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UNITED STATES

NAVAL AIR MISSILE TEST CENTER

TECHNICAL REPORT NO. 90

INTERIM REPORT ON LTV-N-2 (LOON) PROGRAM FROM 1 MARCH 1949 TO 1 SEPTEMBER 1951

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5 SEPTEMBER 1952

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UNCLASSIFIED

TECHNICAL REPORT NO. 90

INTERIM REPORT ON LTV-N-2 (LOON) PROGRAM FROM 1 MARCH 1949 TO 1 SEPTEMBER 1951

PREPARED BY:

REVIEWED BY:

Department Head

APPROVED BY:

Commander NAMTC

BUREAU OF AERONAUTICS

5 SEPTEMBER 1952

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Foreword

The U. S. Naval Air Missile Test Center was established at Point Mugu, California, by the Secretary of the Navy (SecNav ltr Op-24/mad Serial 1373P24 dtd 17 September 1946) effective 1 October 1946. It is an activity of the ELEVENTH Naval District. The Bureau of Aeronautics exercises management and technical control over this activity.

The primary mission of the Naval Air Missile Test Center is the testing and evaluation of guided missiles and their components. NAMTC is assigned cognizance over all facilities at Point Mugu, California, and outlying facilities on San Nicolas Island and the Santa Barbara Channel Islands, collectively referred to as the Sea Test Range.

★ ★ ★

Commander, Naval Air Missile Test Center ..... Captain J. N. Murphy, USN
Commanding Officer, Naval Air Station .... Captain M. T. Evans, USN
Director of Tests, Naval Air Missile Test Center ..... Captain A. C. Packard, USN
Chief Scientist, Naval Air Missile Test Center .... Dr. R. Weller

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interim report on LTV-N-2 (LOON) program from 1 March 1949 to 1 September 1951

summary

This report covers the progress of the LTV-N-2 (LOON) test program from 1 March 1949 to 1 September 1951. During this period, 46 LOON missiles were launched from shore launchers, 38 from submarines, and 3 from the USS NORTON SOUND. Significant progress was made in accomplishing the objectives of the assigned problem details. Completed problem details include tests of the quick-detachable electronics nose mount, dual- and single-JATO launchings, assistance to the NORTON SOUND, tests of the Summers gyro servo control system, acceptance checks of contractor-modified missiles, and Radioplane Recovery System tests.( )

Significant accomplishments during this period were the successful use of a Marine Guidance Computer, development of a promising radar guidance system, successful use of single-JATO launching sleds, flights with live warheads, a pulsejet-powered flight to an altitude of 12,500 feet, development and tests of a warhead-blowoff method of flight termination, and use of the missile as an antiaircraft target during fleet exercises.

Technical development of the radar guidance system was accomplished by Navy Electronics Laboratory. NAMTC performed ground and flight tests and co-ordinated the application of the system with LOON requirements.

From the results of the test program, it is concluded (1) that the quick-detachable nose mount has desirable features which should be incorporated in future missiles, (2) that single-JATO launching sleds are superior to four-JATO or dual-JATO sleds, (3) that zero-length launchings should be avoided if possible, (4) that tests of the McDonnell altitude-compensated fuel meter should be continued, and (5) that turbojet tests should be continued.

An analysis of component and missile reliability indicated that there was no significant change over that reported in reference 11. This fact led to the conclusion that the practical limit of the reliability of the missile with its present components has been reached. Newly manufactured or redesigned components would undoubtedly increase the reliability.

Introduction

The LOON program, directed toward naval application of the World War II German V-1 missile (Buzz Bomb), was established in 1944. Upon the recommendation of the Bureau of Aeronautics, and with the approval of the Chief of Naval Operations, it was planned to launch the JB-2 (Air Force copy of the German V-1 missile) from aircraft carriers against targets in the Japanese Empire. However, the war ended before the program had progressed beyond the developmental stage.

The initial program was conducted under the authority of directives that established the following two projects:

1. TED MTC PA-501.
   (TED NAM 1837)*
   Established on 26 December 1944 for the purpose of investigating the use of the JB-2 Flying Bomb from a CVE-class aircraft carrier.

2. TED MTC EL-302
   (TED NAM 31396 and TED PAU 3101)*
   Established on 6 August 1945 for the purpose of conducting tests of the electronic systems of the missile. The primary purpose of this project was to increase the accuracy of the missile by tracking it in flight with radar and controlling its course by means of a remote radio transmitter.

After the war the JB-2 was redesignated the KGW-1 (LOON). However, the program was still devoted to tests that would result in the development of a missile which could be launched from the decks of the naval ships. On 27 May 1946 the missile designation was again changed to KUW-1 and the missile was reclassified from a "service craft to a testing craft for various components of other P/A."

From 27 May 1946 to 23 August 1950, the LOON test program was devoted exclusively to testing and improving existing or new components. A parallel program was devoted to training fleet personnel and perfecting missile handling and launching techniques aboard submarines. The missile designation was changed to LTV-2 on 30 July 1947 and to LTV-N-2 in April 1948. During this period projects TED MTC PA-501 and TED MTC EL-302 remained in effect but were revised occasionally by the addition or deletion of certain details. The following additional projects, which further modified or augmented the existing test program, were established:

1. TED MTC PA 501.1
   (TED PAU 1801.1)*
   Established on 17 September 1946 to conduct "experimental rocket-type launchings of the KUW-1 for the purpose of obtaining launching data and training personnel, leading to the launching of the KUW-1 from a submarine." In conjunction with this project, the Chief of Naval Operations directed

* These designations were used prior to the establishment of MTC designations.

that a fleet-type submarine be converted to an experimental bombardment t:_: for the launching of guided missiles.

2. TED MTC EL-301

Established on 13 November 1946 for the purpose of evaluating the Summers gyro servo control system in the LOON. The primary purpose of this project was to provide a greater degree of controllability during launching and greater maneuverability during the mid-course phase of flight. This was to be accomplished in part by modification of the LOON to incorporate aileron roll control in lieu of rudder control.

3. TED MTC AR-2301

Established on 8 March 1948 for the "development of a destructor system for severing the wings of the LOON in order to improve the terminal trajectory of the missile."

4. TED MTC 502.1

Established on 31 August 1948 for the purpose of equipping LOON missiles with smoke generating units for use as antiaircraft targets for fleet exercises.

5. TED MTC PA-501.3

Established on 7 January 1949, for the purpose of providing technical and material assistance during the launching of LOON missiles from the USS NORTON SOUND.

6. TED MTC AE-525001

Established on 17 January 1949 for the purpose of conducting flight tests and evaluation of various types of equipment and systems intended for the recovery of pilotless aircraft and pilotless aircraft components detached or ejected in flight. The Bureau of Aeronautics assigned four LOONs to this program on 8 January 1950.

7. TED MTC GM-209

Established on 1 March 1949 for the purpose of providing for LOON flight testing in connection with components improvements, launching, tests which cannot be performed by operational training vessels without the technical assistance of NAMTC, and special tests required by competent authorities. This directive terminated projects TED MTC PA-501, 501.1, and 502.1.

8. TED MTC DE-302.3

Established on 1 March 1950 for the purpose of developing facilities and techniques required to obtain aerodynamic data from free-flight tests of the LOON missile.

9. TED MTC EL-302.1

Established on 29 May 1950 for the purpose of evaluating the AN/ASQ-5 infrared homing equipment in LOON during flights to determine the suitability of this system for possible future use in ship-to-surface guided missiles.

In August 1950 the general aspect of the LOON test program was changed by a series of directives from the Chief of Naval Operations and the Bureau of Aeronautics. On 23 August the Chief of Naval Operations, by reference 1, directed that a reserve of 25 LTV-N-2 (LOON) missiles be established at NAMTC Point Mugu "to provide for operational contingencies until improved guided missiles are available for fleet use." On 30 August the Bureau of Aeronautics directed, by reference 2, that "any LOON's launched hereafter should have in their flight plan only objectives which contribute directly to the improvement of the LOON as an operational weapon." On 30 August, by the promulgation of reference 3, the Chief of Naval Operations directed that the Bureau of Ships and the Bureau of Aeronautics co-ordinate efforts to develop and test an improved command guidance system which would employ radar coding principles and be suitable for use with submarine launched missiles.

In conformance with these directives, projects TED MTC GM-209 and TED MTC EL-302 were revised. Revised project TED MTC GM-209 was promulgated, by reference 4, on 8 December 1950. It directed that the LOON program be devoted to the following specific details:

1. Modification of 25 missiles for assignment to the reserve pool.

2. Tests of improved launching systems and associated components. The emphasis was to be placed on the perfection of single-JATO launching techniques and their adaptation to launchings from submarines.

3. Tests of the armament components of the LOON.

4. Tests of electronic components and systems as outlined in projects TED MTC EL-301 and TED MTC EL-302.

5. Tests of power plant installations. These were to include tests on the existing 21-inch pulsejet engine and tests on the Westinghouse J-30 and the Ranger J-44 turbojet engines.

6. Tests to improve the predictability of the terminal trajectory of the missile.

7. Technical assistance to, and support of, fleet training and evaluation programs using LOON missiles.

The directive that revised Project TED MTC EL-302 was promulgated by reference 5, on 7 March 1951. It established the following specific problem details:

1. Provision of consultive services to the Navy Electronics Laboratory and contractors during the development of the new command guidance system.

2. Continued testing and development of quick-detachable nose mount for electronic components.

3. Development and test of an improved S-band radar beacon.

4. Tests of the AN/DPN-17, an improved radar transponder beacon that was designed to replace the AN/APN-33 radar beacon.

Several additional programs and projects were established to support project TED MTC GM-209. Project TED MTC PP-222 was established by reference 6 on 6 December 1950 for the purpose of determining the ability of the J-30 turbojet engine to withstand the launching accelerations which occur during LOON JATO launchings. On 8 January 1951, reference 7 extended the scope of project TED MTC PP-222 to include the J-44 turbojet engine. Project TED ADC GM-209 was established on 27 December 1950 by reference 8 to complete the development of LOON single-JATO launching equipment. This project also directed that 10 single-JATO launching sleds be manufactured by the Naval Air Development Center for tests at NAMTC.

Several miscellaneous assignments that were not a part of the actual test program were administered by LOON project personnel. They were directly related to the LOON missile and should be mentioned in this report. (1) In June 1949 a contract (reference 9) for the modification of 50 LTV-N-2 (LOON) missiles was awarded to the Marquardt Aircraft Company. The contract was modified by change order "D" in June 1950 to include an additional 27 missiles. Project personnel were charged with the responsibility of assisting the contractor in setting up a modification facility. Instruction to Marquardt employees and general assistance in setting up test equipment were to be provided. Acceptance tests of all modified missiles were to be conducted by NAMTC. (2) After the promulgation of the series of letters of August 1950, it was believed advisable to procure a complete set of up-to-date LTV-N-2 (LOON) drawings which could be supplied to any prospective manufacturer of the missile. LOON project personnel were assigned the task of drawing up specifications for and technically administering such a contract. The contract was awarded to D & R Ltd., Santa Barbara, California in June 1951.

Previous progress reports have been issued (references 10 and 11) and should be consulted if a more detailed history of the earlier phases of the program are desired. This report covers the progress of the LOON program from 1 March 1949 to 1 September 1951. During this period a total of 46 LTV-N-2 (LOON) missiles were launched from shore launchers, 38 from submarines, and 3 from the USS NORTON SOUND.

configuration

MISSILE

The LTV-N-2 is an American-made copy of the German V-1 missile (Buzz Bomb), as manufactured in 1944 and 1945 under the direction of the U. S. Air Force. It is a pilotless conventional mid-wing monoplane powered by a

21-inch pulsejet engine mounted above the rear section of the fuselage. It lacks ailerons but incorporates conventional elevator and rudder control. The characteristics of the missile with standard equipment installed are as follows:

PHYSICAL CHARACTERISTICS

GROSS WEIGHT	5025 LBS.
LENGTH	27 FEET 1 1/16 INCHES
WING SPAN	17 FEET 8 1/8 INCHES
WING AREA	60.7 SQUARE FEET
WING LOADING	82.8 LBS/SQUARE FOOT

PERFORMANCE (AVERAGE)

MAXIMUM SPEED (6,000 FEET ALTITUDE)	400 MILES/HOUR
MAXIMUM RATE OF CLIMB (SEA LEVEL)	800 FEET/MINUTE
SPEED IN A CLIMB (OPTIMUM)	240 MILES/HOUR
SERVICE CEILING	6,000 FEET
RANGE	140 STATUTE MILES

Figure 1 is a photograph of the missile and figure 2 is a cutaway view showing the general arrangement of the major components in the standard configuration.

LAUNCHING DEVICES

Two general methods are used to launch the LTV-N-2 (LOON) missile. In the catapult method, which was used exclusively during the early stages of the program, the missile is accelerated to flying speed before it leaves the launching device. In the JATO method, which has practically replaced the catapult method, the missile is accelerated to flying speed with the aid of one or more JATO units. There are two variations of the JATO launching method. One provides a short-length launching, and the other a zero-length launching. A short-length launching is achieved by aligning the JATO thrust vector so that the JATO sled slippers travel along the launcher rails. A zero-length launching is achieved by aligning the JATO thrust vector so that the JATO sled slippers leave the launching rails without any travel along the rails.

All catapult and booster launchers are equipped with a gasoline drip pan, which is located under the end of the pulsejet-engine tail pipe. A remotely-operated CO_2 smothering system is provided as a safety precaution. The outlet of the system is supported by the gasoline drip pan and is directed into the pulsejet tail pipe. The shore JATO launchers and the USS CUSK launcher are equipped with remotely-controlled water-deluge systems which spray the JATO units and the base of the launcher in the event a fire occurs in the missile prior to launching.

Shore Installations

(1) XM1-1 Catapult

The XM1-1 catapult is a multiple-cartridge, slotted cylinder type of launcher in which smokeless powder charges are used as a propellant. The LTV-N-2, the launching sled, and catapult piston are accelerated to an average end speed of 217 knots after a 150-foot run. The sled and piston drop from the missile immediately after clearing the catapult. The entire catapult structure is of aluminum alloy and steel and weighs approximately 33,000 pounds. The catapult is mounted in a horizontal position. Figure 3 shows the LOON mounted for launching on an XM1-1 type catapult. The catapult is built in 10 sections. The sections, which do not contain powder chambers, are interchangeable. The end speed of the catapult may be altered by varying the powder charge in the seven cartridge chambers. Experience obtained from a number of launchings has established a standard powder loading of 32 sticks in the No. 1 electric cartridge chamber and 58 sticks in each of the 6 remaining flash-ignited cartridge chambers.

The missile is placed on the catapult on an inclined launching sled in order to give the LOON the proper angle of attack immediately after launching. Launching sleds that incline the longitudinal axis of the missile 3°, 6°, or 8° above the horizontal, are available for use.

Complete information on the XM1-type catapult is contained in reference 12.

(2) Rolling Ramp

The rolling ramp is a three-rail ramp designed for simulated shipboard launchings of the LTV-N-2 (LOON). The over-all length of the ramp is 90 feet. The forward 50-foot portion of the ramp, actually utilized during a launching, is inclined 6° above the horizontal. The remaining 40-foot portion is horizontal, corresponding to that section which would be covered by a hanger in a submarine installation. Figure 4 shows the LOON on the launcher.

The entire structure may be made to oscillate in roll at amplitudes of 5° to 15° from top dead center at periods of 6 seconds to 15 seconds. Power to oscillate the ramp is supplied by a gasoline engine. No provisions are made to simulate pitch or yaw. The rolling feature was removed after several successful launchings had been accomplished from submarines, and the ramp was secured in the top dead center position.

This ramp was removed from the NAMTC launching area in August 1950 to make room for other launching installations.

(3) NADC Zero-Length Launcher

This launcher was designed and built by the Naval Air Development Center, Johnsville, Pennsylvania for the purpose of conducting zero-length launchings of LTV-N-2 (LOON), CTV-N-2 (GORGON), and RTV-N-15 (POLLUX) missiles. It was installed at NAMTC in August 1950.

The launcher is a compact unit 107 inches long, 65 inches wide, and 50½ inches high. It is rotatable in azimuth through 360° and adjustable in elevation from +½° to +11°. The launching sled, with one 2.2-KS-33,000 JATO unit attached, is loaded on the launcher with either a crane or a special launching-sled handling cart. The missile is then loaded with a crane. A LOON in launching position on the NADC zero-length launcher is shown in figure 5.

(4) NAMTC Short-Length Launcher

The NAMTC short-length launcher was originally designed as a replacement for the rolling ramp. It is a rail-type launcher with four 8-foot rails for the two front and two rear slippers. The plane of the rear slipper rails is 5 inches above the plane of the front slipper rails. The rails are so designed that the front and rear slippers of the four-JATO launching sled leave the launcher simultaneously. This feature prevents the possibility of a tip-off and consequently and undesirable nose-down pitching acceleration of the missile.

The launcher is trainable in azimuth through an arc of 30° in increments of 5° and is adjustable in elevation from a rail angle of 8° to 16° in increments of 1°. The over-all length is 23 feet, the width is 4 1/4 feet, and the maximum height is 4½ feet. Figure 6 shows the NAMTC launcher with a LOON missile in the launching position.

The launcher was originally designed for only the four-JATO launching sled. With the advent of the single-JATO launching sled, an auxiliary set of rails was installed and the launcher may now be used with either launching sled. Either short-length or zero-length launchings may be accomplished.

Shipboard Installations

(1) Short-Length Launcher aboard the USS NORTON SOUND

The NORTON SOUND launcher was designed by NAMTC. It is a short-length three-rail launcher made of mild steel in a box truss design with diagonal supports and was patterned after the rolling ramp. It is 207 inches long and allows the front slippers of a four-JATO sled to travel 36 inches before clearing the launcher. It is adjustable in elevation from 2° to 8°, but is not trainable.

(2) USS CUSK Launching Installations

The LOON is stored on board the USS CUSK in a deck hangar, aft of the conning tower. The hangar is a cylindrical steel tank, 8 feet 6 inches in diameter. The tank is closed at the aft end by a hydraulically-operated door. No provision is made for entering the hangar directly from within the pressure hull.

Prior to January 1951, the launcher installed aboard the CUSK was identical to the forward 50 feet of the rolling ramp. It could be utilized only with the four-JATO launching sled.

A short-length launcher, patterned after the NAMTC short-length launcher, was installed aboard the CUSK in November and December 1950 during a regular overhaul period. The rail configuration is identical to the NAMTC short-length launcher. However, the supporting structure was strengthened and the launcher was provided with an air-driven training and elevating mechanism. Working platforms also were added outboard of the rails to assist the prelaunching checkout crew. This launcher was designed for use with either the four-JATO or the single-JATO launching sleds. Figure 7 shows the short-length launcher and the hangar installed on the CUSK. The launching installation aboard the CUSK is described in detail in reference 11.

(3) Installation Aboard the USS CARBONERO

The launcher aboard the USS CARBONERO is a three-rail short-length launcher similar to that previously described for the USS NORTON SOUND. The supporting structure was redesigned and strengthened to withstand water loads when the boat is submerged.

The launcher is mounted on the aft 5-inch gun mount with the longitudinal axis of symmetry rotated 15° toward the port quarter. The launching rails are elevated at an angle of 6° above the horizontal. No provisions for adjustment in azimuth or elevation are provided.

The four-JATO sled and the missile are loaded separately by crane directly onto the launcher because no hangar or other means of stowage is provided. Figure 8 shows the launcher installation aboard the CARBONERO. This installation is essentially identical to that described in reference 11 for the CUSK except for the actual launcher.

equipment

STABILIZATION SYSTEM

Stable and controlled flight is achieved with the aid of a pneumatically-operated autopilot, rudder servomotor, and elevator servomotor.

The autopilot contains a yaw rate gyro and a pitch rate gyro — each of which is restrained to precess in one plane only — and a free gyro, which measures angular displacements. In addition to the gyros, the autopilot contains two systems of air lines. One system provides air to drive the gyros, and the other system is used to transmit intelligence to the servomotors.

The servomotors consist of a diaphragm unit, an air valve connected to the diaphragm, a double acting piston, a chamber, and three air pressure fittings.

The missile is stabilized by the action of the three gyros. The vertical reference is established by the displacement gyro, which rotates about an axis that is inclined 20° to the horizontal. The inclination of the rotational axis is maintained by a pair of pendulous vanes. If the missile pitches, the frame of the autopilot moves with reference to the displacement gyro. This displacement causes a differential pressure to be applied across the servomotor diaphragm and thereby opens the air valve. This allows high pressure air to enter the piston chamber and move the piston. The elevator, which is attached to the piston, deflects in a direction that returns the missile to its original attitude. Similar action deflects the rudder when the missile rolls or yaws. The rate gyros act in a conventional manner and are utilized to damp out oscillations in pitch and yaw by causing the elevator and rudder to be displaced in a direction that opposes the angular velocity.

The missile is stabilized in either an 8° climbing attitude or in level flight, depending upon the setting of an altitude control unit which is mounted on the autopilot frame. When flying at altitudes below that which is set in the control unit, the missile is stabilized in an 8° climb. When the preset altitude is reached, the control unit rotates one of the displacement gyro gimbal rings through an arc of 8°. This creates a new vertical reference and causes the missile to stabilize in level flight and maintain the desired altitude.

The missile is turned by precessing the displacement gyro in the horizontal plane. This is accomplished when one of two magnetic coils is energized by the radio command system. The magnetic coil attracts a soft iron shoe mounted on one of the gimbal rings and applies a precessional torque.

A more complete explanation of the stabilization system can be found in reference 20.

CONTROL

A schematic sketch of the LTV-N-2 control system is shown in figure 9. The AN/ARW-17 is a 30- to 42-mc, crystal-regulated, frequency-modulated, control receiver with five tone-channel selectors. The five relays of this unit operate in response to the five tone-channels of the command transmitter.

The control signals are transmitted by a modified T/24/ARW-3 command transmitter and AN-10/ARW-3 amplifier. The transmitter is crystal-regulated and contains 10 audio oscillators for frequency modulation of the carrier. Only the five highest audio-frequency oscillators of the transmitter are used in this system. The amplifier unit is used to increase the power output of the transmitter from 25 to 250 watts.

The coded commands to the missile are keyed by the C-33(XN)-ARW-3 flight-control box. A three-position rotary switch marked "code selector" makes connections in the box in order that the operator may select the code through which the command is sent. If three missiles were tracked and controlled simultaneously, each would be on an individual code.

In addition to the ARW-17 receiver, the missile control system consists of a C-363/ASW control relay box and a CP-28/ASW computer. The control relay box contains six relays that form parts of the "dump" circuits and the "turn-command" circuits. The CP-28/ASW computer is an electromechanical timing device which is used to energize the autopilot slaving coils for a given time interval. The time interval is dependent upon the number of turn-command pulses received by the ARW-17 receiver.

