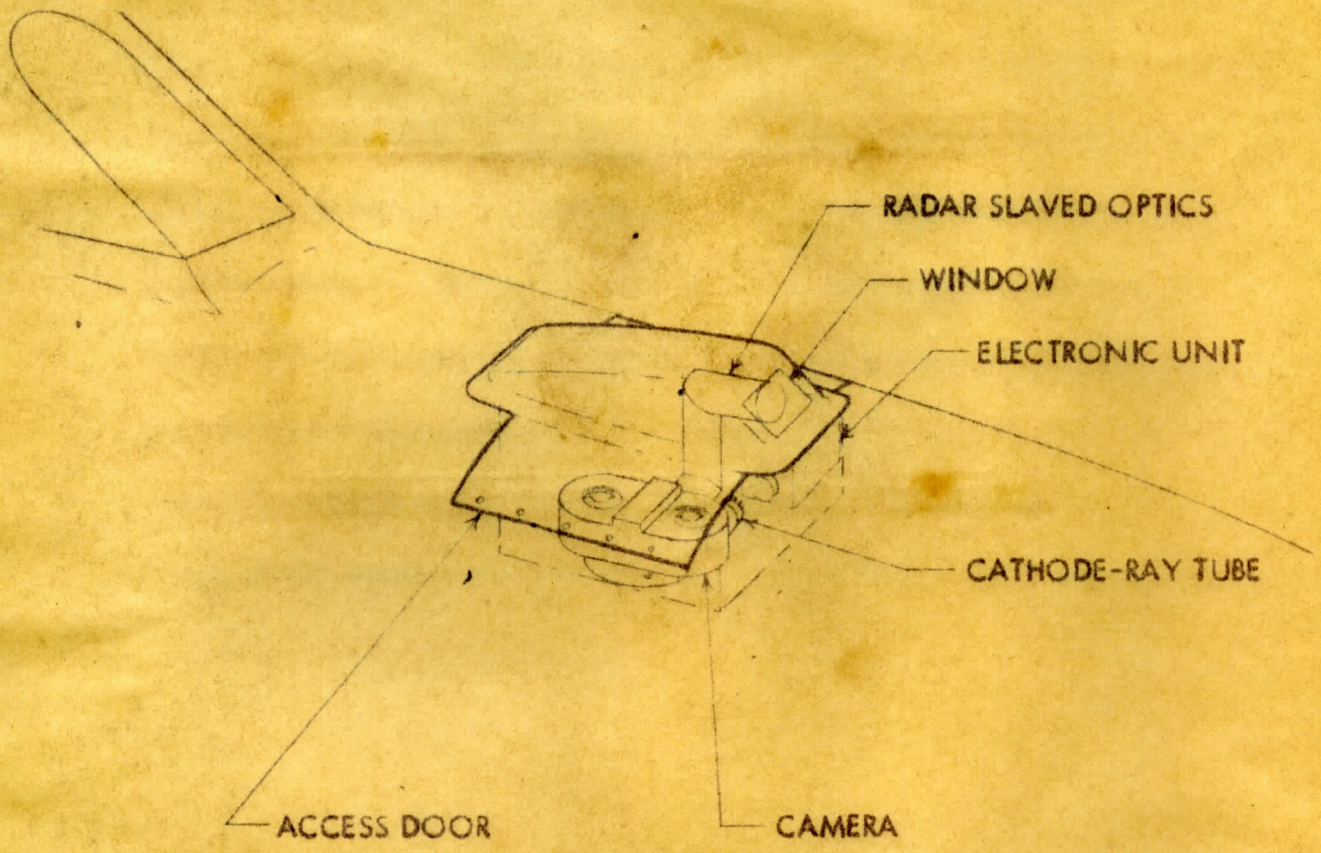
Scoring is accomplished by first selecting the motion picture film frame on which the missile blip and target blip coincide. Displaying the range information in a horizontal trace offers a very convenient technique for selecting the proper film frame to evaluate. The illustration on the preceding page shows what has been found to be the simplest method.

During a brief period, aircraft-missile range increases in a very nearly linear manner; in the same time, the aircraft-target range decreases in a very nearly linear manner. If a straightedge is laid along the film through successive frames so that the missile blip leading edges are joined, and again so that target leading edges are joined, an elongated "X" will be produced. The proper frame to use will be that which appears at the intersection of the two lines forming the "X". With this technique, it is not essential that perfect radar video signals be present at all times; it is only required that blips appear sufficiently often that the "X" can be laid out. Scoring can therefore be performed in the presence of intense noise or even if coincidence occurs during a radar null.

With the proper film frame selected, scoring is done by scaling the miss distance shown in the photograph and applying appropriate factors as determined by the range markers and optical system geometry. With a 10-inch lens, one frame width is 475 feet for each mile of range; if a miss shown is, say, 10% of a frame width at 2-1/2 miles range, the actual miss was 119 feet.

CONSTRUCTION

Unit construction of the D-200 plus the utilization of existing external connections for deriving the required voltages from the Fire Control System greatly simplifies its installation. Adjustments are held to a minimum and operation is simple enough for check-outs to be performed by normally-trained radar technicians and/or cameramen. Preflight of the installation will require only loading and checking of the camera mechanism with a cursory inspection of the radar presentation during the radar preflight of the airplane. The D-200 will be operated automatically in flight without attention from the pilot, utilizing impulses generated by missile firing signals.



D-200 SCORER INSTALLATION
ON F-89H AIRCRAFT

FIGURE 2