TRACKING

The missile is equipped with either an AN/APN-33 or AN/APN-33A radar transponder beacon. The AN/APN-33 radar transponder beacon operates in the frequency range from 2,750 to 2,950 mc. It is mounted in the nose section and is equipped with a receiving and a transmitting antenna. The AN/APN-33A beacon is a modified AN/APN-33 beacon that operates in the 2,750 and 3,500 mc range. It is equipped with a single antenna which both receives and transmits. Several beacon antenna configurations are used. These are shown in figure 10.

Several different radars have been used for tracking. The model SV-1 radar is used during all flights launched from submarines. The SP-1M was formerly used for flights launched from shore launchers, but it has been replaced by the SCR-584/615B. The SV-4, a shore-based version of the SV-1, also is used for shore launchings.

The SV radar is a high S-band aircraft-warning radar designed for installation aboard submarines. It is a pulse-type manual tracking radar having a pulse repetition frequency of 400 per second and a peak power output of 500 kilowatts. Target information is presented on a 5-inch PPI (plan position indicator) scope, and on 3-inch A-scan and B-scan scopes. When used in conjunction with a radar beacon in the LOON missile, the average maximum range is approximately 100 statute miles.

The SV installations aboard the USS CUSK and the USS CARBONERO are equipped with a special B-type repeater which was designed and built by the Navy Electronics Laboratory. This unit presents missile range and indicates missile position relative to the course line.

The SCR-584/615B is an S-band radar that incorporates features of both the SCR-584 and the SCR-615B radars. It is an automatic tracking pulse-type radar with a pulse repetition frequency of 1,707 pulses per second. Peak power output is 750 kilowatts. Maximum range is approximately 125 statute miles. When used in conjunction with LOON test flights, the radar data is presented on an Electronic Associates Model 156 plotting board.

TELEMETRY.

Two types of telemetry are used in the LTV-N-2 (LOON). The AN/AKT-1A is a pulse time-sharing system designed by the Naval Research Laboratory for use in the LOON. This is a 10-channel system that operates in the 520 to 525 mc band and transmits with a peak power output of approximately 250 watts.

The transmitter and the power supply are mounted in a cylindrical can, which is placed in the warhead section. The complete installation, with the exception of the end instruments, is accessible from the front of the warhead and may be readily replaced if a failure occurs during prelaunching checkouts.

The AN/AKT-1A system is being replaced by the AN/AKT-10 system. The AN/AKT-10 operates in the 215 to 230 mc range and utilizes frequency-modulated subcarrier oscillators to frequency-modulate the RF carrier. The normal peak power output is 3 watts; however, a power amplifier may be used to increase the peak power output to 30 watts. Six channels of continuous information may be transmitted. The sixth channel may be commutated to provide 15 items of information, each sampled at 10 times per second.

The complete system, with exception of the end instruments, has been packaged to form an installation similar to the AN/AKT-1A. The installation is shown in figure 11.

FUEL AND PROPULSION SYSTEM

The fuel and propulsion system consists of a 180-gallon fuel tank, fuel lines, cut-off valve, fuel regulator, and a 21-inch pulsejet engine.

The pulsejet engine is essentially a hollow cylinder that consists of an inlet diffuser, a combustion chamber, a transition cone and a tail pipe. A grill that contains the flapper valves, the starting air nozzles, and the fuel nozzles, separates the inlet diffuser and the combustion chamber. A spark plug is mounted at the top center of the combustion chamber. Total weight of the engine is approximately 300 pounds. It resonates at a frequency of 42 cps and develops 700 pounds of static thrust at sea level.

The fuel line leads from the bottom of the fuel tank, through the cutoff valve, through the fuel regulator, and thence to the fuel nozzles in the grill.

The fuel cutoff valve contains a spring that holds it in a closed position. The valve is opened by compressed air, which forces the valve to move against the spring. When the valve is fully opened, a pin engages a detent in the valve shaft and holds it in the open position. Closing of the valve is accomplished by a solenoid that disengages the detent pin and allows the spring to move the valve shaft to the closed position.

The fuel-metering unit regulates the fuel flow according to the missile airspeed. An altitude-compensating bellows, although a part of the unit, is not used because early flights indicated that its operation was erratic. The fuel-metering unit also contains a control for regulating the fuel flow during engine starting.

Operation of the propulsion system is as follows: (1) pressurize fuel tank to 100 psi by compressed air; (2) initiate flow of starting air through starting air nozzles; (3) initiate flow of fuel to fuel nozzles by opening fuel cutoff valve, and energize spark plug; (4) after engine has started, stop flow of starting air and change starting fuel flow to normal fuel flow. The engine continues to operate until fuel flow is cut off.

Maximum operating altitude of the standard propulsion system is 6,000 feet. Although engine operation is self-sustaining after the initial starting pulse, a continuous spark ignition system is employed. This system has successfully restarted the engine on several occasions when propulsion failures occurred.

FLIGHT TERMINATION

Flight termination is accomplished by a radio command. Upon receipt of the command, the wings are severed from the missile, the control surfaces are streamed, and the fuel to the engine is shut off. A delay of 0.3 second occurs between the severing of the left and right wing. This delay induces a stabilizing roll in the missile during the terminal trajectory.

The severance of each wing results from the explosion of a shaped charge, of composition C3, which is retained within an annular groove machined into a mild steel disc. The disc is held inside of the hollow wing spar by machine screws. The composition C3 is ignited by an M36 electric detonator contained in a mechanical detonator safe device secured to the outside of the spar.

The control surfaces are caused to stream by severance of the signal lines from the autopilot to the rudder and elevator servo actuators. This is brought about by a detonator guillotine, which is a 1-inch hollow tube approximately 6 inches long. The signal lines are threaded through four holes drilled through the tube at right angles to the longitudinal axis. At the receipt of the dump command, an explosive charge in the after end of the detonator guillotine tube is ignited and a metal slug, with a cutting surface machined into the leading edge, is ejected down the tube where it severs each of the four signal lines.

The engine fuel is shut off by a solenoid-operated valve. The solenoid is energized when the metal slug of the detonator guillotine trips a microswitch as it leaves the forward end of the tube.

If the missile fails to respond to the dump command, a Veeder-Root counter energizes the dump circuit after the missile has traveled a predetermined distance. This is accomplished by a mechanical counter operating in conjunction with a small air log propeller mounted on the nose of the missile. Each propeller is calibrated and is labeled with the number of turns per mile.

ORDNANCE COMPONENTS

The ordnance components of the LTV-N-2 (LOON) consist of a 2,000-pound tritonal-loaded warhead, two T74 electrical fuzes, a T9 inertia switch, and a T8 nose switch. Figure 12 shows a schematic diagram of the installation. Figure 13 shows the location of the various components in the LOON missile. More complete information on the ordnance components may be obtained in reference 13. It should be noted that the T84 mechanical fuze originally was used in place of one of the T74 electrical fuzes. However, tests conducted by the Bureau of Ordnance during October 1950 proved the T84 fuze to be unsafe and it was removed from the system.

test procedure at NAMTC

Preparations for a LOON test flight normally commence approximately 3 weeks prior to the actual flight. At that time the detailed test objectives are assigned and the missile configuration required to accomplish the test objectives is selected.

Approximately 2 weeks are required for shop personnel to perform the routine checkout of the air, fuel, and propulsion systems and to install the electrical cabling, electronic components, and the telemetering system. The installation of other special equipment required for the test i also made during this period.

Approximately 20 people, including mechanics, technicians, engineers, and officers are assigned to the LOON project team.

After the missile has been completely prepared, the weight and center of gravity are determined with an electronic weighing scale. The launching sled also is assembled and its weight and center of gravity are determined. The location of the center of gravity of the missile — sled combination is calculated from the two measured values and the sled adjustment for obtaining the proper alignment of the JATO thrust vector with respect to the combined center of gravity can then be made. This work is normally completed 2 days before the launching is scheduled.

Approximately 1 week before the test flight, a "Request for Scheduling Test" form is submitted to the Test Scheduling Officer. This form contains all pertinent information relative to the particular test flight. Copies are distributed to all interested supporting departments of NAMTC to insure that equipment and personnel will be available for the scheduled test. Detailed arrangements with the supporting departments are usually made by telephone or conference after the "Request for Scheduling Test" form has been distributed.

On the day before the scheduled launching, the launching sled is loaded on the launcher and the missile is transported to a heated overnight storage building located in the launching area.

At 0800 on the morning of the launching, the missile is loaded on the launcher and the missile check crew commences the prelaunching checkout. A briefing conference, which is conducted by the assigned Test Control Officer, is held at approximately 0900. The conference is for the purpose of insuring that the supporting departments are briefed on all the details of the test. Any last minute changes in the schedule or procedural details which have been omitted previously are discussed.

At 1030, an airplane in which a beacon and missile receiving equipment have been installed, commences a flight that simulates the expected flight of the missile. The tracking radars that have been assigned for the missile test flight are used to track the beacon in the airplane. Control signals are transmitted from the missile ground control station at periodic intervals and the field strength that exists in the vicinity of the aircraft is monitored. This flight assists in insuring that all ground command and tracking equipment is operating at peak efficiency

At 1200 or approximately 2½ hours before launching time, area clearance airplanes are dispatched to the Sea Test Range. These airplanes, equipped with loud-speakers and signal lights, attempt to keep ships out of areas over which the missile will fly. The activities of the area clearance aircraft are co-ordinated from the area clearance center located in the launching area.

The 60-minute warning is the first official warning sounded. This is sounded when all the missile prelaunching checks have been practically completed. At the receipt of the 60-minute warning, all supporting departments commence active preparation for their part in the missile flight.

The 15-minute warning is sounded only if the Sea Test Range is clear and all supporting departments are completely ready for the operation. At the 15-minute warning, the two chase airplane pilots man their aircraft and the launching ordnance crew commences the final installation of the ordnance components (JATO igniters, wing blowoff igniters, etc).

At the 10-minute warning, the chase airplanes are directed to take off. If both chase airplanes are airborne at the 5-minute warning, the count down is continued. Otherwise the warning is held until the airplanes are airborne.

At the 3-minute warning, the missile internal air supply and telemeter transmitter are turned on and the launching pad is cleared of all personnel. All electrical circuits from the blockhouse to the launcher are armed and the missile is ready for launching.

The 1-minute warning is sounded by the chase airplane pilots when they are in a position that will allow them to pass over the launcher at the instant of launching.

At the 30-second warning, the automatic count down sequence is started by the Launching Officer. All functions, such as missile autopilot displacement gyro uncaging, camera starting, and JATO ignition pulses, occur automatically. The sequence may be stopped and a "hold fire" effected from any one of four stations at any time. The stations are located at the launching blockhouse, area clearance center, Tracking and Control, and telemetric receiving station.

The pulsejet engine is started manually at the 25-second warning. At the 10-second warning, the autopilot displacement gyro is uncaged and a return pulse, which indicates that the gyro has uncaged, illuminates an indicator light in the blockhouse. The cameras, which are used to cover each launching, are started at the 2-second warning. At zero time the JATO units are ignited and a reference timing pulse is transmitted to all apparatus on which flight data is recorded.

Immediately after launching, the center of activity shifts to the Tracking and Control Room, which corresponds to the Combat Information Center aboard ship. This room contains the missile-command-control console, radar plotting tables, radio transmitting and receiving equipment, and a direct telephone link with the telemetric receiving station.

During the flight, the Test Control Officer is continuously informed of the location and status of the missile from the radar plot and from verbal reports of the missile speed and altitude that are transmitted every 30-seconds by the chase airplane pilots. Any pertinent telemetered information may be readily obtained by telephone from the telemetric receiving station. Control commands, as directed by the test control officer, are transmitted to the missile by the control console operator. If the control equipment in the tracking and control room fails, control commands are transmitted from a secondary control station, which is ordinarily located in one of the area clearance airplanes.

The test flight is terminated by the transmission of the "dump" command after the chase airplane pilots report that the area is clear. In the event that the dump command is not received, the missile is dumped at a predetermined range by the action of the air log propeller and the Veeder-Root counter, which was described under "Configuration."

During each test flight, all radio transmissions that concern the flight are monitored and recorded so that a permanent record may be kept. This includes a transcript of the chase airplane pilot's "talkback" and recordings of all commands sent to the missile. The telemetered information is recorded on a roll of photographic paper. Translation of the received telemetered data is performed by LOON project engineers.

Operations conducted from the USS CUSK and the USS CARBONERO are similar to those conducted from shore except that the primary tracking and control room is aboard ship. Telemetry is not used during test flights that originate from the submarines.

results and discussion

The LOON test program is conducted under the authority of several project directives, each of which consists of one or more problem details. The results of the over-all launching program, with particular emphasis on the general reliability of components, are presented at the end of this section. Table I, appendix A, contains a résumé of each individual LOON test flight.

Because of the general complexity of the LOON program, the problem details will be discussed individually. The number to the right of the problem detail headings indicates the number of flights conducted which had that problem detail as a test objective and which were of sufficient duration to contribute usable data. Flight failures, or the adoption of equipment as standard, sometimes resulted in a greater number of flights than indicated.

PROBLEM DETAIL RESULTS

1. Test of NAMTC and Sperry GM-1 Command Guidance Computer EL-302 (4 flights)

Only the NAMTC computer was evaluated with flight tests. The four flights indicated that the computer is capable of guiding the missile along a straight course from the launching site to the target. It was necessary to discontinue the tests when the SP-1M radar was transferred to another project.

No flight tests were conducted utilizing the Sperry GM-1 computer. It was planned to conduct simulated missile flights using the TO-2 airplane. However, the assigned airplane, which had been instrumented for the tests, was lost in a crash before any tests were conducted.

This problem detail was not reassigned by reference 5.

2. Test of the Quick Detachable Electronic Nose Mount EL-302 (9 flights)

This unit was designed to permit quick changing of the electronic components. All the electronic units, with the exception of the power supply, are contained in the nose section in a shock-mounted box, as shown in figures 14, 15, and 16. The entire nose section and the electronic components may be connected in 60 seconds. Seven successful flights were conducted utilizing the original design (figure 15) which incorporated large springs and snubbers for the shock-absorbing units. Five flights have been made utilizing an improved unit (figure 16) which incorporates Lord shock mounts in place of the springs and snubbers. The units have proved to be very satisfactory for the following reasons:

a. They permit checkout of the major electronic components prior to actual installation in the missile and thereby decrease the time required for the missile to be on the launcher.

b. They allow quick replacement of electronic units that fail during the prelaunch checkout.

3. Marine Guidance Computer EL-302 (14 flights)

The Marine Guidance Computer is an adaptation of the NAMTC computer and is designed for use in close-air-support operations. When used in conjunction with the LOON missile, the computer and radar were located in the vicinity of the target. The radar tracked the missile as it approached the target and provided missile position, course, and speed data to the computer. The computer then analyzed the data and transmitted course-change commands that would guide the missile toward the target. It also computed the position for the dump point and transmitted the "dump" command when the missile reached that position.

The Marine Guidance Computer participated in 14 flights. Ten of these were for the purpose of testing the ability of the computer to guide the missile over the target and did not include the sending of the dump command The dump command was actually transmitted on two flights. The miss distances were 360 and 600 yards from the target. On two other flights, faulty operation of equipment prevented the transmission of the dump command, although the computer demonstrated that it was capable of guiding the missile over the target.

These flights indicate that the computer is capable of performing the task for which it was designed when continuous and accurate data is provided by the radar. Except for several isolated cases, the failure of the system to operate satisfactorily could be attributed directly to poor radar performance. This problem detail was not reassigned by reference 5.

4. Assistance to Project TROUNCE* (38 flights)
EL-302 and GM-209

During this report period, 38 missiles were launched from submarines by TROUNCE personnel. Because this program was well established, very little technical assistance was required of NAMTC personnel. The major contribution of NAMTC was the provision of facilities and material.

Active support of the TROUNCE program by NAMTC personnel was provided during two shore launchings that were telemetered. The telemetric transmitters for these tests were provided by NAMTC and the installation and prelaunch checkout were conducted by NAMTC personnel.

5. Improved Command Guidance System (2 flights)
EL-302

This detail was a joint effort that involved NEL (Navy Electronics Laboratory), Project TROUNCE personnel, and NAMTC. The development phase was assigned to NEL. Technical assistance was furnished by NAMTC and TROUNCE. Test flights were performed at NAMTC.

The system, designated TROUNCE I, was designed to eliminate the normal radio command system by utilizing the tracking radar to transmit control commands to the missile. This was done by coding the radar pulses. The missile equipment is identical to that used for the radio-command system except that the radio receiver was replaced by a decoder that converted the coded radar pulses into command functions. The physical dimensions of the decoder and the radio receiver were identical.

Before missile flights were conducted, numerous tests were made that utilized piloted aircraft equipped with the missile components of the system. These tests revealed that it was possible to transmit intelligence by radar pulse coding to ranges of 150 miles.

Two missile flights were conducted utilizing the system. On one flight, the missile was launched from the NAMTC short-length launcher and control was shifted successfully from NAMTC to the CUSK, and then to the CARBONERO. Each station maintained positive radar track and successfully transmitted control commands. However, it was necessary to execute the "dump" with the stand-by radio control system. The second flight was also highly successful. The missile was tracked and controlled throughout the flight and was dumped at a range of 93 miles from the controlling station. In each case, the

* Originally Project DERBY

flight was terminated because the missile was approaching the radar horizon. It is believed that control ranges of 150 miles would be realized if the missile were capable of flying at higher altitudes.

6. Improved Launching System (5 flights)
GM-209

This problem detail was promulgated essentially for the purpose of testing dual-JATO and single-JATO launching configurations. Zero-length launchings were conducted from the rolling ramp and the NADC zero-length launcher; short-length launchings were conducted from the NAMTC short-length launcher.

Two successful zero-length dual-JATO launchings were conducted from the rolling ramp. Dual-JATO launchings were discontinued in April 1949 because the more desirable single-JATO configuration was then undergoing developmental tests. A detailed report on the dual-JATO launching techniques was presented in reference 19.

One unsuccessful and one successful but unsatisfactory launching were conducted from the NADC launcher. The unsuccessful launching was attributed to a misaligned JATO unit that caused the missile to nose over and crash on the beach. The second launching was successful but was unsatisfactory because the missile had a 58° nose-up attitude at separation. These two launchings indicated that the JATO alignment tolerances for zero-length launchings are extremely small and this type of launching should be avoided if possible.

Three successful single-JATO launchings were conducted from the NAMTC short-length launcher. These tests indicated that the single-JATO launching configuration is satisfactory when used in conjunction with a short-length launching. Subsequent to these tests, all shore launchings and all shipboard launchings from the USS CUSK have utilized single-JATO sleds. These launchings have proved that the method is superior to the four-JATO launching configuration in that the JATO alignment procedure is simpler and the launching sleds are more compact and more economical to manufacture. Figure 17 is a photograph of the single-JATO launching sled.

This problem detail also included tests of a launching retarder which was designed to eliminate the shock loading transmitted to the missile at the instant of JATO closure disc rupture. A detailed report on the device, which functions by pulling a steel cone through a ductile brass tube, was submitted by reference 14. Tests indicated that the device caused the thrust loading to be applied gradually, and consequently decreased the peak loading applied at the tow hook by approximately 50 per cent. The device is now used during all shore JATO launchings.

7. Armament Components Tests (3 flights)
GM-209

Before flight tests were made with a loaded warhead, extensive ground tests and flight tests of inert detonation systems were conducted. These preliminary tests indicated that the T84 mechanical fuze was unsafe for operational use and, as reported under "Configuration", it was replaced by a T74 electrical fuze.

The first and third flight tests were successful. The system armed at the correct time and a high order detonation was observed at impact. The second test was unsatisfactory in that the warhead failed to detonate upon impact. The reason for the failure is believed to have been caused by the severing of the electrical lead that extends from the warhead to the arming micro-switch of the Veeder-Root counter in the rear of the missile. As a result of this test, it was recommended that the Bureau of Ordnance investigate the possibility of replaceing the present arming switch of the Veeder-Root counter with a mechanical latching relay which would remain closed in the event that an open developed in the Veeder-Root counter arming circuit.

8. Tests of Power Plant Installations (9 flights)
GM-209

Propulsion system tests were conducted in an endeaver to improve the performance of the missile. These involved testing the 21-inch pulsejet with an improved altitude-compensated fuel meter, and testing J-30 and J-44 turbojet engine installations.

Eight flights were conducted that contributed usable data on the McDonnell V-2 altitude-compensated fuel meter. The fuel metering system with this unit installed is shown in figure 18. These flights indicated that it was possible to fly the missile at altitudes up to 12,000 feet. Considerable difficulty was experienced in maintaining the preset basic fuel meter setting after the missile was airborne. Telemetered fuel-pressure data indicated that, although the meter responded to changes in altitude and airspeed, the fuel pressure during a given flight was either higher or lower than that which would be expected from the ground setting. In most cases, lean fuel metering resulted in poor missile performance, whereas rich and normal settings resulted in excellent performance. The reasons for the shift in setting are being investigated. It is felt that the McDonnell fuel meter, when perfected, will increase the versatility of the missile by permitting flights at higher altitudes.

The turbojet engine installations are expected to increase the missile performance with respect to speed, operating altitude, and range. One missile, shown in figure 19, was modified to accomodate a Westinghouse J-30 engine. This engine had a normal rated thrust of approximately 1,400 pounds and was expected to increase the missile speed to 450 — 500 miles an hour at an altitude of 20,000 feet. The missile was launched in August 1951 but, because of an apparent misalignment of the booster — JATO thrust vector, it crashed immediately after launching and no data on flight performance were obtained. The short flight did provide vital data on engine performance which indicated that no adverse effects were experienced during the launching phase. It is planned to launch five more missiles as soon as the modifications are completed.

Preliminary tests are being conducted on the J-44 engine to determine the effect of launching acceleration on the bearings and general operation. If these tests prove that reliable engine operation can be expected, two airframes are to be modified to incorporate this engine.

9. Improved Dump Systems (6 flights)
GM-209

The method of dumping the missile has undergone a series of changes in an effort to improve the predictability of the terminal trajectory. The present method, which has been used with some success, incorporates wing blowoff with a 0.3-second delay between the severing of the left and right wing. A detailed report on this method was presented in reference 15. Experience with this method over the past two years has shown that the trajectory of the freely falling spin-stabilized missile is unpredictable in that a high-amplitude pitch oscillation is frequently observed.

Recent tests of a method that separates the warhead from the missile by means of explosive attachment bolts have shown great promise. It is believed that the high inertial and gravitational forces will overshadow the relatively low aerodynamic forces and result in a predictable trajectory. Six flights utilizing this method of flight termination have been attempted and all have been successful. Figure 20 is a photograph showing the action of the missile and freely falling warhead immediately after the receipt of the "dump" command. The tests have shown that some means must be devised to prevent the tumbling action of the warhead, in order to insure that the warhead attitude upon impact is nose down. It is planned to conduct future tests with a small parabrake attached to the after end of the warhead. This parabrake will be designed to prevent tumbling of the freely falling warhead.

10. Installation of Smoke Generators (4 flights)
GM-209

Smoke generator units were manufactured mainly for use in fleet exercises when the LOON was to be used as an antiaircraft target. Four units were flown during this report period. One was shore-launched in August 1949 and operated satisfactorily. Three units were used during the fleet exercises off Hawaii in November 1949. One unit remains for future use.

11. Dynamic Flight Measurements (1 flight)
DE-302.3

This project was established to determine the feasibility of obtaining certain aerodynamic parameters from free flight tests of missiles and missile models. The LOON was selected as a vehicle for the preliminary tests because it has few space limitations for instrumentation and will fly reliably for a reasonably long period. One missile was assigned for directional stability tests and was delivered to the Douglas Aircraft Corporation for the installation of special instrumentation and test equipment. It was launched in July 1950 and was flown according to the desired test program. Complete telemetered data was obtained however, an irregular rudder oscillation, which persisted throughout the flight, caused an unwanted directional vibration to be superimposed upon the natural oscillations. Consequently the analysis of the data has been prolonged inordinately.

12. Furnish Technical and Material Assistance to the USS NORTON SOUND (3 flights)
PA-501.3

During this report period, NAMTC provided technical and material assistance to the USS NORTON SOUND for the launching of three LOONs. All flights were nominally successful. One of these flights was particularly significant in that the missile was successfully launched and controlled in Alaskan waters where extremely cold and adverse weather conditions were experienced.

13. Summers Gyro Servo Control System (4 flights)
EL-301

The Summers gyro servo control system was an electronic system designed to replace the present pneumatic autopilot and control system. Its main advantages over the present system were increased maneuverability and controllability of the missile. These were achieved by removing the rudder control and replacing it with aileron control.

Four flights were attempted with this system The first three flights indicated that the system apparently lost vertical reference during the launching phase and during turns. These flights were all terminated prematurely for causes directly attributable to loss of reference. The fourth flight, which utilized a system that was modified to eliminate the loss of correct vertical reference, was successful in proving that the system was capable of increasing the controllability and maneuverability of the missile. However, the missile exhibited a decided directional drift to the left which had to be corrected by control commands throughout most of the flight

The project was terminated in June 1951 by the promulgation of reference 16.

Progress on certain details that did not involve actual missile flights is discussed in the following paragraphs.

14. Study of AN/APA-76 Autopilot
Study of AN/ASQ-5 AN/ASA-6 Heat Homer
EL-302

These two problem details were actually assigned as two different items; however, they were actually a joint effort because the ultimate missile installation was to incorporate both systems.

An extensive study was conducted to determine the compatibility of the missile — APA-76 combination. This study indicated that the autopilot was capable of stabilizing and controlling the missile. The ASQ-5 — ASA-6 study was essentially for the purpose of preparing an engineering proposal for the flight testing of 14 LOON missiles equipped with the ASQ-5 heat homing equipment. The study was completed and the report was submitted to the Bureau of Aeronautics by reference 17.

15. Acceptance Checks of Marquardt
Modified Missiles
EL-302

From August 1949 to May 1951 LOON project personnel inspected and accepted 77 LOON missiles which were delivered under contract N123s-63366 (reference 9) by the Marquardt Aircraft Company.

16. Develop New S-Band
Radar Beacon Antenna
EL-302

This antenna was to be designed for ultimate use with the improved command guidance system. The desired antenna pattern was based on the requirements for possible tactical missile use. It was envisioned that such a flight would involve a launching submarine that would track and control the missile to a rendezvous point in the vicinity of a second submarine. The second submarine would guide the missile to the target by means of an automatic guidance computer.

A prototype antenna was designed and constructed. Preliminary ground tests indicated that the antenna had a horizontal pattern of 105° centered at a relative bearing of 180°. The vertical pattern was 40° centered on a line rotated 18° below the longitudinal missile axis. A minor lobe existed forward. The back-to-front ratio was greater than 6 to 1. This pattern was considered very desirable from an operational standpoint. Extensive aircraft flight tests and ground tests of the antenna installed on the missile are in progress.

17. Consultative Service for Design and Construction of CP-98 (XN)/UPW Command Guidance Computer EL-302

The CP-98 (XN)/UPW command guidance computer contract was awarded to the Ultrasonics Corporation, Cambridge, Massachusetts, and will be built according to specifications originated at NAMTC. The computer will be designed for installation aboard a submarine and, by analyzing missile position and velocity data with respect to target position, will cause proper control commands to be sent to the missile so as to score a hit on the target.

Since the awarding of the contract, NAMTC personnel have been in attendance at numerous conferences with the contractor, NEL personnel, and Project TROUNCE personnel. Problems relative to the computer have been discussed at these conferences.

18. Ready Missile Program GM-209

In accordance with reference 1, a stockpile of 25 missiles has been established at NAMTC. This was a joint effort which involved LOON and TROUNCE project personnel. To insure that the missiles in the stockpile are maintained in the best possible condition, a rotational plan has been established whereby all newly modified missiles are assigned to the stockpile and all missiles utilized for submarine launchings are taken from the group that has been in the stockpile for the longest period of time.

A shortage of launching sleds existed during the early phases of this program. However, NAMTC is currently manufacturing four-JATO launching sleds and delivery of single-JATO launching sleds from O & R, San Diego commenced in August 1951. Consequently, sufficient sleds are now available for both the stockpile and the test program.

19. Cancelled or Incomplete Problem Details

The following problem details were assigned but either were cancelled before any progress was made or are awaiting the delivery of equipment

PROBLEM DETAILS	PROJECT
SIMULTANEOUS TRACK AND CONTROL OF TWO OR THREE LOONS. (CANCELLED.)	EL-302
INSTALLATION AND TEST OF SPERRY GM-1 COMPUTER ABOARD A SUBMARINE. (CANCELLED.)	EL-302
EVALUATION OF AN/DPN-17 MINIATURIZED RADAR BEACON. (AWAITING EQUIPMENT.)	EL-302
EVALUATION OF AN/ARW-55 AND AN/ARW-56 400 MC RADIO CONTROL EQUIPMENT. (AWAITING EQUIPMENT.)	EL-302
EVALUATION OF AN/APW-11 CONTROL EQUIPMENT. (CANCELLED.)	EL-302

RELIABILITY

Despite a concentrated effort for improvement during this report period, the reliability of the missile and its components has not changed appreciably over that reported in reference 11. Table II, appendix A, presents the performance of the components during each LOON flight test. Table III, appendix A, summarizes the performance of the components and presents a comparison with the reliability of components presented in reference 11. It is realized that a more detailed breakdown of the failures would be desirable. However, in most cases, the failures could be isolated only as far as one of the components listed in table II. For example, if a propulsion failure occurred, it was usually impossible to attribute it to one of the direct causes, i.e., loss of air pressure on fuel tank, obstruction in fuel line, faulty fuel meter, or grille failure. Consequently it had to be classified as a propulsion failure, with no further breakdown possible.

As stated in reference 18, the over-all reliability of a missile is the product of the individual reliabilities of "series" components. If the components of LOON are considered to be launching sled, beacon, receiver, autopilot, propulsion system, and dump system, then the maximum expected reliability of the missile can be calculated as follows:

$$P_{over\text{-}all} = P_{launching} \times P_{sled} \times P_{beacon} \times P_{receiver} \times P_{autopilot} \times P_{propulsion} \times P_{dump}$$

$$P_{over\text{-}all} = 92.6 \times 91.2 \times 95.3 \times 89.5 \times 92.7 \times 92.7$$

$$P_{over\text{-}all} = 61.8 \text{ per cent}$$

The discrepancy between the calculated reliability of 61.8 per cent and the actual value of 55.9 per cent can be attributed to certain miscellaneous components such as batteries, airframe structures, etc. that actually should be considered as one of the "series" components. These additional components were neglected because failures occurred only in isolated instances and they represented a multitude of components whose reliability approached 100 per cent.

Because the reliability of the missile has remained essentially constant since 1 January 1948, it is believed that the practical limit has been reached. This does not imply that no progress in LOON testing technique has been made in the past 3 years. It indicates that the improved techniques have just kept pace with components deterioration. It is pointed out that all the missile components, with the exception of CP-28 computers and the C-363 control relay boxes, were manufactured prior to 1946. Certain components, such as beacons and receivers were delivered to NAMTC from other agencies, after prolonged use on their projects.

It is believed that the reliability of the missile could be improved if newly manufactured components, or components of improved design, were used in place of the components on hand.

CONCLUSIONS

During this report period, the LOON missile has continued to demonstrate its versatility as a test vehicle and as a training vehicle for fleet personnel. The main factors that contribute to its value are relatively long range and endurance, simplicity of its basic systems, adequate internal space for installation of experimental equipment, reasonable reliability, and relatively low initial cost.

Significant progress has been made in accomplishing the objectives of the assigned projects. The conclusions reached from the results of the flight test program may be enumerated as follows:

1. The use of automatic guidance computers in controlling the missile is both feasible and desirable. However, provisions for manual control must be provided until the reliability of the radar — computer link is improved.

2. The quick-detachable electronic nose mount should be incorporated as part of the standard configuration, as soon as sufficient units can be manufactured. Experience with the LOON has shown that the idea of packaging all the electronics components in an accessible and easily removed carrier box, should definitely be considered for future missiles.

3. Fleet personnel assigned to the USS CARBONERO and the USS CUSK have reached a degree of proficiency in preparing, launching, and controlling a LOON missile that should allow these vessels to use the missile operationally if conditions so warrant.

4. The TROUNCE I guidance system is very promising and should provide greater security against countermeasures than the radio command system now in use.

5. The relative simplicity of the single-JATO launching sled in regards to both alignment procedure and construction, make it superior to both the dual-JATO and the four-JATO launching sleds.

6. Short-length JATO launchings are more reliable than zero-length JATO launchings.

7. The NAMTC-designed launching retarder decreases by 50 per cent the peak loading applied to the missile tow hook.

8. With minor modifications to the electrical circuits, the present warhead-detonating system should prove adequate for operational use.

9. Test of the McDonnell altitude-compensated fuelmeter should be continued because, if perfected, it will increase the versatility of the missile by permitting flights to altitudes of at least 12,000 feet.

10. Tests of the J-30 and J-44 turbojet installations should be continued.

11. A method of increasing the predictability of the terminal trajectory must be devised. The present method of wing blowoff results in an unpredictable trajectory. Further tests of the warhead-blowoff method, with particular emphasis on the prevention of tumbling, should be conducted.

12. The Summers gyro servo control system proved that it was capable of increasing the maneuverability and the controllability of the LOON missile. However, lack of a reliable vertical reference system and excessive directional drift made it unacceptable for use in the LOON.

13. The reliability of the missile and missile components has reached a practical maximum. It would probably increase if newly manufactured or redesigned components were provided.

references

1. CNO Secret letter OP-512/mm Serial 0082P51 of 23 August 1950.

2. BuAer Secret letter Aer-GM-241 Serial 001042 of 30 August 1950.

3. CNO Secret letter OP-512B/lct Serial 0010P51 of 30 August 1950.

4. BuAer Confidential letter Aer-GM-241 Serial 012829 of 8 December 1950.

5. BuAer Confidential letter Aer-EL-745 Serial 02901 of 7 March 1951.

6. BuAer Confidential letter Aer-PP-211 Serial 012728 of 6 December 1950.

7. BuAer Confidential letter Aer-PP-212 Serial 0226 of 8 January 1951.

8. BuAer Confidential letter Aer-GM-241 Serial 013534 of 27 December 1950.

9. Contract No. N123s-63366 dated 17 June 1949.

10. NAMTC Technical Report No. 28, "Interim Report on LOON Program to 1 January 1948," dated 26 April 1948.

11. NAMTC Technical Report No. 54, "Interim Report on LOON Program from 1 January 1948 to 1 March 1949," dated 8 July 1949.

12. NAMTC Technical Report No. 8, "The XM-1 Catapult," dated 1 February 1947.

13. War Department Technical Bulletin TB9X-108, "Ordnance Components for JB-2 Bomb," dated 27 March 1945.

14. NAMTC Technical Memorandum Report No. 41, "The Launching Retarder," dated 21 April 1950.

15. NAMTC Technical Report No. 48, "LTV-N-2 (LOON) Wing Blowoff System," dated 15 June 1949.

16. BuAer Restricted letter Aer-EL-4211 Serial 58672 of 14 June 1951.

17. NAMTC Confidential letter Serial 02-324 of 27 January 1950.

18. NAMTC Technical Report No. 75, "A Study of Methods for Achieving Reliability of Guided Missiles," dated 10 July 1950

19. NAMTC Technical Report No. 66, "Dual-JATO Launching of the LTV-N-2 (LOON) Missile," dated 20 January 1950.

20. T. O. No. 11-75 BA-3, "Assembly, Preparation and Launching of Pilotless Aircraft type JB-2," dated 1 June 1945.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE	MID-COURSE PHASE				
DATE	NO. FIRED	MISSILE NO	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSIL- ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT
1949 3-31	172	1002		XMI-1 Catapult	6° Catapult sled	1. Test and evalu.te 3 gyro servo control system	6°	Good	700	245	353	5800	Dump sig-nal not sent	73 mi. 223°T from NAMTC
4-20	173	1051		XMI-1 Catapult	6° Catapult sled	1. Test and evaluate electronics components nose mount and automatic command signal computer- to maximum range	6°	Satisfactory L.W. down 10°	500	234	234	1100	Dump signal not sent	13mi. 210°T from NAMTC
4-21	174	614	5140	Rolling Ramp	2-Jato Northrop sled	1. Zero length launch 2. Test sled recovery device 3. Theodolite tracking of red 60,000 cp flare 4. Evaluate command signal computer	9°	Satisfactory left wing down	700	200	200	5900	simul-tan-eous wing blow-off	38mi. 213°T from NAMTC
4-28	175	599		Rolling Ramp	2-Jato Northrop sled	1. Zero length launch 2. Collect data on terminal trajectory	9°	Good	700	235	338	4800	simul-tan-eous wing blow-off*	1500 yds. SE Begg Rock
5-10	176	1074		XMI-1 Catapult	6° Catapult sled	1. Evaluate automatic command signal computer 2. Track and control	6°	Satisfactory slight left wing down	400	230	280	5200	simul-tan-eous wing blow-off	118mi. 223°T from NAMTC
5-19	177	1046		USS Carbonero short length launcher	4-Jato	1. Zero length launch from newly installed launcher 2. Track and control to geographical target	9°	Satisfactory left wing down 10°	800	230	325	5200	simul-tan-eous wing blow-off	1,000 yds. 060°T from Begg Rock
6-2	178	738		USS Carbonero short - length launcher	4-Jato	1. Train Carbonero personnel 2. Conduct zero - length launch 3. Track and control to Begg Rock	9°	Satisfact-ry left wing down 10°	500	208	347	4700	simul-tan-eous wing blow-off	1,000 yds. 240°T from Begg Rock
6-14	179	590	5180	USS Carbonero short length launcher	4-Jato	1. Zero length launch 2. Track and control to Begg Rock	9°	Poor 5° nose down 10° right wing down	500	235	[illegible]	4500	simul-tan-eous wing blow-off	1.5mi. 213°T from Begg Rock
6-20	180	243	5090	XMI-1 Catapult	6° Catapult sled	1. Test and evaluate electronics components nose mount 2. Evaluate vertically polarized command receiver antenna	6°	Failure						150 ft. from end of cata-pult
6-29	181	586	5140	USS Cusk 40 ft. ramp	4-Jato	1. Zero length launch 2. Track and control to Begg Rock 3. Practice relaying of control 4. Evaluate vertically polarized receiver antenna	9°	Failure						250 yds. astern of Cusk
6-29	182	597	5075	USS Carbonero short length launcher	4-Jato	Same as No. 586 above	9°	Satisfactory 10° left wing down	700	220	355	4700	simul-tan-eous wing blow-off	131mi. 220°T from NAMTC

*Secondary Control Plane

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SUMMARY OF LOON FLIGHTS

		LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE			ELECTRONICS			GENERAL
TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
valu te 3ummes gyro rol system	6°	Good	700	245	353	5800	Dump signal not sent	73 mi. 223°T from NAMTC	No chance to operate	AKT-1A Failed at 1.31 minutes	Good response to 4 left and 3 right turn commands	SV-4 Radar APN-33A Beacon Good track	Most successful 3ummers flight to date. Excellent stabilization and control except that altitude control never reached 5500 feet lock on altitude.
valuate electronics nose mount and command signal o maximum range	6°	Satisfactory L.W. down 10°	500	234	234	1100	Dump signal not sent	13mi. 210°T from NAMTC	No chance to oper-	AKT-1A Good	Responded to left and right turn commands from computer	SP-1MB radar APN-33 Beacon Good track	Probable autopilot failure. Missile fell off on left wing and crashed into sea.
th launch recovery device e tracking of red flare command signal	9°	Satisfactory left wing down	700	200	200	5900	simultaneous wing blow-off	38mi. 213°T from NAMTC	NAMTC	No	Responded to left and right turn commands from computer	SP-1MB radar APN-33 Beacon Good track	Engine torched, lost thrust, missile stalled. Transmitted dump signal after loss of about 3,000 feet.
th launch ata on terminal y	9°	Good	700	235	338	4800	simultaneous win. blow-off	1500 yds. SE Begg Rock	NAMTC	No	Good	SP-1MB radar APN-33 Beacon Lost beacon at 20 miles	
automatic command mputer control	6°	Satisfactory slight left wing down	400	230	280	5200	simultaneous wing blow-off	118mi 223°T from NAMTC	NAMTC	AKT-1A satis. to 80 mi. Poor to 100 mi.	Good	SP-1MB radar APN-33 Beacon Good track	
h launch from alled launcher control to geo- target	9°	Satisfactory left wing down 10°	800	230	325	5200	simultaneous wing blow-off	1,000 yds. 060°T from Begg Rock	NAMTC	No	Good	SV-4 on Carb. SV-4 at NAMTC APN-33A Beacon Good track	First launching from Carbonero. SV-4 had good track throughout. SV-1 lost beacon at 35 miles and regained it at 45 miles.
bonero personnel ro - length launch control to Begg	9°	Satisfactory left wing down 10°	500	208	347	4700	simultaneous wing blow-off	1,000 yds. 240°T from Begg Rock	Carbonero	No	Good	SV-4 on Carb. SV-4 at NAMTC APN-33A Beacon Good track	Poor sled separation
h launch control to Begg	9°	Poor 5° nose down 10° right wing down	500	235	321	4500	simultaneous wing blow-off	1.5mi. 213°T from Begg Rock	Cusk	No	Good	SV-4 on Carb. SV-4 at NAMTC APN-33A Beacon Good track	
valuate electronics nose mount vertically polar- and receiver	6°	Failure						150 ft. from end of catapult		AKA-1A Good for 0.6 sec when antenna broke off			Sled separated from missile while on catapult. Missile crashed on beach.
h launch control to Begg relaying of control vertically polarized antenna	9°	Failure						250 yds. astern of Cusk		No			Sled failed to separate from missile.
586 above	9°	Satisfactory 10° left wing down	700	220	355	4700	simultaneous wing blow-off	131mi. 220°T from NAMTC	No response from Cusk, NAMTC, S.C.P.	No	No response from all stations	SV-4 on Carb. SV-4 at NAMTC APN-33A Beacon No track	Electrical system failed. No control response, no beacon track, VRC failed to function. Missile flew to fuel exhaustion.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION								LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE				
DATE	NO FIRED	MISSILE NO	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJ CTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CON-
7-15	183	1061	5100	XMI-1 Catapult	6° Catapult sled	1. Test Summers gyro - servo control system	6°	Satisfactory left wing down			270	900		12 mi. 240°T from NAMTC		AKT-1A Good	Good
7-21	184	742	5080	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test automatic command signal computer. 3. Test vertically polarized receiver antenna 4. Test delay wing blowoff	6°	Satisfactory 10° left wing down	700	210	334	4900	Delay wing blow-off with 0.3 sec delay	70 mi 232°T from NAMTC	No response from NAMTC Affirmative from secondary control	AKT-1A Good	Good
8-5	185	244		USS Norton Sound Short length launcher	4-Jato	1. Train Norton Sound personnel in LOON launching, tracking and control 2. Use LOON as antiaircraft target	9°	Satisfactory slight left wing down				5000	simultaneous wing blow-off	59 mi. from Norton Sound	Norton Sound	No	Good
8-9	186	534	5040	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test automatic command signal computer 3. Test vertically polarized receiver antenna 4. Test delayed wing blowoff	6°	Satisfactory slight left wing down	400	220	320	5000	Delay wing blow-off	Not known	NAMTC, secondary control plane results not known	AKT-1A Good to 75 miles	Inadequ ate con trol, althoug respon was affirm-ative
8-26	187	1067	5220	USS Cusk 40 ft. ramp	4-Jato	1. Track from Cusk, submerged 2. Zero-length launch 3. Test vertically polarized receiver antenna 4. Practice relay of track and control 5. Test smoke generator 6. Test delay wing blowoff	9°	Poor 30° left wing down	500	210	355	5400	Delay wing blow-off	80 mi. from NAMTC	NAMTC, Cusk, secondary control plane	No	Good
8-26	188	821	5150	USS Carbonero short length launcher	4-Jato	Same as 1067 above	9°	Satisfactory slight left wing down	700	205	350	5200	Delay wing blow-off	Not known	All stations no response	No	Good
8-26	189	836	5025	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test vertically polarized receiver antenna 3. Test delay wing blowoff	6°	Failure					Delay wing blow-off	1.8mi from NAMTC	NAMTC no response	AKT-1A Good	None attempted
9-28	190	778	5130	USS Carbonero short length launcher	4-Jato	1. Track and control from Cusk submerged and Carbonero on surface 2. Zero length launch 3. Test vertically polarized receiver antenna 4. Practice relay of track and control	9°	Satisfactory slight left wing down	700	226	365	4800	Delay wing blow-off	87 mi from NAMTC	All Stations sent Dumped by Secondary control plane	No	Good
9-29	191	776	5270	USS Cusk 40 ft. ramp	4-Jato	Same as 778 above	9°	Satisfactory slight left wing down	900	225	355	5100	Delay wing blow-off	80 mi from NAMTC	None sent	No	Good
10-3	192	256	5060	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test vertically polarized receiver antenna 3. Test delay wing blowoff	6°	Good	700	220	350	5100	Delay wing blow-off	93.5mi 214°T from NAMTC	Secondary control plane	AKT-1A. Good to 15 secs. after dump	Good
10-12	193	249		USS Norton Sound short length launcher	4-Jato	1. Test AEW track and control relay system	9°	Satisfactory slight left wing down			350	5000	simultaneous wing blow-off	137mi from Norton Sound	NO RESPONSE FROM NORTON SOUND NAMTC SECONDARY CONTROL PLANE	No	Good

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SUMMARY OF LOON FLIGHTS

		LAUNCHING PHASE		MID-COURSE PHASE		TERMINAL PHASE			ELECTRONICS			GENERAL
ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
6°	Satisfactory left wing down			270	900		12 mi. 240°T from NAMTC		AKT-1A Good	Good	SP-1MB radar APN-33 Beacon Good track	No altitude commands were given, as the altitude of the missile was not known. Engine torched, missile lost altitude and crashed. Chase pilot failed to report missile altitude.
6°	Satisfactory 10° left wing down	700	210	334	4900	Delay wing blow-off with 0.3 sec delay	70 mi. 232°T from NAMTC	No response from NAMTC Affirmative from secondary control	AKT-1A Good	Good	SP-1MB radar APN-33 Beacon Good track	Engine torched at 65 miles and missile crashed. Computer sent improper course changes.
9°	Satisfactory slight left wing down				5000	simultaneous wing blow-off	59 mi. from Norton Sound	Norton Sound	No	Good	SP-1MB radar APN-33 Beacon Lost track after 5 minutes	Detailed flight data was not submitted by the Norton Sound. Flight was apparently successful.
6°	Satisfactory slight left wing down	400	220	320	5000	Delay wing blow-off	Not known	NAMTC, secondary control plane results not known	AKT-1A Good to 75 miles	Inadequate control, although response was affirmative	SP-1MB radar APN-33 Beacon Good to 75 mi.	Rudder apparently full 15° left for most of flight. Missile disappeared in fog bank at 75 miles, altitude 3500 ft.
9°	Poor 30° left wing down	500	210	355	5400	Delay wing blow-off	80 mi. from NAMTC	NAMTC, Cusk, secondary control plane	No	Good	SV-1 on Cusk APN-33A beacon Good track	All objectives achieved, except only left wing detonator operated.
9°	Satisfactory slight left wing down	700	205	350	5200	Delay wing blow-off	Not known	All stations no response	No	Good	SV-4 on Carb. APN-33A Beacon Good track	All obje[illegible] achieved except neither wing detonator oper[illegible]. Engine cutoff failed to operate, missile [illegible] to 107 miles before losing beacon track. Chase plane turned back at 100 miles due to low fuel supply.
6°	Failure					Delay wing blow-off	1.8mi. from NAMTC	NAMTC no response	AKT-1A Good	None attempted	SV-4 at NAMTC APN-33A Beacon	Fuel pressure dropped from normal to zero just before missile cleared end of catapult. Believe engine cutoff ,dn unseated due to catapult acceleration.
9°	Satisfactory slight left wing down	700	226	365	4800	Delay wing blow-off	87 mi. from NAMTC	All Stations sent. Dumped by secondary control plane	No	Good	SV-4 at NAMTC SV-4 on Carb. SV-1 on Cusk APN-33A Beacon Good track	All objectives achieved.
9°	Satisfactory slight left wing down	900	225	355	5100	Delay wing blow-off	80 mi. from NAMTC	None sent	No	Good	SV-4 at NAMTC SV-4 on Carb. SV-1 on Cusk APN-33A Beacon Good track	Right wing sheared off during violent turn maneuver.
6°	Good	700	220	350	5100	Delay wing blow-off	93.5mi 214°T from NAMTC	Secondary control plane	AKT-1A. Good to 15 secs. after dump	Good	SV-4 at NAMTC APN-33A Beacon Good track	Considered excellent flight. However, only left wing blowoff, although voltage was applied to both detonators. First flight to employ modified fuel cutoff pin.
9°	Satisfactory slight left wing down			350	5000	simultaneous wing blow-off	137mi from Norton Sound	NO RESPONSE FROM NORTON SOUND NAMTC SECONDARY CONTROL PLANE	No	Good	APS-20 radar APN-33A Beacon Good track	Missile successfully vectored over target, but failed to respond to dump signal, or VRC. Flew to fuel exhaustion

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE		MID-COURSE PHASE		TE…		
DATE	NO FIRED	MISSILE NO	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITI…	OP…
10-31	194	592	5120	USS Cusk 40 ft. ramp	4-Jato	1. Launch, track and control missile to geographical target	9°	Good	700	215	215	4500	Not in-stalled	Not known	None sent
11-4	195	246	5060	XMI-1 Catapult	6° Catapult sled	1. Test automatic command signal computer 2. Test detachable electronics nose mount 3. Test vertically polarized receiver antenna 4. ~~Test delay wing blowoff~~	6°	Good	400	210	347	4500	Delay wing blow-off	1.9 mi. 270°T from Begg Rock	NAMTC
11-7	196	640	5245	USS Cusk 40 ft. ramp	4-Jato	1. Launch, track and control a LOON which had been prepared at an advanced base 2. Provide high speed aerial target for fleet.	9°	Poor 60° left wing down					Not installed	1000 Ft. astern of Cusk	None sent
11-7	197	535	5310	USS Carbonero short length launcher	4-Jato	Same as 640 above	9°	Satisfactory slight left wing down			340		Not installed	Not known	Cusk
11-8	198	814	5140	XMI-1 Catapult	6° Catapult sled	1. Test automatic command signal computer 2. Test horizontally polarized receiver antenna 3. Test delay wing blowoff	6°	Good	400	217	340	5600	Delay wing blow-off	Not known	All stations no re-spon…
12-5	199	935	5050	XMI-1 Catapult	6° Catapult sled	1. Test automatic command signal computer 2. Test detachable electronics nose mount 3. Test delay wing blowoff	6°	Good						½ mile from NAMTC	None sent
12-9	200	230	5240	Rolling ramp	4-Jato	1. Conduct zero length launch 2. Test simultaneous wing blowoff.	9°	Good	800	210	312	5300	simultaneous wing blow-off	79 miles 209°T from NAMTC	NAMT…
12-21	201	1075	5090	Rolling ramp	4-Jato	1. Conduct zero length launch 2. Test cable stablizer 3. Test sled separation device 4. Test McDonnell fuel meter 5. Test continuous spark 6. Test delayed wing blowoff	9°	Poor left outboard Jato burst safety diaphragm at .25 seconds	800	210	340	8150	Delayed wing blow-off	99 miles from NAMTC	NAMT…
1950 1-12	202	903	5150	USS Cusk 40 ft. ramp	4-Jato	1. Test NEL Precision B scope radar repeater. 2. Test vertically polarized receiver antenna 3. Conduct zero length launching	9°	Good	850	230	360	5600	Delayed wing blow-off	74 miles from Cusk	USS Cusk
1-16	203	227	5060	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test Marine Guidance Computer 3. Test McDonnell fuel meter 4. Test detonator guillotine device.	6°	Good	1000	200	320	8500	Delayed wing blow-off	116 miles 226°T from NAMTC	NAM…
1-16	204	1199		USS Norton Sound short length launcher	4-Jato	1. Practice launching, tracking and controlling LOON under adverse weather conditions 2. Test autopilot compartment heater installation	9°	Good			350	5000	simultaneous wing blow-off	Unknown	Unkno… if comman… sen…

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SUMMARY OF LOON FLIGHTS

			LAUNCHING PHASE		MID-COURSE PHASE		TERMINAL PHASE			ELECTRONICS			GENERAL
TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
k and control eographical target	9°	Good	700	215	215	4500	Not in-stall-ed	Not known	None sent	No	None sent	SV-1 on Cusk APN-33A Beacon Lost beacon track at 25 miles	Believe engine failed at 25 miles. Missile was obscured by overcast, and not seen again. Fleet exercise off Hawaii
ic command signal able electronics lly polarized re-na ing blowoff	6°	Good	400	210	347	4500	Delay wing blow-off	1.9 mi. 270°T from Begg Rock	NAMTC	AKT-1A Good	Good	SP-1MB radar APN-33 Beacon Lost abruptly at 11 miles	Reason for beacon failure not known. Delay wing blowoff induced oscillations in pitch as well as anticipated roll rate.
k and control a ad been prepared d base speed aerial tar- t.	9°	Poor 60° left wing down					Not in-stalled	1000 Ft. as-tern of Cusk	None sent	No	None sent		Missile had sharp left wing down at sled separation. Attempted to recover but had insufficient altitude. Crashed into sea. Fleet exercise off Hawaii.
above	9°	Satisfactory slight left wing down			340		Not in-stalled	Not known	Cusk	No	Response good for Cusk. No response to Car-bonero signals	SV-1 on Cusk SV-4 on Carb. APN-33A Beacon Good track to limit of radar scope	Dump signal sent at 80 miles. No visual confirmation, but lost beacon. Fleet exercise off Hawaii.
ic command signal tally polarized enna ing blowoff	6°	Good	400	217	340	5600	Delay wing blow-off	Not known	All sta-tions no re-sponse	No	No re-sponse	SP-1MB radar APN-33 Beacon No track	Electronics system failed. Believe delay timer did not function.
ic command signal able electronics ing blowoff	6°	Good						½ mile from NAMTC	None sent	AKT-1A Good	None attempt-ed	SV-4 at NAMTC	150 ft. from end of catapult missile rolled right 110° and crashed in water. Autopilot functioned properly to oppose roll. believed caused by wing structural failure.
length launch neous wing	9°	Good	800	210	312	5300	simul-tan-eous wing blow-off	79 miles 209°T from NAMTC	NAMTC	No	Good	SV-4 at NAMTC APN-33A Beacon Good after 40 miles	All objectives achieved.
length launch tablizer paration device ll fuel meter ous spark wing blowoff	9°	Poor left outboard Jato burst safely diaphram at .25 seconds	800	210	340	8150	Delay-ed wing blow-off	99 miles from NAMTC	NAMTC	No	Good	SV-4 at NAMTC APN-33A Beacon Good track	Stabilizer cable parted at drum during launching. Engine smothered by Jato smoke. Restarted by continuous spark. Altitude record established.
cision B scope ter. lly pol rized enna length launching	9°	Good	850	230	360	5600	Delay-ed wing blow-off	74 miles from Cusk	USS Cusk	No	Good	SV-1 on Cusk APN-33A Good track	Le ft wing only severed at dump.
able electronics Guidance Computer ll fuel meter tor guillotine	6°	Good	1000	200	320	8500	Delay-ed wing blow-off	116 miles 226°T from NAMTC	NAMTC	AKT-1A Good	Good	SV-4 at NAMTC 615B-584 on San Nicolas Island APN-33A Good track to 114 miles	New altitude record. Marine guidance computer not utilized beyond 35 miles due to low missile speed.
ching, tracking ing LOON under er conditions lot compartment llation	9°	Good			350	5000	simul-tan-eous wing blow-off	Un-known	Un-known if com-mand sent	No	Good to 30 miles	SP-1MB on Norton Sound Good track	Launched in Alaskan waters. Missile turned 70° then failed to respond to further turn commands. Beacon lost at 102 miles.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE		
DATE	NO. FIRED	MISSILE NO	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT.	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SI…	TELE…
2-7	205	1165	5085	XMI-1 Catapult	6° Catapult sled	1. Test detachable electronics nose mount 2. Test Marine Guidance Computer 3. Test McDonnell fuel meter	6°	Good	1000	222	357	9200	Delay wing blow-off did not re-spond	140 miles 230°T from NAMTC	NAMTC, Cusk, stand-by con-trol	AKT-1A Good
2-8	206	794	5100	USS Cusk 40 ft. ramp	4-Jato	1. Conduct zero length launch 2. Test NEL precision B scope radar repeater 3. Test vertically polarized receiver antenna 4. Test Marine Guidance Computer	9°	Satisfactory 10° left wing down	600	220	347	5100	simul-tan-eous wing blow-off	3000 yds. 090°T from Begg Rock	USS Cusk	No
2-8	207	247	5140	USS Cusk 40 ft. ramp	4-Jato	1. Conduct zero length launching 2. Test NEL precision B scope radar repeater 3. Test vertically polarized receiver antenna	9°	Failure						1.5 miles from Cusk	None sent	No
2-28	208	231	5100	Rolling ramp	4-Jato	1. Conduct zero length launching 2. Test sled separation device 3. Test detachable electronics nose mount 4. Test McDonnell fuel meter 5. Test Marine Guidance Computer	9°	Good					Delayed wing blow-off actuat-ed pre-maturely	1.5 miles from NAMTC	None sent	AKT-1A Good
3-22	209	1200	5140	USS Cusk 40 ft. ramp	4-Jato	1. Conduct zero length launching 2. Test Marine Guidance Computer	9°	Satisfactory 15° nose up, slight left wing down	1000	220	355	5900	Delay-ed wing blow-off	360 yds. 090°T from Begg Rock	Mar-ine guid-ance stati-ons	No
3-28	210	221	5080	XMI-1 Catapult	8° Catapult sled	1. Test detachable electronics nose mount 2. Test McDonnell fuel meter	8°	Wing blew off before launch was complete					Delay-ed wing blow-off act-uated premat-urly	250 yds. from end of cata-pult	None sent	AKT-1A Good
4-12	211	1004	5120	USS Cusk 40 ft. ramp	4-Jato	1. Conduct zero length launching 2. Test Marine Guidance Computer	9°	Good	1000	210	350	5900	Delay-ed wing blow-off	Un-known	USS Cusk	No
4-12	212	644	5100	USS Cusk 40 ft. ramp	4-Jato	1. Conduct a zero length launching 2. To hit a target 1 mile square centered on Begg Rock 3. To track and control while submerged	9°	Good	No record	No record	390	5000	Delay-ed wing blow-off	2000 yds. 130°T from Begg Rock	USS Cusk	No
5-1	213	1147	5200	XMI-1 Catapult	8° Catapult sled	1. Test Marine Guidance Computer	8°	Good	1000	230	350	5200	Delay-ed wing blow-off	600 yds. 033°T from Begg Rock	Marine guidance compu-ter ([illegible]tomatic)	No
5-3	214	890	5140	USS Cusk 40 ft. ramp	4-Jato	1. Test Marine Guidance Computer	8°	Satisfactory slight left wing down	800	230	345	5250	Delay-ed wing blow-off	10mi… 213°T from Pegg Rock	Marine guid-ance sta-tion (man-ually)	No
5-3	215	639	5160	USS Cusk 40 ft. ramp	4-Jato	1. Train Cusk personnel 2. Test NEL SV-1 radar range unit	9°	Satisfactory left wing down	800	200	220	8400	simul-tan-eous wing blow-off	105 miles 226°T from Cusk	USS Cusk	No

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SUMMARY OF LOON FLIGHTS

		LAUNCHING PHASE		MID-COURSE PHASE			TERMINAL PHASE		ELECTRONICS			GENERAL
ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT.	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
6°	Good	1000	222	357	9200	Delay wing blow-off did not re-spond	140 miles 230°T from NAMTC	NAMTC Cusk, stand-by con-trol	AKT-1A Good	Good	SV-4 at NAMTC SV-1 on Cusk 615B-584 on San Nicolas Island APN-33A Beacon Good track	New altitude and distance record.
9°	Satisfactory 10° left wing down	600	220	347	5100	simul-tan-eous wing blow-off	3000 yds. 090°T from Begg Rock	USS Cusk	No	Good	SV-1 on Cusk SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good track	Marine guidance unable to control missile due to failure in transmitting equipment.
9°	Failure						1.5 miles from Cusk	None sent	No	None attempt-ed	SV-1 on Cusk APN-33A Beacon	Missile rolled 180° during launching - Flew inverted into water.
9°	Good					Delayed wing blow-off actuated pre-maturely	1.5 miles from NAMTC	None sent	AKT-1A Good	None attempt-ed	SV-4 at NAMTC 615B-584 at San Nicolas Island AN/APN-33A Beacon	After launching the missile commenced a normal climb. At 1.5 miles the right wing blowoff charge detonated. The cause was attributed to the delay timer which was tripped during launching. When the 30 second timer ran down, voltage was applied to right wing detonator.
9°	Satisfactory 15° nose up, slight left wing down	1000	220	355	5900	Delay-ed wing blow-off	360 yds. 090°T from Begg Rock	Mar-ine guid-ance stati-ons	No	Good	SV-1 on Cusk 615B-584 at San Nicolas Island APN-33A Beacon Good track	Control was shifted to Marine Computer at a range of 30 miles from San Nicolas Island. Computer successfully controlled missile and transmitted "dump" command. First successful employment of computer on missile flight.
8°	Wing blew off before launch was complete					Delay-ed wing blow-off act-uated premat-urly	250 yds. from end of cata-pult	None sent	AKT-1A Good	None attempt-ed	SV-4 at NAMTC	Immediately after clearing the catapult, the left wing of the missile was detonated and the missile crashed on the beach and ricochetted into the water. The cause of the premature actuation is unknown.
9°	Good	1000	210	350	5900	Delay-ed wing blow-off	Un-known	USS Cusk	No	Good	SV-1 on Cusk 615b-584 at San Mi-·las Island APN-33A Beacon Good track	Marine guidance station erroneously tracked chase plane. After error was discovered, the Cusk assumed control of missile which had taken divergent course. After a series of control commands the dump signal was transmitted.
9°	Good	No record	No record	390	5000	Delay-ed wing blow-off	2000 yds. 130°T from Begg Rock	USS Cusk	No	Good	SV-1 on Cusk SV-4 at NAMTC APN-33A Beacon Good track	All objectives achieved except that impact position was wide of target area.
8°	Good	1000	230	350	5200	Delay-ed wing blow-off	600 yds. 033°T from Begg Rock	Marine guidance compu-ter (au-tomatic)	No	Good	SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good ·rack	Missile was acquired by radar on San Nicolas Island at range of 30 miles. Missile was then vectored to Begg Rock by the computer and dumped. This was second successful flight with Marine guidance computer.
8°	Satisfactory slight left wing down	800	230	345	5250	Delay-ed wing blow-off	10 miles 213°T from begg Rock	Marine guid-ance sta-tion (manu-ally)	No	Good	SV-1 on Cusk SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good track	Control was shifted to Marine guidance station at range of 32 miles. At range of 3 miles the radar track was lost when radar automatic elevation tracking unit was activated. Missile had passed dump point when track was regained.
9°	Satisfactory left wing down	800	200	220	8400	simul-tan-eous wing blow-off	105 miles 226°T from Cusk	USS Cusk	No	Good	SV-1 on Cusk SV-4 at NAMTC APN-33A Beacon Good track	McDonnell fuel meter installed. Autopilot set to 10,000 ft. Low speed and altitude due to poor fuel meter performance. Tracking range was maximum achieved to date by submerged submarine. Significant flight despite poor performance.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE	MID-COURSE PHASE			TE…		
DATE	NO FIRED	MISSILE NO	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSI…	C…
5-17	216	992	5180	USS Carbonero short length launcher	4-Jato	1. Train Carbonero personnel 2. To test vertical command antenna and SV-1 radar on Carbonero 3. Test MEL B scope radar repea…	9°	Good	1000	240	342	5600	Delayed wing blow-off	80 miles 214°T from NAMTC	USS Car… one…
6-8	217	238	5200	Rolling Ramp	4-Jato	1. Test McDonnell fuel meter 2. Conduct long range flight with 90° heading change. 3. Dress rehearsal for Aero free flight missile. (DE 302.3)	9°	Good	650	250	330	12400	Delayed wing blow-off	100 miles 230°T from NAMTC	NAM…
6-12	218	1080	5090	Rolling Ramp	4-Jato	1. Test Marine guidance computer 2. Test sled separation device	9°	Good					Delayed wing blow-off	1000 yards from NAMTC	Non… sen…
6-22	219	1078	5150	USS Carbonero short length launcher	4-Jato	1. Train Carbonero personnel 2. Hit geographical target 3. To test vertical command antenna	9°	Satisfactory left wing down	1000	220	370	5000	Delayed wing blow-off	96 miles from NAMTC	Non… cer…
6-22	220	630	5090	XMI-1 Catapult	8° Catapult sled	1. Test Marine guidance computer	8°	Satisfactory 10° left wing down	1000	260	350	5400	Delayed wing blow-off	75 miles 213°T from NAMTC	Mar… gui… anc… sta… (ma… ual…
7-28	221	242	5150	Rolling Ramp	4-Jato	1. To determine directional aerodynamic data on the LOON missile. (This was the first missile to be launched under project TED NTC DE 302.3)	8°	Satisfactory left wing down	1500	240	265	4500	Detonator guillotine	100 miles 210°T from NAMTC	NA…
8-9	222	1064	5160	XMI-1 Catapult	8° Catapult sled	1. To test a Marquardt modified missile as received from the contractor 2. To hit a geographic target (1 sq. mile centered on Begg Rock)	8°	Satisfactory left wing down	1000	235	330	4500	Delayed wing blow-off	55 miles 210°T from NAMTC	NA…
9-15	223	250	5125	USS Cusk 40 ft. ramp	4-Jato	1. To hit target on western tip of San Nicolas Island 2. To test ordnance components of warhead	8°	Satisfactory left wing down	500	220	350	4500	Delayed wing blow-off	65 miles 211° from NAMTC	US… Cu…
9-18	224	636	5100	XMI-1 Catapult	8° Catapult sled	1. To test Marine guidance computer	8°	Good					Delayed wing blow-off	4000 yards from NAMTC	No… se…
9-18	225	207	5100	NAMTC short length launcher	4-Jato	1. Test Marine guidance computer 2. Test NAMTC short length launcher	9°	Good	1200	220	355	5800	Delayed wing blow-off	68 miles 213°T from NAMTC	NA…
10-12	226	945	5090	USS Carbonero short length launcher	4-Jato	1. To hit a land target on west end of San Nicolas Island 2. To train Carbonero personnel	9°	Poor nose down left wing down	1000	220	350	4300	Delayed wing blow-off	.7 mile from target point	US… Ca… bo… er…

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SUMMARY OF LOON FLIGHTS

			LAUNCHING PHASE		MID-COURSE PHASE				TERMINAL PHASE		ELECTRONICS		GENERAL
TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
bonero personnel ertical command an- SV-1 radar on B scope radar repeater	9°	Good	1000	240	342	5600	Delayed wing blow-off	80 miles 214°T from NAMTC	USS Carbonero	No	Good	SV-1 on Carbonero SV-4 at NAMTC APN-33A Beacon Good track	This flight was primarily to test new equipment on the Carbonero. All equipment operated as expected. Chase plane broke off chase at 65 miles due to bad weather.
onell fuel meter ong range flight heading change earsal for Aero free ssile. (DE 302.3)	9°	Good	650	250	330	12400	Delayed wing blow-off	100 miles 230°T from NAMTC	NAMTC	AKT-1A Good	Good	SV-4 at NAMTC APN-33A Beacon Good track	Excellent flight in all respects. New altitude record established. Total of 150 miles traversed by missile.
ne guidance computer separation device	9°	Good					Delayed wing blow-off	1000 yards from NAMTC	None sent	No	None attempted	SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon	After booster burnout the missile nosed over and crashed into sea, carrying sled with it. No definite conclusions as to cause.
bonero personnel aphical target ertical command	9°	Satisfactory left wing down	1000	220	370	5000	Delayed wing blow-off	96 miles from NAMTC	None sent	No	Good	SV-1 on Carbonero SV-4 at NAMTC APN-33A Beacon Poor track	Poor beacon performance prevented tracking by Carbonero or NAMTC. Missile was dumped by veederoot counter.
ne guidance computer	8°	Satisfactory 10° left wing down	1000	260	350	5400	Delayed wing blow-off	75 miles 213°T from NAMTC	Marine guidance station (manually)	No	Good	SV-4 At NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good track	Satisfactory flight in all respects. Marine computer operated satisfactorily. However, personnel error prevented dump signal from being transmitted.
ine directional ic data on the LOON (This was the first be launched under D MTC DE 302.3)	8°	Satisfactory left wing down	1500	240	265	4500	Detonator guillotine	100 miles 210°T from NAMTC	NAMTC	Bendix DKT-3 Good	Good	615B-584 at NAMTC and San Nicolas Island APN-33 Beacon Good track	Although useable data for directional stability constants were obtained, it was clouded by a persistant rudder oscillation and slow speed.
Marquardt modified received from the eographic target e centered on	8°	Satisfactory left wing down	1000	235	330	4500	Delayed wing blow-off	55 miles 210°T from NAMTC	NAMTC	No	Poor	615B-584 at NAMTC APN-33 Beacon Good track	A severe rudder oscillation prevented the missile from responding to control commands.
rget on western tip olas Island rdnance components	8°	Satisfactory left wing down	500	220	350	4500	Delayed wing blow-off	65 miles 211° from NAMTC	USS Cusk	No	Good	SV-1 on Cusk SV-4 at NAMTC 615B-584 on San Nicolas Island APN-33A Beacon Good track	Equipment failure in range unit on Cusk prevented missile from being dumped on target.
rine guidance	8°	Good					Delayed wing blow-off	4000 yards from NAMTC	None sent	No	None attempted	615B-584 at San Nicolas Island and NAMTC APN-33 Beacon	Engine cut off pin actuated during catapult run and missile cleared catapult with dead engine. Missile glided to splash point.
e guidance short length	9°	Good	1200	220	355	5800	Delayed wing blow-off	68 miles 213°T from NAMTC	NAMTC	No	Good	615B-584 at NAMTC and San Nicolas Island APN-33 Beacon Good track	Control shifted to Marine guidance station at range of 37 miles. Radar contact at that station lost when missile was 12,000 yds. from target.. Missile passed over target and was dumped by NAMTC. First launching from NAMTC short length launcher.
and target on west Nicolas Island arbonero personnel	9°	Poor rose down left wing down	1000	220	350	4300	Delayed wing blow-off	.7 mile from target point	USS Carbonero	No	Good	SV-1 on Carbonero SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good track	First successful attempt to hit a land target.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE			
DATE	NO FIRED	MISSILE NO.	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETER	
10-18	[illegible]	1031	5280	NAMTC Short length launcher	4-Jato	1. Test McDonnell fuel mete. 2. Determine climb data by varying missile pitch attitude 3. Test NAMTC short length launcher	9°	Good	1000	200	300	5000	Delayed wing blow-off	32 miles 213°T from NAMTC	NAMTC	AKT-1A good except for commutated channel	Go
11-1	228	963	?300	NADC zero length launcher	Single Jato	1. Test NADC zero length launcher 2. Test single Jato launching configuration	9°	Failure					None	400 feet from launcher	None attempted	No	No in
12-1	229	887	5100	USS Carbonero short length launcher	4-Jato	1. To hit a land target on west end of San Nicolas Island 2. To train Carbonero personnel	9°	Good	1000	220	350	4500	Delayed wing blow-off	83 miles 222°T from NAMTC	PTC San Nicolas Island	No	Po
12-2	230	1018	5020	NAMTC short length launcher	Single Jato	1. Test single Jato launching configuration 2. Test NAMTC short length launcher 3. Test McDonnell fuel meter ~~4. Test warhead blowoff~~	9°	Poor extreme nose up left wing down	No climb		290	250	War-head blow-off	5 miles 213°T from NAMTC	None sent	No	No at ed
12-2	231	995	5080	USS Carbonero short length launcher	4-Jato	1. To hit a geographic target 1 sq. mile centered on Begg Rock 2. To train Carbonero personnel	9°	Good	Unknown	Unknown	Unknown	Unknown	Delayed wing blow-off	Unknown	USS Carbonero	No	Ur
12-7	232	1064	5340	NAMTC short length launcher	4-Jato	1. To test ordnance components of warhead 2. To hit a geographic target 1 sq. mile centered on Begg Rock 3. To test NAMTC short length launcher	9°	Failure					Delayed wing blow-off	500 yards from launcher	None sent	AKT-10	N a e
12-15	233	1028		NAMTC short length launcher	4-Jato	1. To test ordnance components of warhead.	9°	Good	800	220	375	4700	Delayed wing blow-off	58 miles 231°T from NAMTC	USS Carbonero	AKT-10 Good	G
12-15	234	950		USS Carbonero short length launcher	4-Jato	1. To test ordnance components of fully fused and loaded warhead	9°	Satisfactory nose up left wing down	800	205	360	5000	Delayed wing blow-off	1.2 miles 0.0°T from Begg Rock	USS Carbonero	No	G
1951 1-4	235	638		USS Cusk short length launcher	4-Jato	1. Test new short length launcher on Cusk 2. To hit geographical target 1 sq. mile centered on Begg Rock	9°	Good	1000	220	340	3500	Delayed wing blow-off	64 miles 215°T from NAMTC	USS Cusk	No	G
1-15	236	793	5330	NAMTC short length launcher	4-Jato	1. Test Summers gyro-servo stabilization and control system 2. Test NAMTC short length launcher 3. Test McDonnell fuel meter	9° 26'	Poor	1500	200	230	1500	Simultaneous wing blow-off	6 miles from NAMTC	NAMTC	AKT-1A Good	F
1-30	237	1048	5145	USS Carbonero short length launcher	4-Jato	1. To hit a geographical target 100 miles 225°T from NAMTC 2. To relay control of missile from Carbonero to Cusk	9°	Poor left wing 30° down at separation	1000	210	345	5500	Delayed wing blow-off	105 miles 219°T from NAMTC	USS Cusk	No	(

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SUMMARY OF LOON FLIGHTS

			LAUNCHING PHASE	MID-COURSE PHASE			TERMINAL PHASE			ELECTRONICS			GENERAL
	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT.	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
r vary- ude	9°	Good	1000	200	300	5000	Delayed wing blow-off	32 miles 213°T from NAMTC	NAMTC	AKT-1A good except for commutated channel	Good	615B-584 at NAMTC APN-33 Beacon Good track	Missile became erratic upon receipt of first attitude change command. After missile stabilized, and assumed normal climb, the engine torched and missile stalled and crashed.
uncher ing	9°	Failure					None	400 feet from launcher	None attempted	No	None installed	None used	This was a dummy missile with no components except an autopilot installed. Failure due to misalignment of Jato and retarder.
west d nnel	9°	Good	1000	220	350	4500	Delayed wing blow-off	83 miles 222°T from NAMTC	PTC San Nicolas Island	No	Poor	SV-1 on Carbonero SV-4 at NAMTC 615B-584 at San Nicolas Island APN-33A Beacon Good track	Missile did not respond to control commands due to low receiver sensitivity.
ing launch- r	9°	Poor extreme nose up left wing down	No climb		290	250	War-head blow-off	5 miles 213°T from NAMTC	None sent	No	None attempted	615B-584 at NAMTC APN-33 Beacon	After 78 seconds of flight the dump signal was actuated prematurely and flight terminated.
et egg nnel	9°	Good	Unknown	Unknown	Unknown	Unknown	Delayed wing blow-off	Unknown	USS Carbonero	No	Unknown	SV-1 Carbonero SV-4 at NAMTC APN-33A Beacon No track	Poor weather prevented use of chase plane. After launching, Carbonero and NAMTC were unable to gain affirmative track. Dump command sent after 4 minutes of flight.
nts et egg th	9°	Failure					Delayed wing blow-off	500 yards from launcher	Noro sent	AKT-10	None attempted	SV-4 at NAMTC APN-33A Beacon	Apparent Jato misalignment caused missile to roll during launching. It crashed just after separation.
nts	9°	Good	800	220	375	4700	Delayed wing blow-off	58 miles 231°T from NAMTC	USS Carbonero	AKT-10 Good	Good	SV-4 at NAMTC SV-1 on Carbonero APN-33A Beacon Good track	Ordnance components operated satisfactorily.
nts d	9°	Satisfactory nose up left wing down	800	205	360	5000	Delayed wing blow-off	1.2 miles 030°T from Begg Rock	USS Carbonero	No	Good	SV-1 on Carbonero SV-4 at NAMTC APN-33A Beacon Good track	Ordnance components operated satisfactorily. High order detonation on impact.
uncher et 1 g	9°	Good	1000	220	340	3500	Delayed wing blow-off	64 miles 215°T from NAMTC	USS Cusk	No	Good	SV-1 on Carbonero SV-4 at NAMTC APN-33A Beacon Good track	First launching from newly installed short length launcher aboard USS Cusk.
system r	9° 26'	Poor	1500	200	230	1500	Simultaneous wing blow-off	6 miles from NAMTC	NAMTC	AKT-1A Good	Poor	615B-584 at NAMTC MPG at NAMTC APN-33 Beacon Poor track	After separation, missile commenced left turn, and would not respond to control commands although they did reach the missile. Dump command sent when missile left sea test range.
rget TC ile	9°	Poor left wing 10° down at separation	1000	210	345	5500	Delayed wing blow-off	105 miles 219°T from NAMTC	USS Cusk	No	Good	SV-1 on Cusk and Carbonero SV-4 at NAMTC APN-33A Beacon Good track	Transmission of erroneous turn commands prevented missile from hitting target.

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SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION									LAUNCHING PHASE		MID-COURSE PHASE					TERMINA PHASE
DATE	NO. FIRED	MISSILE NO.	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN.	CLIMB SPEED KNOTS	MAX. SPEED KNOTS	MAX. ALT FT.	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP	
1-31	238	826	5180	USS Cusk short length launcher	4-Jato	1. To hit a geographical target 100 miles 225°T from NAMTC 2. To relay control of missile from Cusk to Carbonero	9°	Good	1000	220	370	5500	Delayed wing blow-off	90 miles 224°T from NAMTC	USS Carbonero	No
2-1	239	492	5260	NAMTC short length launcher	4-Jato	1. Test McDonnell fuel meter 2. Test warhead blowoff	9°25'	Good	750	210	220	12,500	War-head blow-off	110 miles 220°T from NAMTC	NAMTC	AKT-10 Good
3-8	240	882	5240	NAMTC short length launcher	4-Jato	1. Test Radioplane Recovery System under Project TED MTC AE 525001	9°25'	Good	1000	210	330	4900	Recovery system	3 miles from Western tip of San Nick. Is.	NAMTC	AKT-10 Good
3-13	241	1059	5310	NAMTC short length launcher	Single Jato	1. Test single Jato launching configuration 2. Test warhead blowoff 3. Test new nosemount configuration	9°11'	Satisfactory left wing down, nose up	500	210	285	4500	War-head blow-off	1 mile 2?0°T from Begg Rock	NAMTC	AKT-10 Good
3-21	242	1094		USS Cusk short length launcher	4-Jato	1. Test electronic nose mount 2. Test warhead blow-off 3. Test McDonnell fuel meter	9°	Satisfactory nose up left wing down	700	200	340	6900	War-head blow-off	104 miles 216°T from NAMTC	NAMTC	No
3-29	243	1069	5100	NADC Zero length launcher	Single Jato	1. Test NADC single Jato launcher 2. Test warhead blowoff 3. Hit geographical target 1 sq. mile centered on Begg Rock	9°	Poor 50° nose up right wing down	900	218	330	4800	War-head blow-off	2600 yards 102°T from Begg Rock	NAMTC	No
4-5	244	560	5100	NAMTC short length launcher	Single Jato	1. Test single Jato launching configuration 2. Test McDonnell fuel meter	8°55'	Good	200	183	235	4300	Simultaneous wing blow-off	117 miles 217°T from NAMTC	NAMTC	No
4-19	245	735	4890	NAMTC short length launcher	Single Jato	1. Test McDonnell fuel meter 2. Test warhead stabilization drag chute	9°10'	Good	500	200	235	7200	War-head blow-off	84 miles 220°T from NAMTC	NAMTC	AKT-10 Goo
5-2	246	977	5050	USS Cusk short length launcher	4-Jato	1. Test ordnance components of fully fused and loaded warhead 2. Hit a geographical target	9°	Good	1500	235	320	4200	Simultaneous wing blow-off	-	Stand-by control plane	No
5-2	247	975	5070	USS Cusk short length launcher	Single Jato	1. Test single Jato launching configuration on USS Cusk 2. To relay control of the missile from the Cusk to the Carbonero 3. Hit geographical target 100 miles bearing 225°T from NAMTC	9°	Good	1000	226	350	5100	Delayed wing blow-off	45 miles 219°T from NAMTC	None sent	No
5-14	248	982	5420	NAMTC short length launcher	Single Jato	1. Test [illegible] gyro servo stabilization and control system	8°40'	Good	800	210	315	5800	Simultaneous wing blow-off	68 miles 212°T from NAMTC	None sent	AKT 1A fai at mir

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SUMMARY OF LOON FLIGHTS

	LAUNCHING PHASE		MID-COURSE PHASE				TERMINAL PHASE			ELECTRONICS			GENERAL
TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX. SPEED KNOTS	MAX. ALT FT.	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
aphical target T from NAMTC rol of missile Carbonero	9°	Good	1000	220	370	5500	Delayed wing blow-off	90 miles 224°T from NAMTC	USS Carbonero	No	Good	SV-1 on Cusk and Carbonero SV-4 at NAMTC APN-33A Beacon Good track to 25 miles	Missile oscillated in pitch and yaw, causing beacon to fail. Beacon failure precluded hitting target.
l fuel meter blowoff	9°25'	Good	750	210	220	12,500	War-head blow-off	110 miles 220°T from NAMTC	NAMTC	AKT-10 Good	Good	615B-584 at NAMTC APN-33Beacon Good track	New altitude record. Warhead blowoff satisfactory.
e Recovery Project TED MTC	9°25'	Good	1000	210	330	4900	Recovery system	3 miles from Western tip of San Nick. Is.	NAMTC	AKT-10 Good	Good	SV-4 at NAMTC on chase plane None in missile	Recovery system consisted of 1 parabrake, 3 parachutes, and 2 flotation bags. System worked as planned except that parachutes failed structurally.
ato launching blowoff ount configuration	9°11'	Satisfactory left wing down, nose up	500	210	285	4500	War-head blow-off	1 mile 210°T from Begg Rock	NAMTC	AKT-10 Good	Good	615B-584 at NAMTC APN-33 Beacon Good track	Low speed believed caused by improper fuel meter setting.
ic nose mount blow-off l fuel meter	9°	Satisfactory nose up left wing down	700	200	340	8900	War-head blow-off	104 miles 216°T from NAMTC	NAMTC	No	Good to 76 miles	SV-4 at NAMTC SV-1 on Cusk APN-33A Beacon Good track	All objectives achieved. Low sensitivity of receiver prevented control beyond 76 miles from Cusk.
gle Jato launcher blowoff cal target 1 sq. on Begg Rock	9°	Poor 50° nose up right wing down	900	218	330	4800	War-head blow-off	2600 yards 102°T from Begg Rock	NAMTC	No	Good	615B-584 at NAMTC APN-33 Beacon Good track	Radar plot exhibited excessive fluctuations in azimuth and prevented accurate determination of dump point.
Jato launching ll fuel meter	8°55'	Good	200	183	235	4300	Simultaneous wing blow-off	117 miles 217°T from NAMTC	NAMTC	No	Good	615B-584 at NAMTC APN-33Beacon Good track	McDonnell fuel meter apparently set too lean.
ll fuel meter stabilization	9°10'	Good	500	200	235	7200	War-head blow-off	84 miles 220°T from NAMTC	NAMTC	AKT-10 Good	Good	615B-584 at NAMTC APN-33 Beacon Good track	McDonnell fuel meter set too lean. Stabilization chute failed to prevent tumbling of warhead.
components of and loaded warhead phical target	9°	Good	1500	235	320	4200	Simultaneous wing blow-off	-	Stand-by control plane	No	Negative	SV-1 on USS Cusk SV-4 at NAMTC APN-33A Beacon Good track	Missile failed to respond to control commands. Believed to have been caused by low receiver sensitivity. Warhead did not detonate.
Jato launching n on USS Cusk trol of the missile k to the Carbonero ical target 100 225°T from NAMTC	9°	Good	1000	226	350	5100	Delayed wing blow-off	45 miles 219°T from NAMTC	None sent	No	Good	SV-1 on Cusk and Carbonero SV-4 at NAMTC APN-33A Beacon Good track	Autopilot failure caused missile to crash at range of 45 miles.
gyro servo n and control	8°40'	Good	800	210	315	5800	Simultaneous wing blow-off	68 miles 212°T from NAMTC	None sent	AKT-1A failed at 1.5 minute	Good	615B-584 at NAMTC APN-33 Beacon Good track	After early erratic flight, the missile stabilized and flew satisfactorily. Missile exhibited high maneuverability but would not hold straight course without commands.

TABLE I

SUMMARY OF LOON FLIGHTS

IDENTIFICATION & CONFIGURATION								LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE				
DATE	NO. FIRED	MISSILE U.	WGT	LAUNCHER	SLED CONFIGURATION	TEST OBJECTIVES	ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSITION	ORIGIN OF DUMP SIGNAL	TELEMETER	
5-29	249	1036	5180	USS Carbonero short length launcher	4-Jato	1. Hit geographic target 1 sq. mile centered on Begg Rock 2. To assist in evaluation of special radar and C/M equipment aboard USS Spinax.	9°	Good	1000	210	340	5200	War-head blow-off	1 mile 305°T from Begg Rock	USS Carb-onero	No	Go
5-31	250	1068	5050	NAMTC short length launcher	Single Jato	1. Test McDonnell fuel meter 2. Test warhead blowoff	8°50'	Good					War-head blow-off	1 mile from NAMTC	None sent	AKT-10 Good	No a ec
6-21	251	746	5150	NAMTC short length launcher	Single Jato	1. Test McDonnell fuel meter 2. Test warhead blowoff	9°	Good	500	210	225	8200	War-head Blow-off	114 miles 216°T from NAMTC	NAMTC	AKT-1A Good	Go
6-28	252	622	5130	USS CUSK short length launcher	Single Jato	1. Test Trounce I guidance system 2. Test single Jato launching configuration	9°	Good	1000	210	210	3000	War-head Blow-off	18 miles 214°T from Cusk	None sent	No	Go On Co se
7-18	253	1173	5130	USS CARBONERO short length launcher	4 Jato	1. Relay control from Carbonero to Cusk 2. Test warhead blowoff 3. Hit a geographical target 100 miles bearing 221°T from NAMTC	9°	Satisfactory 30° nose up	800	240	360	5900	War-head Blow-off	158 miles 206°T from NAMTC	All sta-tions None re-ceived	No	Ne
7-20	254	1071	5050	NAMTC short length launcher	Single Jato	1. Test Trounce I guidance system	9°	Satisfactory 20° left wing down	800	230	345	4300	Simul. wing blow-off	130 miles 220°T from NAMTC	Stand-by Con-trol	AKT-10 Good	Go
8-16	255	772	5090	USS CUSK short length launcher	Single Jato	1. Test Trounce I guidance system 2. Train Cusk personnel	9°	Good	700	217	217	2600	De-layed Wing blow-off	12 miles from Cusk	None sent	No	No se
8-22	256	596	5480	NAMTC short length launcher	Single Jato	1. Test J-30 Turbojet engine installation	9°	Failure					Simul. wing blow-off	500 yards from laun-cher	None sent	AKT-10 Good	No se
8-30	257	228	5160	USS CARBONERO short length launcher	4 Jato	1. Test ordnance components of fully fused and loaded warhead 2. Hit a geograph. target 1 sq. mile centered on Begg Rock 3. Train Carbonero personnel	9°	Good	1200	210	320	5700	Simul. wing blow-off	2 miles 220°T from Begg Rock	USS Car-bonero	No	Go
8-31	258	503	5075	NAMTC short length launcher	Single Jato	1. Test Trounce I guidance system	9°	Poor 45° nose up	1000	225	355	5300	Simul. wing blow-off	93 miles 220°T from NAMTC	NAMTC	AKT-10 Good	Go

TABLE I

SUMMARY OF LOON FLIGHTS

	LAUNCHING PHASE	MID-COURSE PHASE				TERMINAL PHASE			ELECTRONICS			GENERAL
ANGLE OF MISSILE ON LAUNCHER	ATTITUDE	MAX R/C FT/MIN	CLIMB SPEED KNOTS	MAX SPEED KNOTS	MAX ALT FT	METHOD OF DUMP	IMPACT POSIT.	ORIGIN OF DUMP SG.	TELEMETERING	CONTROL RESPONSE	RADAR BEACON	REMARKS
9°	Good	1000	210	340	5200	War-head blow-off	1 mile 305°T from Begg Rock	USS Carbonero	N>	Good	SV-1 at NAMTC SV-1 on Cusk and Spinax APN-33A Beacon Good track	All objectives achieved.
8°50'	Good					War-head blow-off	1 mile from NAMTC	None sent	AKT-10 Good	None attempted	615B-584 at NAMTC APN-33 Beacon Good track	Crash caused by personnel error. Cotter pins left out of control rod hinge pins. Hinge pin on elevator shaken out by vibration.
9°	Good	500	210	225	8200	War-head Blow-off	114 miles 216°T from NAMTC	NAMTC	AKT-1A Good	Good	615B-584 at NAMTC APN-33 beacon Good track	Poor performance caused by McDonnell fuel meter which apparently changed basic setting.
9°	Good	1000	230	210	3000	War-head Blow-off	18 miles 214°T from Cusk	None sent	No	Good Only 1 Command sent	SV-1 on Cusk SV-4 at NAMTC APN-33A beacon Good track	Autopilot failure precluded accomplishment of objective No. 1.
9°	Satisfactory 30° nose up	800	240	360	5900	War-head Blow-off	158 miles 206°T from NAMTC	All stations None received	No	Negavivo	SV-1 on Cusk and Carbonero SV-4 at NAMTC APN-33A beacon Good track	Missile failed to respond to any control commands from any station.
9°	Satisfactory 20° left wing down	800	230	34	4300	Simul wing blow-off	130 miles 220°T from NAMTC	Stand-by Control	AKT-10 Good	Good	SV-4 at NAMTC SV-1 on Cusk APN-33A beacon Good track	First successful missile flight utilizing Trounce I control system. Twenty seven commands successfully transmitted.
9°	Good	700	217	217	2600	Delayed Wing blow-off	12 miles from Cusk	None sent	No	None sent	SV-4 at NAMTC SV-1 on Cusk APN-33A beacon Good track	Propulsion system failure prevented attainment of objective No. 1
9°	Failure					Simul wing blow-off	500 yards from launcher	None sent	AKT-10 Good	None sent	SV-4 at NAMTC APN-33A beacon	Missile assumed 75° attitude at separation. It recovered but low speed caused it to crash.
9°	Good	1200	210	320	5700	Simul. wing blow-off	2 miles 220°T from Begg Rock	USS Carbonero	No	Good	SV-1 on Carbonero SV-4 at NAMTC APN-33A beacon Good track	Carbonero unable to track beacon due to excessive frequency spread. Commands sent at suggestion of NAMTC. Warhead detonated at impact.
9°	Poor 45° nose up	1000	225	355	5300	Simul. wing blow-off	93 miles 220°T from NAMTC	NAMTC	AKT-10 Good	Good	SV-4 at NAMTC APN-33A beacon Good track	Excellent flight in all respects

B

TABLE II

SUMMARY OF COMPONENT PERFORMANCE

1950 DATE	FIRING NUMBER	MISSILE NUMBER	ROCKET LAUNCH	XM1 LAUNCH	BEACON[1]	TELE-[2] METER	REC[3]	AUTO-[4] PILOT	DUMP	PRO-PULSION	MISC. EQUIP. FAILURE	REMARKS
12 JAN	202	903	OK	–	OK	OK	OK	OK	OK	OK		USS CUSK
16 JAN	203	227	–	OK	OK	OK	OK	OK	OK	OK		
16 JAN	204	1139	OK	–	OK	OK	–	OK	–	OK	MISSILE FAILED TO TURN LATE IN FLIGHT	USS NORTON SOUND
7 FEB	205	1165	–	OK	OK	OK	OK	OK	–	OK		NO DUMP ATTEMPTED
8 FEB	206	794	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
8 FEB	207	247	X	–	–	–	–	–	–	–		USS CUSK
28 FEB	208	231	OK	–	–	OK	–	OK	–	OK	DELAY TIMER FAILURE	
22 MAR	209	1200	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
28 MAR	210	221	–	–	–	–	–	–	X	–	WING BLOWOFF ACTUATED PREMATURELY	
12 APR	211	1004	OK	–	OK	–	OK	OK	–	OK		USS CUSK
12 APR	212	644	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
1 MAY	213	1147	–	OK	OK	–	OK	OK	OK	OK		
3 MAY	214	890	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
3 MAY	215	639	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
17 MAY	216	992	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
8 JUN	217	238	OK	–	OK	OK	OK	OK	OK	OK		
12 JUN	218	1080	OK	–	–	–	–	–	–	–	SEPARATION DEVICE	
22 JUN	219	1078	OK	–	X	–	OK	OK	–	OK		USS CARBONERO
22 JUN	220	630	–	OK	OK	–	OK	OK	OK	OK		
28 JUL	221	242	OK	–	OK	OK	OK	–	OK	OK		SPECIAL AUTOPILOT CONFIGURATION
9 AUG	222	1064	–	OK	OK	–	OK	X	OK	OK		
15 SEP	223	250	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
18 SEP	224	636	–	OK	–	–	–	–	–	–	ENGINE CUT-OFF PIN	
12 OCT	226	945	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
18 OCT	227	1031	OK	–	X	OK	OK	OK	OK	X		
1 NOV	228	963	OK	–	–	–	–	OK	–	–		DUMMY MISSILE
1 DEC	229	887	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
2 DEC	230	1018	OK	–	–	–	–	–	OK	–		
2 DEC	231	995	OK	–	X	–	–	–	–	–		USS CARBONERO
7 DEC	232	1066	X	–	–	–	–	–	–	–		
15 DEC	233	1028	OK	–	OK	OK	OK	OK	OK	OK		
15 DEC	234	950	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO

X FAILURE

– NO TRIAL

OK SUCCESSFUL

NOTES:

1. INCLUDES BEACON, DYNAMOTOR, AND ANTENNAS.
2. INCLUDES TELEMETRIC TRANSMITTER, BATTERY PACK, END INSTRUMENTS, AND ANTENNA.
3. INCLUDES RECEIVER, CONTROL RELAY BOX, COMPUTER AND ANTENNA.
4. INCLUDES AUTOPILOT, SERVOMOTORS, CONTROL SURFACES AND LINKAGES, AND AIR SYSTEM.

SECRET

TABLE II

SUMMARY OF COMPONENT PERFORMANCES

1949 DATE	FIRING NUMBER	MISSILE NUMBER	ROCKET LAUNCH	XM1 LAUNCH	BEACON[1]	TELE-METER[2]	REC[3]	AUTO-PILOT[4]	DUMP	PRO-PULSION	MISC. EQUIP. FAILURE	REMARKS
31 MAR	172	1002	–	OK	OK	X	OK	–	–	OK		SUMMERS AUTOPILOT
20 APR	173	1051	–	OK	OK	OK	OK	X	–	OK		
21 APR	174	614	OK	–	OK	–	OK	OK	OK	X		TWO-JATO LAUNCHING
28 APR	175	599	OK	–	X	–	OK	OK	OK	OK		TWO-JATO LAUNCHING
10 MAY	176	1074	–	OK	OK	OK	OK	OK	OK	OK		
19 MAY	177	1046	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
2 JUN	178	738	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
14 JUN	179	590	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
20 JUN	180	243	–	X	–	–	–	–	–	–		
29 JUN	181	597	OK	–	–	–	–	OK	–	OK	PROBABLE BATTERY FAILURE	USS CARBONERO
15 JUL	183	1061	–	OK	OK	OK	OK	–	–	OK		SUMMERS AUTOPILOT
21 JUL	184	742	–	OK	OK	OK	OK	OK	OK	X		
5 AUG	185	244	OK	–	–	–	–	–	–	–		USS NORTON SOUND – NO DATA AVAILABLE
9 AUG	186	534	–	OK	OK	OK	OK	X	–	OK		
26 AUG	187	1067	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
26 AUG	188	821	OK	–	OK	–	OK	OK	X	OK		USS CARBONERO
26 SEP	189	836	–	OK	–	OK	–	–	–	X		
28 SEP	190	778	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
29 SEP	191	776	OK	–	OK	–	OK	X	–	OK	STRUCTURAL FAILURE OF RIGHT WING SPAR	USS CUSK
3 OCT	192	256	–	OK	OK	OK	OK	OK	OK	OK		
12 OCT	193	249	OK	–	OK	–	OK	OK	X	OK		USS NORTON SOUND
31 OCT	194	592	OK	–	OK	OK	OK	OK	–	–		USS CUSK
4 NOV	195	246	–	OK	X	OK	OK	OK	OK	OK		
7 NOV	196	640	X	–	–	–	–	–	–	–		USS CUSK
7 NOV	197	535	OK	–	OK	OK	OK	OK	OK	OK		USS CARBONERO
8 NOV	198	814	–	OK	–	–	–	OK	–	OK	DELAY TIMER FAILURE	
5 DEC	199	935	–	OK	–	–	–	–	–	–	STRUCTURAL FAILURE	
9 DEC	200	230	OK	–	OK	–	OK	OK	OK	OK		
21 DEC	201	1075	OK	–	OK	–	OK	OK	OK	OK	FAILURE OF ONE JATO	

X FAILURE

– NO TRIAL

OK SUCCESSFUL

NOTES:

1. INCLUDES BEACON, DYNAMOTOR, AND ANTENNAS.
2. INCLUDES TELEMETRIC TRANSMITTER, BATTERY PACK, END INSTRUMENTS, AND ANTENNA.
3. INCLUDES RECEIVER, CONTROL RELAY BOX, COMPUTER AND ANTENNA.
4. INCLUDES AUTOPILOT, SERVOMOTORS, CONTROL SURFACES AND LINKAGES, AND AIR SYSTEM.

SECRET

TABLE II

SUMMARY OF COMPONENT PERFORMANCE

1951 DATE	FIRING NUMBER	MISSILE NUMBER	ROCKET LAUNCH	XM1 LAUNCH	BEACON[1]	TELE-METER[2]	REC[3]	AUTO-PILOT[4]	DUMP	PRO-PULSION	MISC. EQUIP. FAILURE	REMARKS
4 JAN	235	638	OK	–	OK	–	OK	OK	OK	OK		USS CUSK
15 JAN	236	793	OK	–	X	OK	OK	–	OK	OK		SUMMERS AUTOPILOT
30 JAN	237	1048	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
31 JAN	238	826	OK	–	OK	–	OK	X	OK	OK		USS CUSK
1 FEB	239	492	OK	–	OK	OK	OK	OK	OK	OK		
8 MAR	240	882	OK	–	–	OK	OK	OK	OK	OK		RADIOPLANE RECOVERY SYSTEM
13 MAR	241	1059	OK	–	OK	OK	OK	OK	OK	OK		
21 MAR	242	1094	OK	–	OK	–	X	OK	OK	OK		USS CUSK
29 MAR	243	1069	OK	–	OK	–	OK	OK	OK	OK		
5 APR	244	560	OK	–	OK	–	OK	OK	OK	OK		
19 APR	245	735	OK	–	OK	OK	OK	OK	OK	OK		
2 MAY	246	977	OK	–	OK	–	X	OK	OK	OK		USS CUSK
2 MAY	247	975	OK	–	OK	–	OK	X	–	OK		USS CUSK
14 MAY	248	982	OK	–	OK	X	OK	–	–	OK		SUMMERS AUTOPILOT
29 MAY	249	1036	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
31 MAY	250	1068	OK	–	–	–	–	–	–	–		
21 JUN	251	746	OK	–	OK	OK	OK	OK	OK	–		MCDONNELL FUEL METER
28 JUN	252	622	OK	–	OK	–	–	X	–	–		USS CUSK TROUNCE I
18 JUL	253	1173	OK	–	OK	–	X	OK	–	OK		USS CARBONERO
20 JUL	254	1071	OK	–	OK	OK	–	OK	OK	OK		TROUNCE I
16 AUG	255	772	OK	–	OK	–	–	OK	–	X		USS CUSK TROUNCE I
22 AUG	256	[illegible]	X	–	–	OK	–	–	–	–		J-30 TURBOJET
30 AUG	257	[illegible]	OK	–	OK	–	OK	OK	OK	OK		USS CARBONERO
31 AUG	258	503	OK	–	OK	OK	–	OK	OK	OK		TROUNCE I

X FAILURE

– NO TRIAL

OK SUCCESSFUL

NOTES:

1. INCLUDES BEACON, DYNAMOTOR, AND ANTENNAS.
2. INCLUDES TELEMETRIC TRANSMITTER, BATTERY PACK, END INSTRUMENTS, AND ANTENNA.
3. INCLUDES RECEIVER, CONTROL RELAY BOX, COMPUTER, AND ANTENNA.
4. INCLUDES AUTOPILOT, SERVOMOTORS CONTROL SURFACES AND LINKAGES, AND AIR SYSTEM.

SECRET

TABLE III

SUMMARY OF RELIABILITY

	ATTEMPTS	SUCCESSFUL	PER CENT RELIABILITY	PER CENT RELIABILITY REPORTED IN REFERENCE 11
JATO LAUNCHINGS	68	63	92.6	94
XM1-1 LAUNCHINGS	18	17	94.5	96
BEACON [1]	68	62	91.2	NOT REPORTED
TELEMETER [2]	30	28	93.3	97
RECEIVER [3]	63	60	95.3	NOT REPORTED
AUTOPILOT [4]	67	60	89.5	91.0
DUMP SYSTEM	55	51	92.7	90.5
PROPULSION SYSTEM	69	64	92.7	92.0

NOTES:

1. INCLUDES BEACON, DYNAMOTOR, AND ANTENNAS.
2. INCLUDES TELEMETRIC TRANSMITTER, BATTERY PACK, END INSTRUMENTS, AND ANTENNA.
3. INCLUDES RECEIVER, CONTROL RELAY BOX, COMPUTER AND ANTENNA.
4. INCLUDES AUTOPILOT, SERVOMOTORS, CONTROL SURFACES AND LINKAGES, AND AIR SYSTEM.

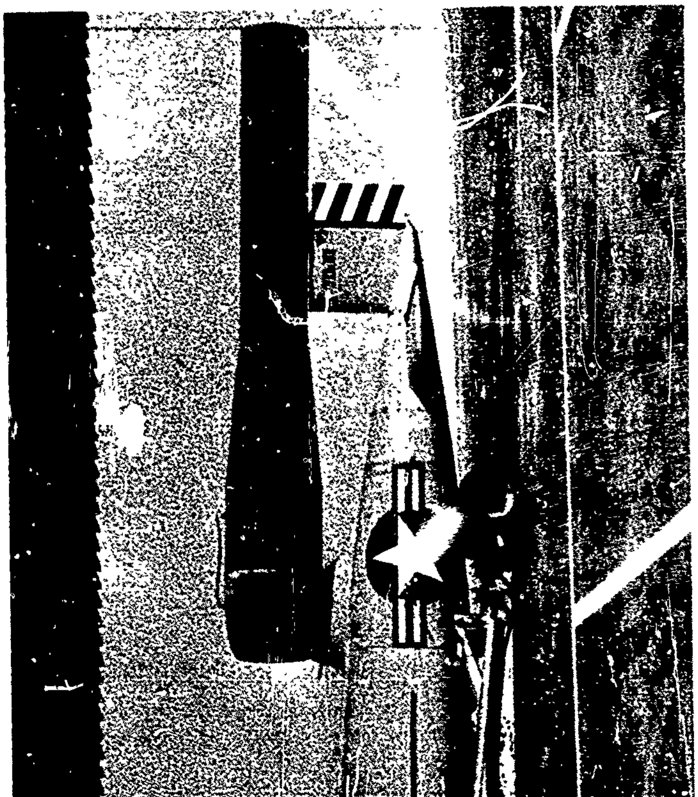


Fig. 1. LTV-N-2 (LOON) Missile.

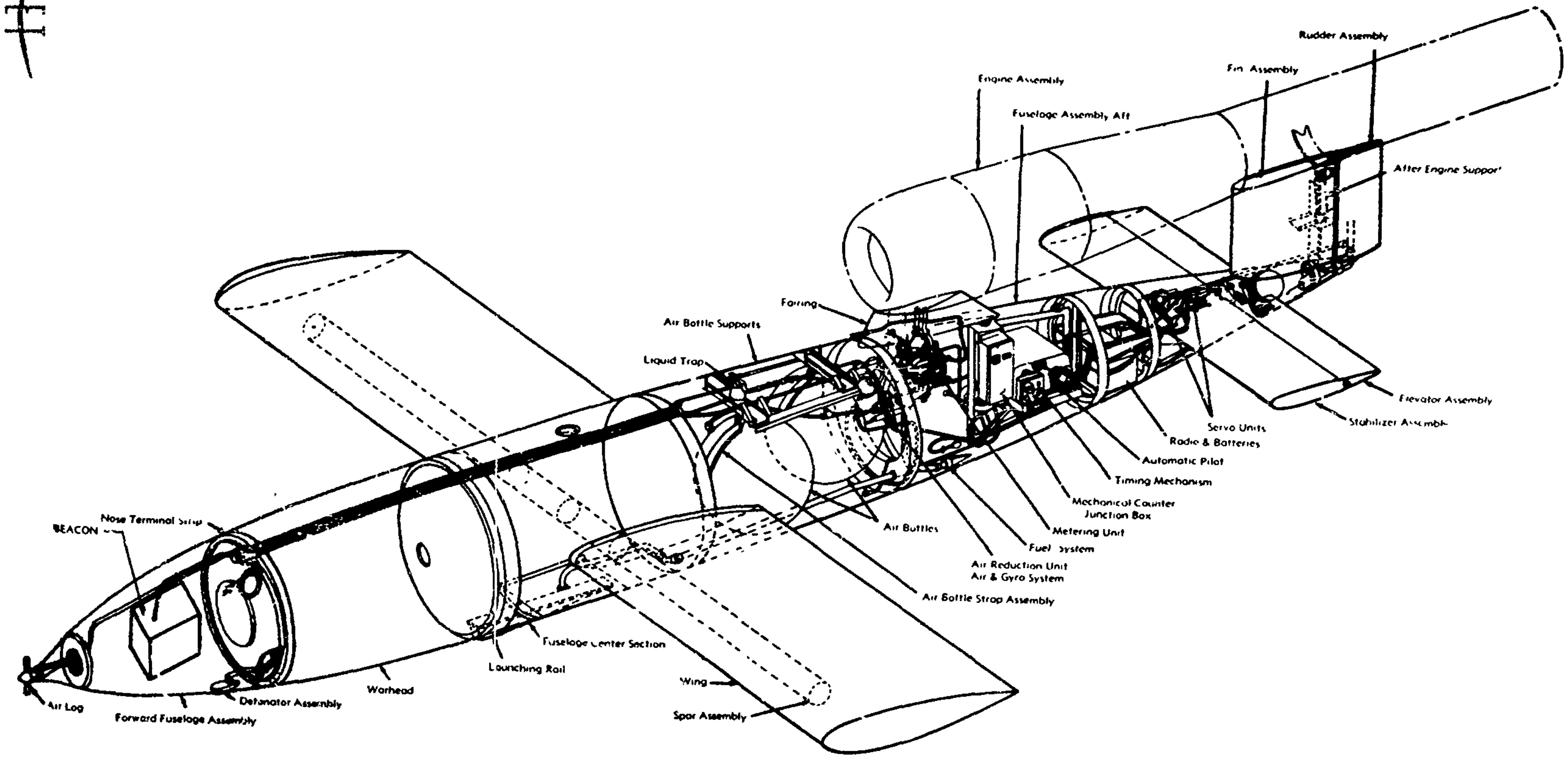


Fig. 2. Cutaway View of LTV-N-2 (LOON).

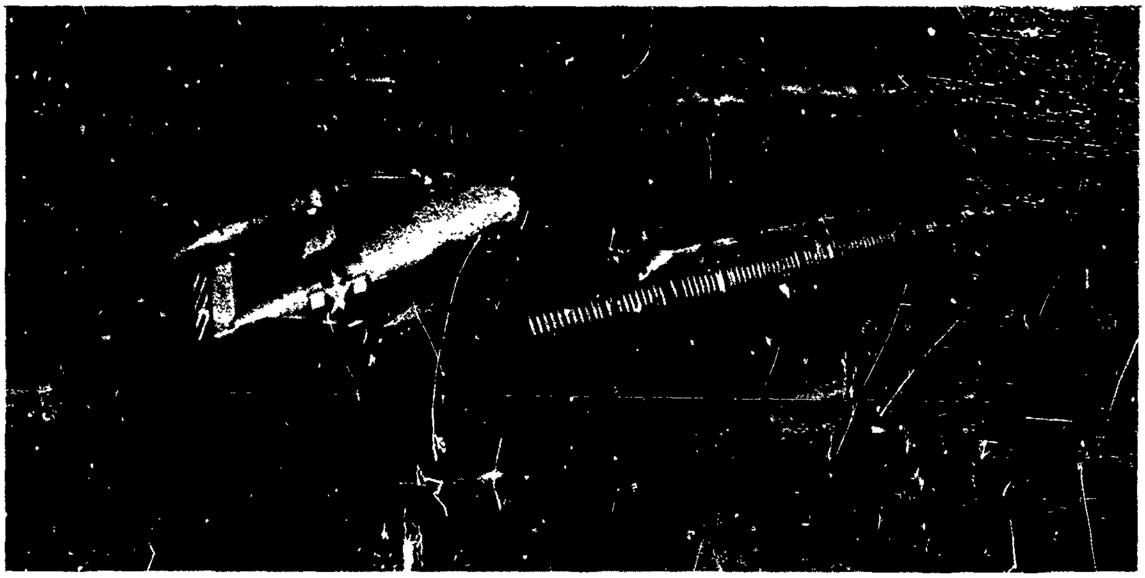


Fig. 3. XM1 Catapult With LOON in Launching Position.

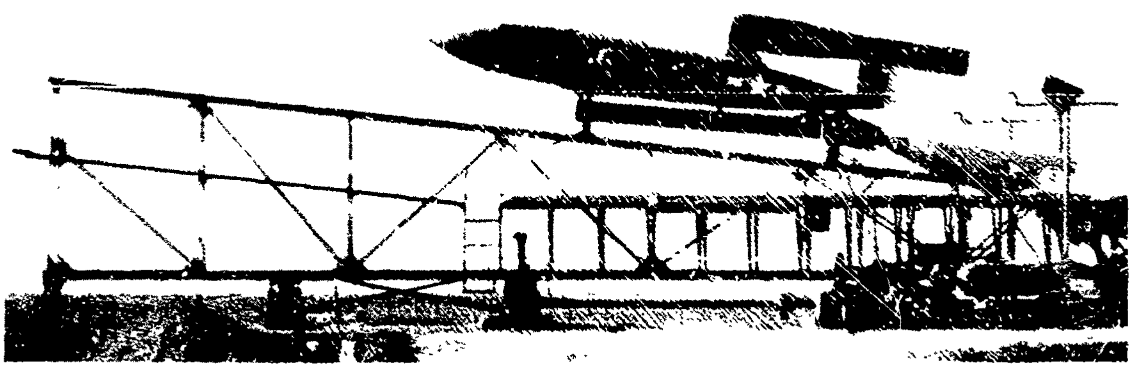


Fig. 4. Rolling Ramp Showing LOON and Four-JATO Launching Sled Immediately After Ignition.

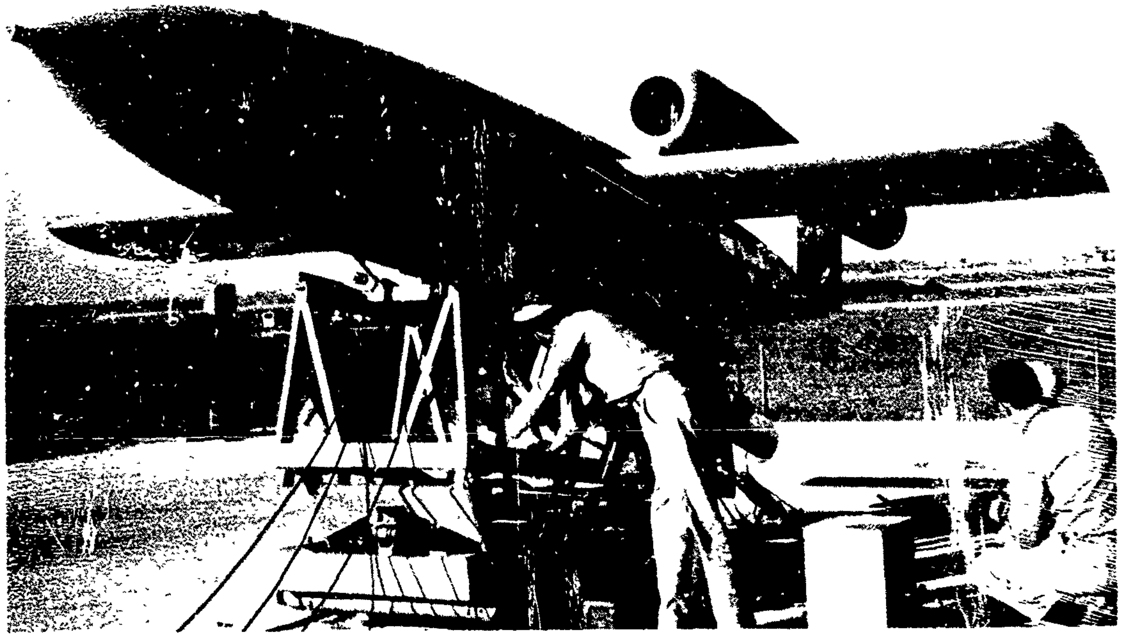


Fig. 5. LOON in Launching Position on NADC Zero-Length Launcher.

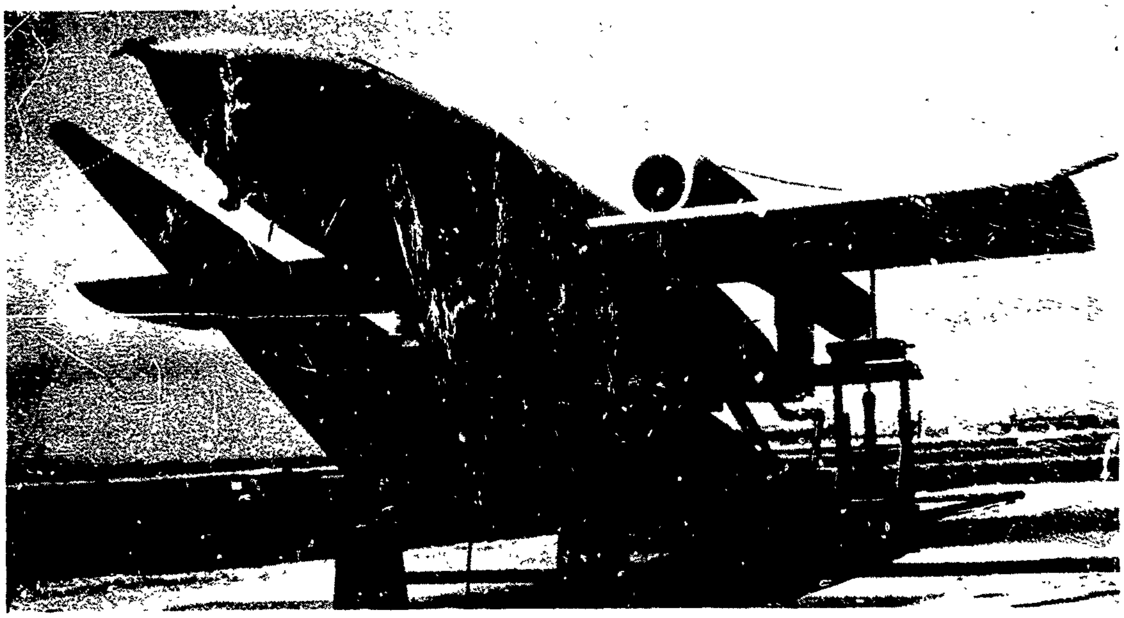


Fig. 6. LOON in Launching Position on NAMTC Short-Length Launcher.

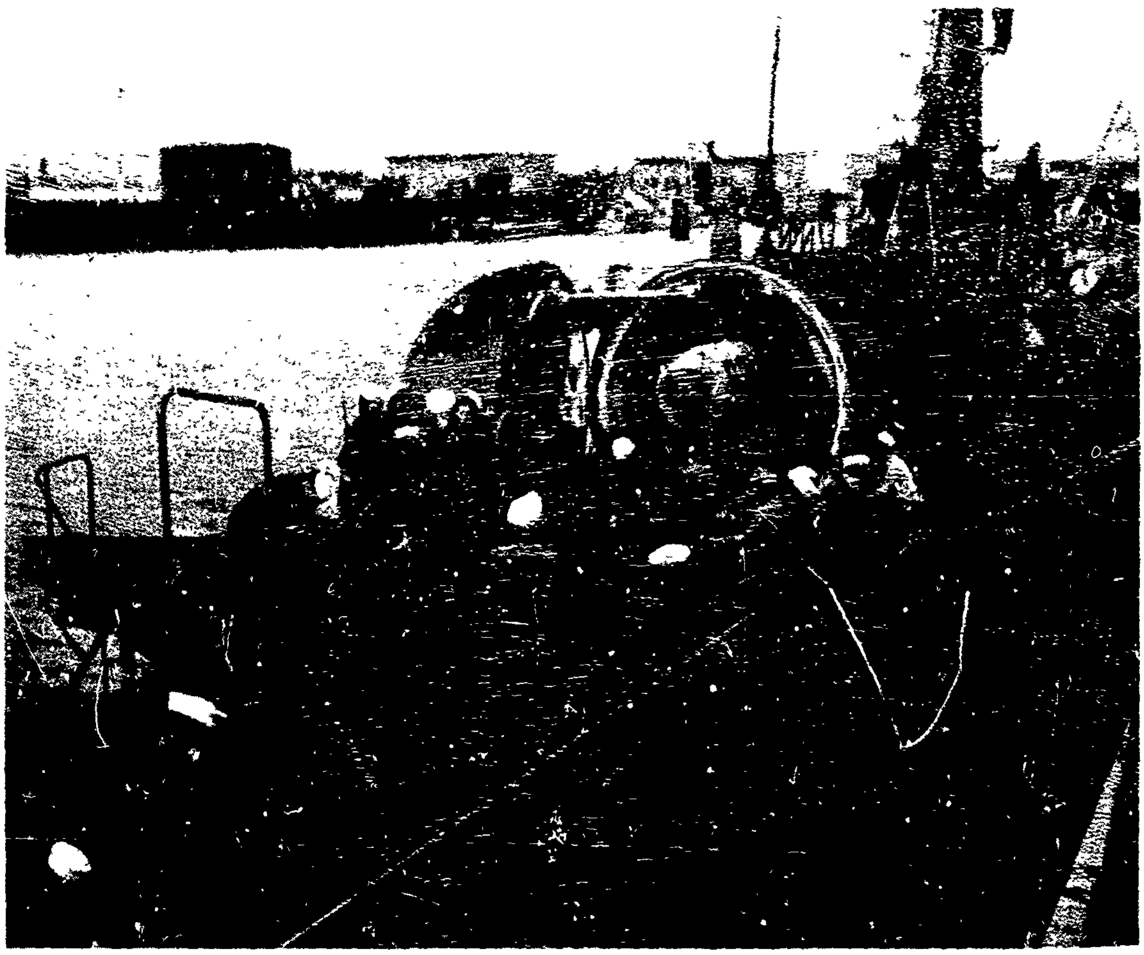


Fig. 7. Launching Installation on Deck of USS CUSK.

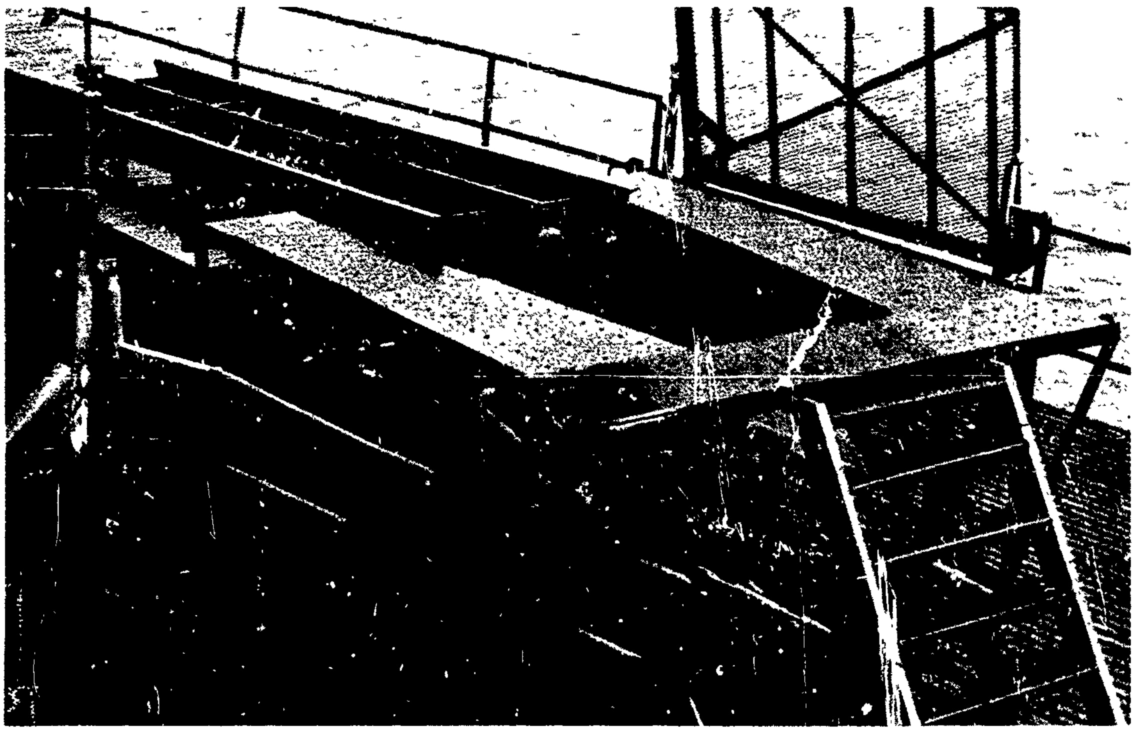


Fig. 8. USS CARBONERO Short-Length Launcher.

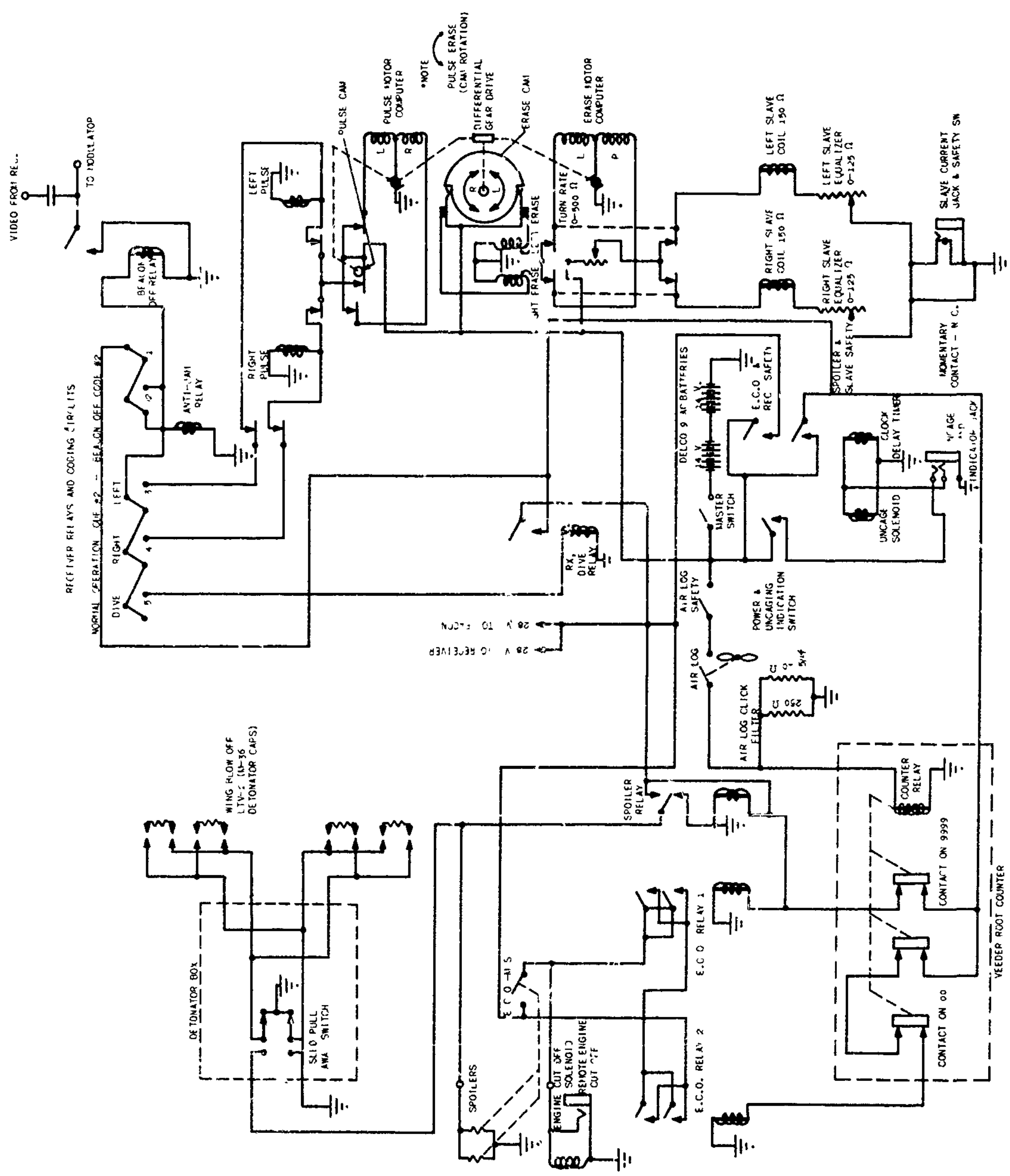
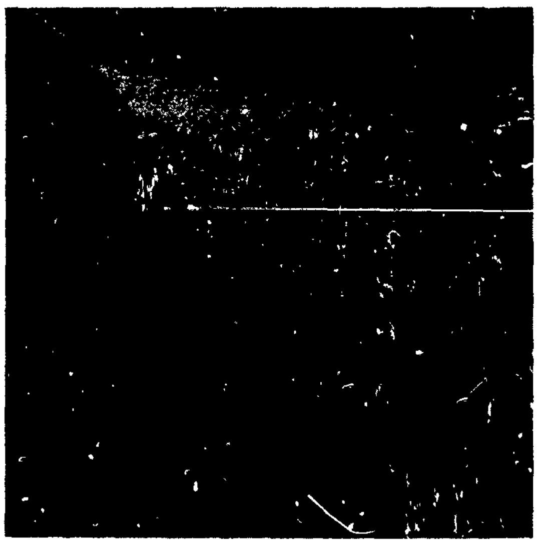


Fig. 9. Schematic Diagram of LOON Control System.

Omni-directional

Dual Polycone

Wing-tip Polycone



Quarter Wave Stub

Fig. 10. Beacon Antenna Configurations.

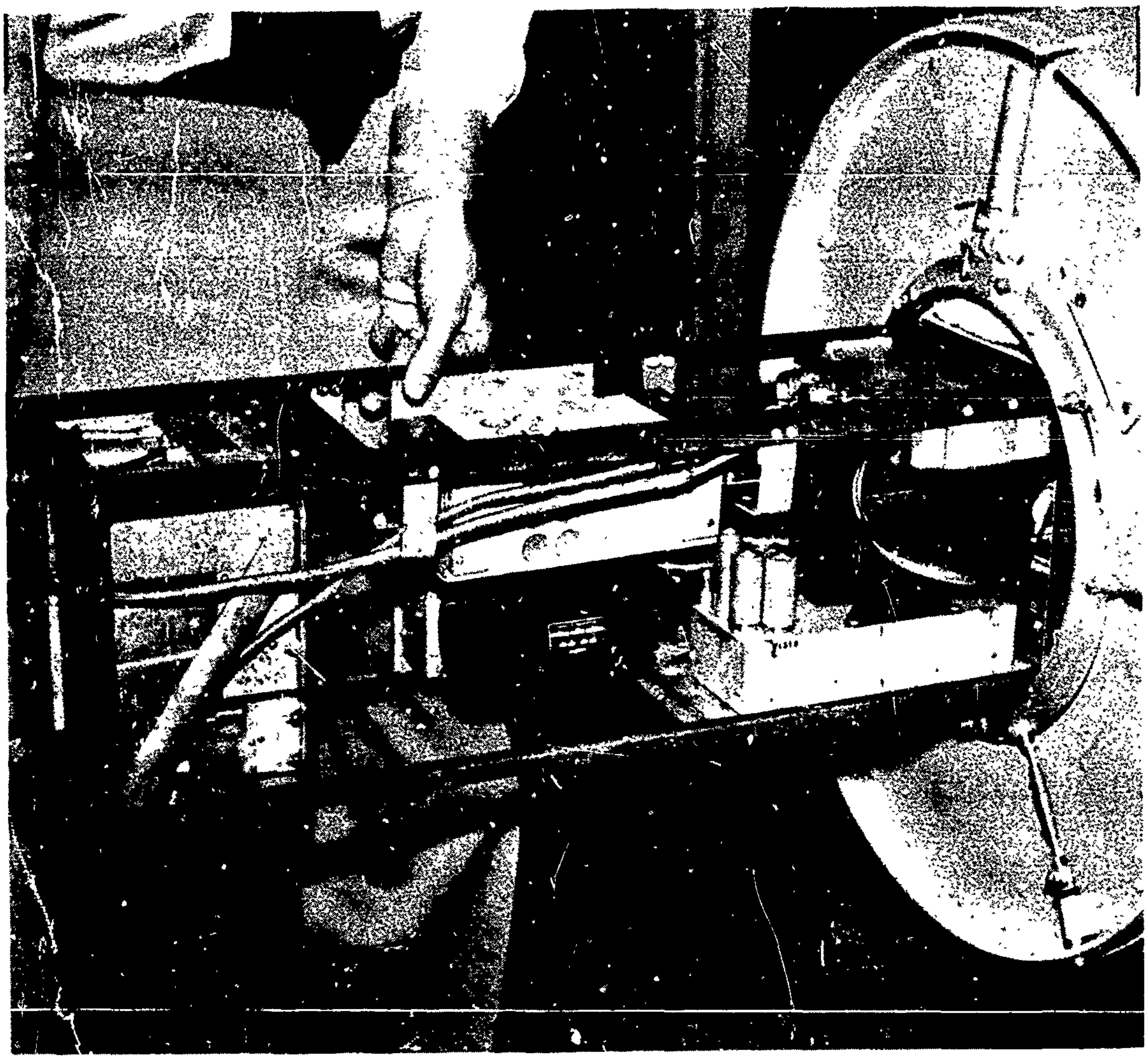


Fig. 11. AN/AKT-10 Telemeter Installation.

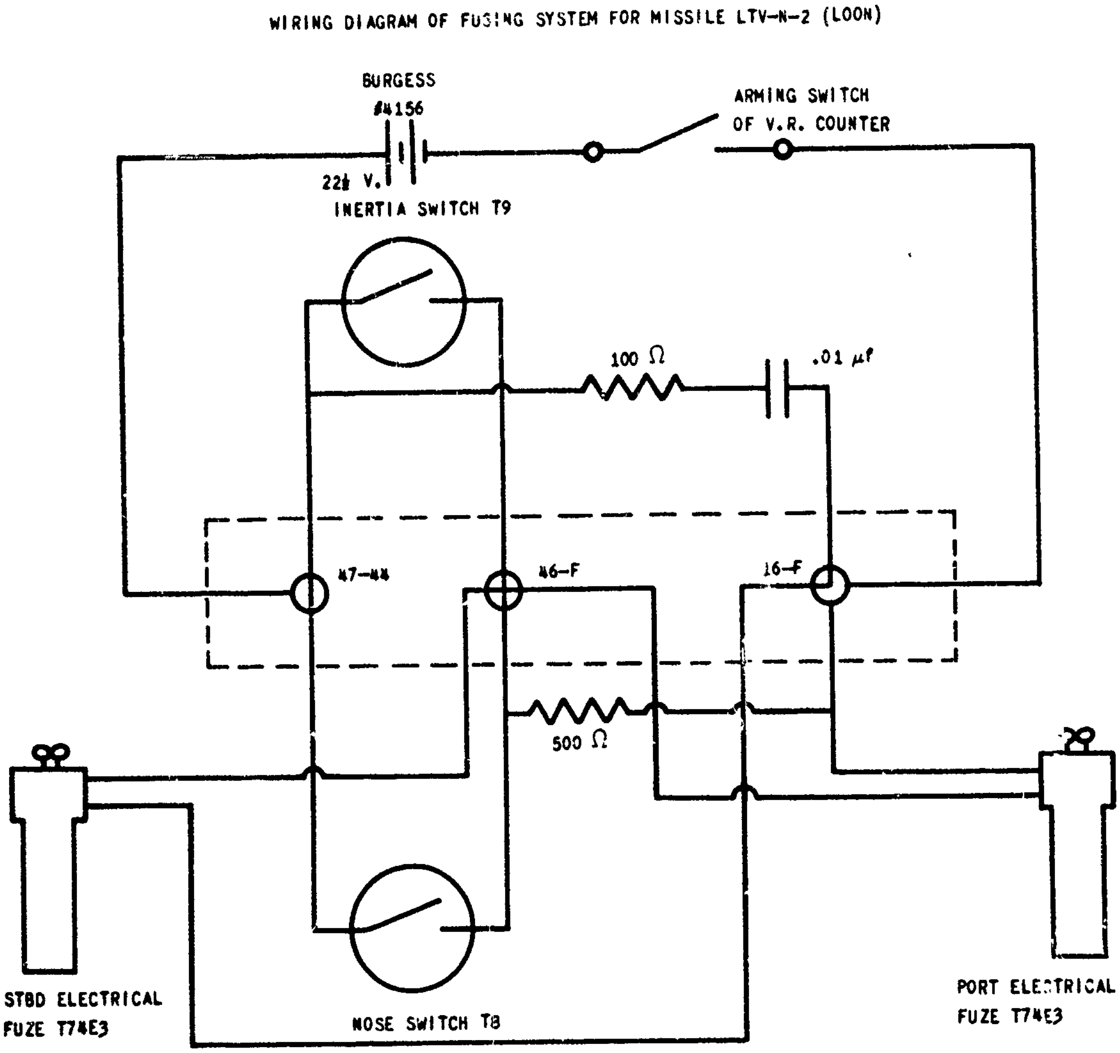


Fig. 12. Schematic Diagram of LOON Warhead-Detonating System.

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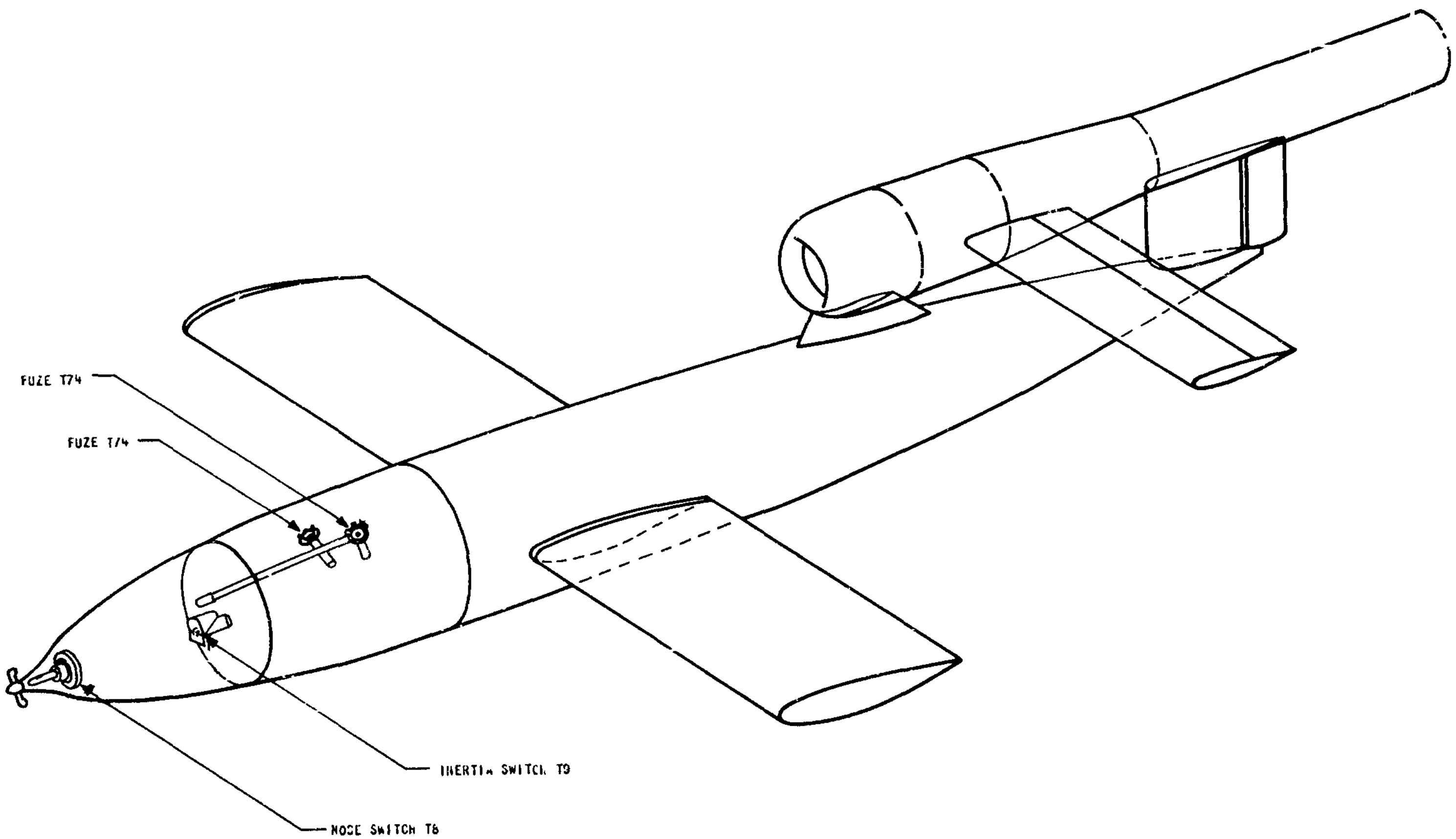

Fig. 13. Location of Warhead Ordnance Components.

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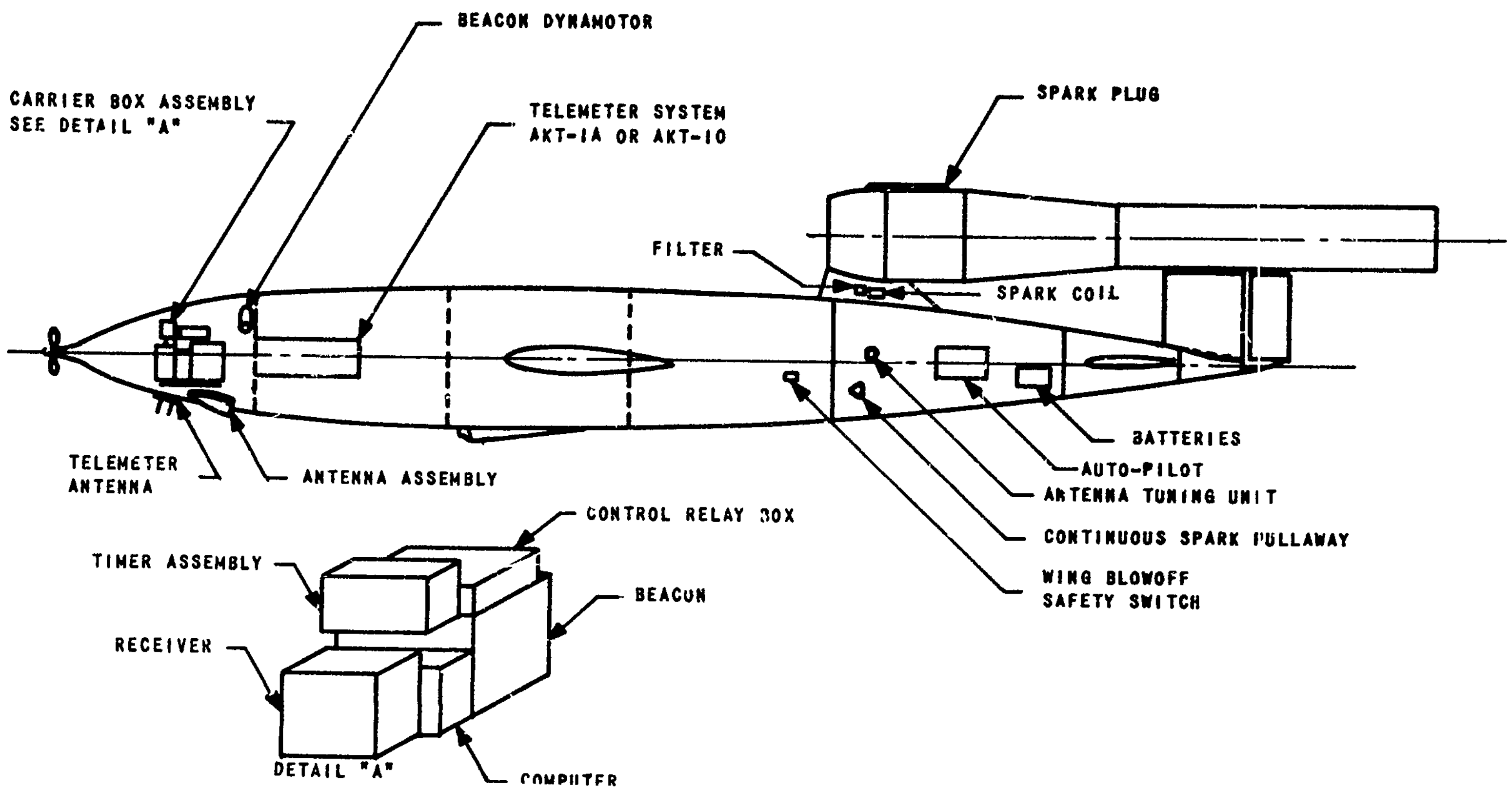

Fig. 14. Schematic Diagram of Quick-Detachable Nose Mount Configuration.

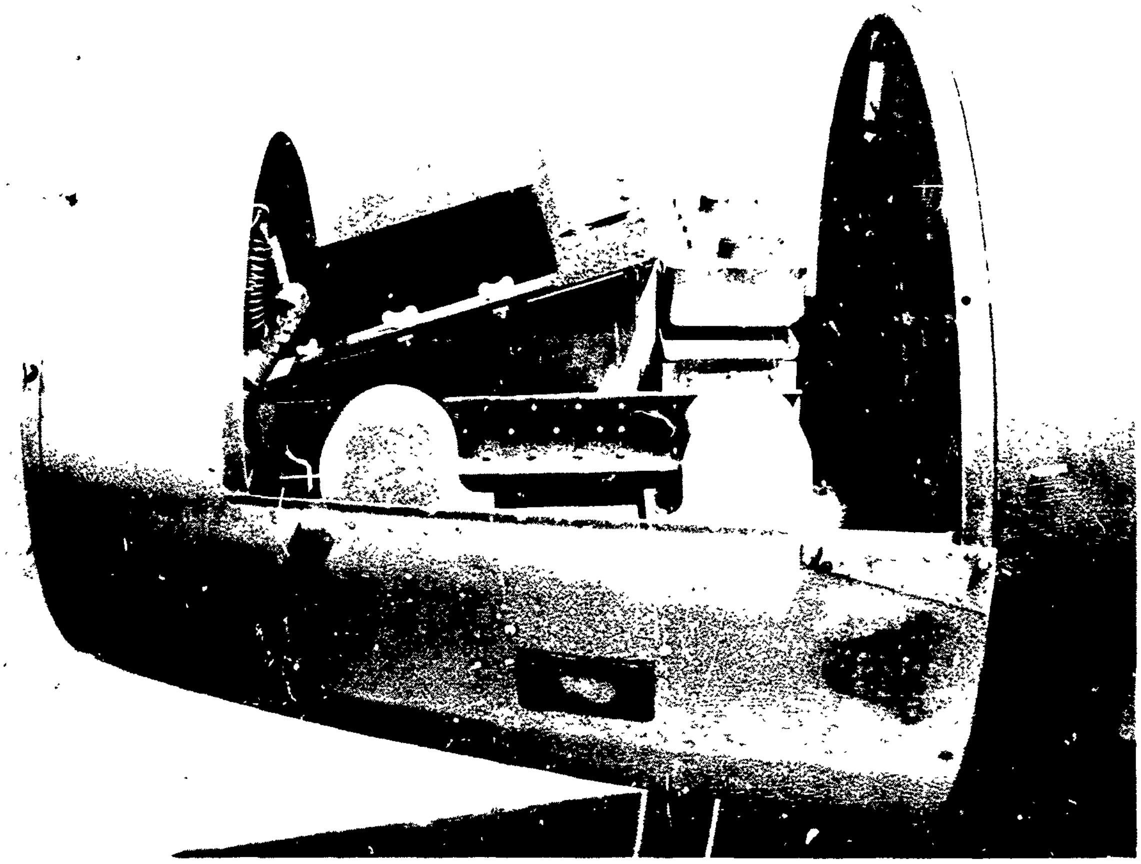

Fig. 15. Original Electronics Nose Mount.

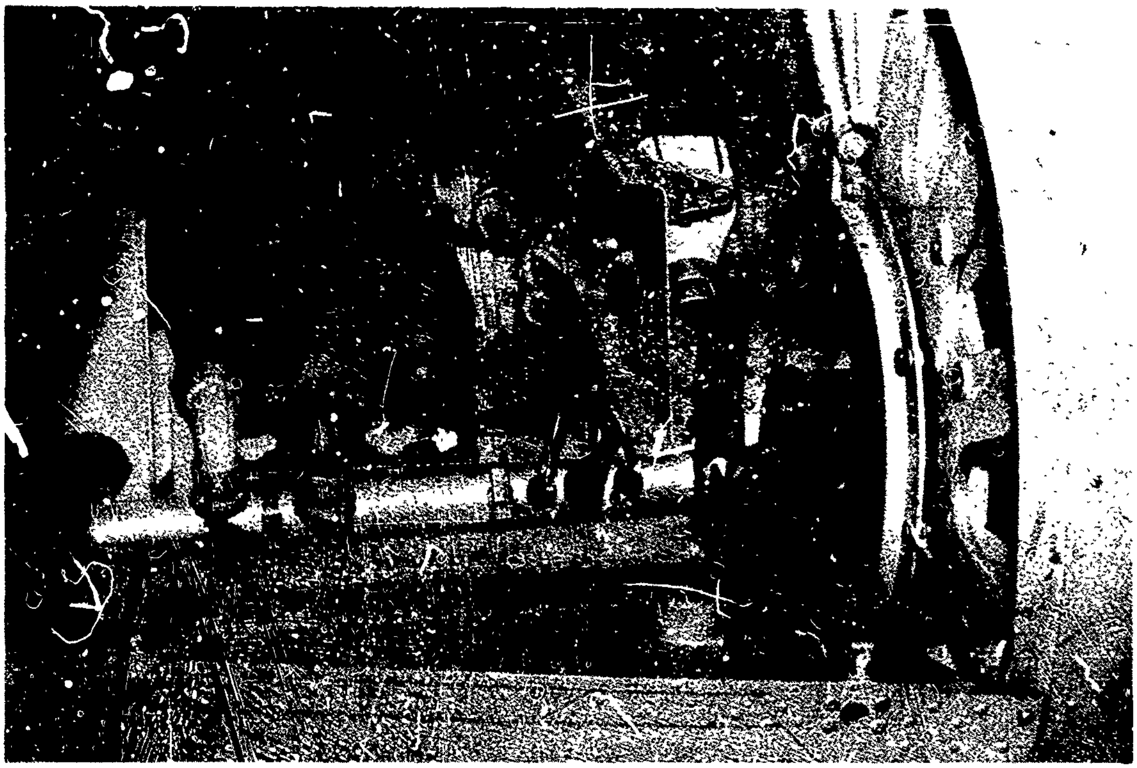

Fig. 16. Modified Electronics Nose Mount.

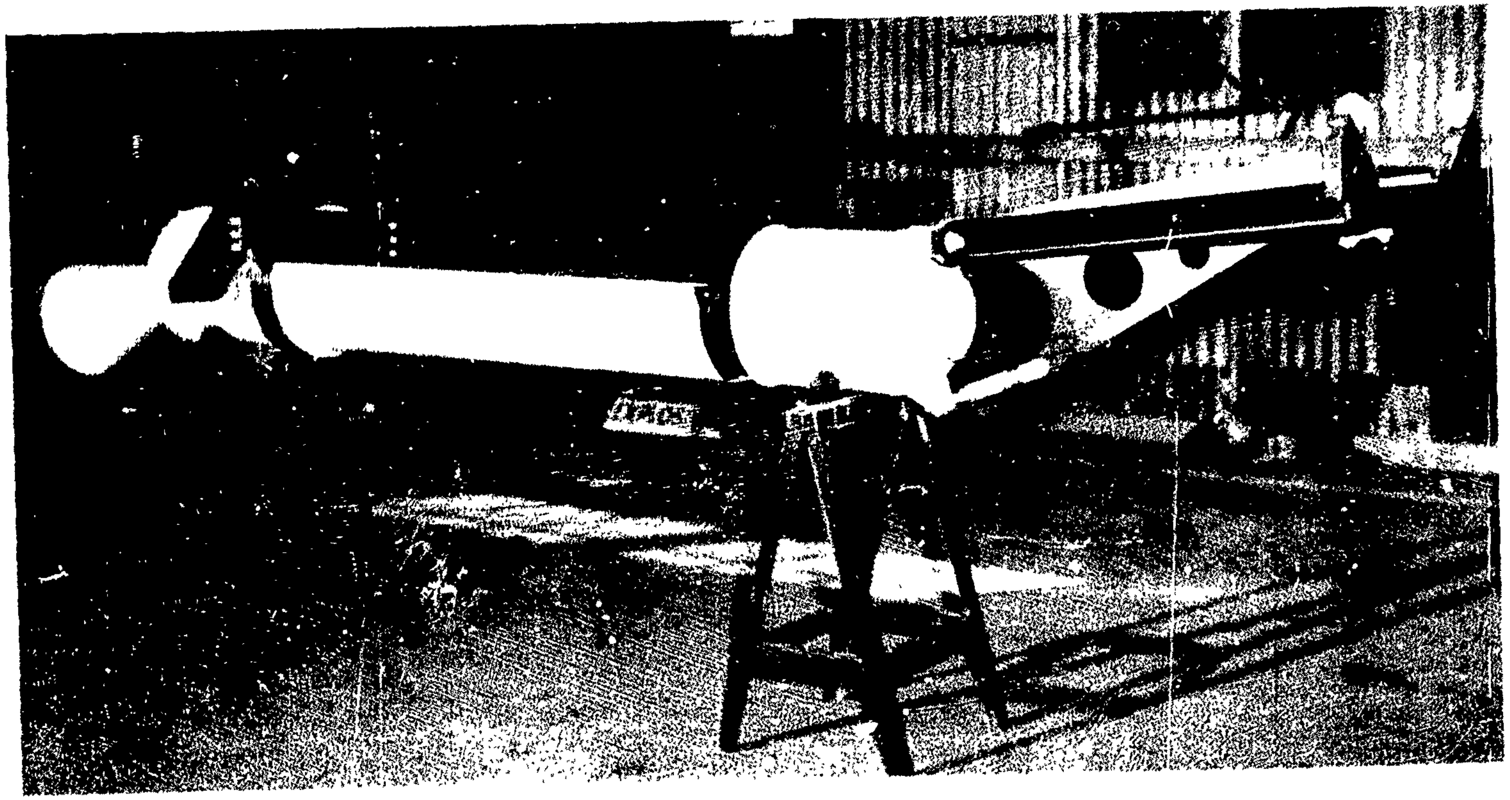

Fig. 17. Single-JATO Launching Sled.

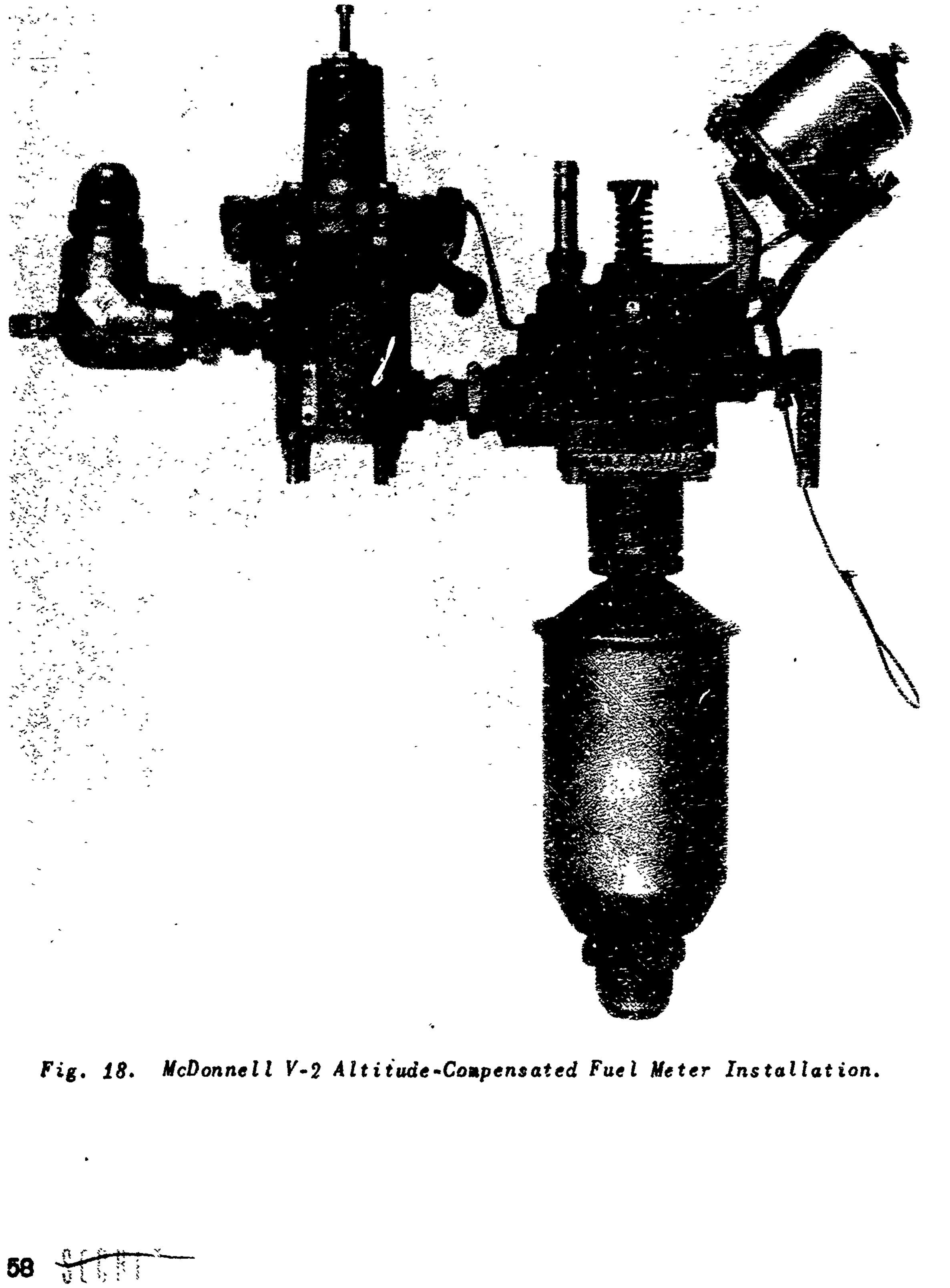

Fig. 18. McDonnell V-2 Altitude-Compensated Fuel Meter Installation.

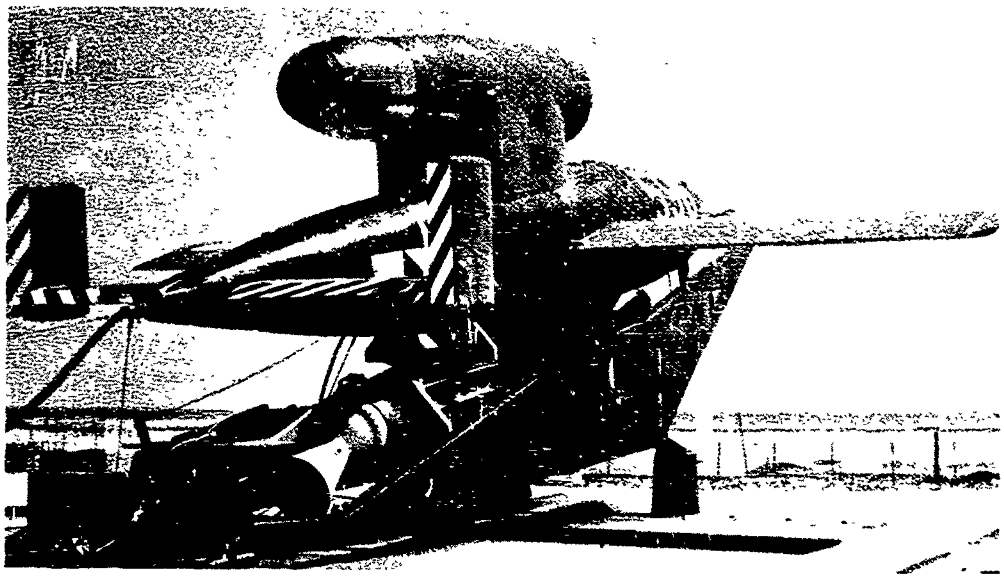

Fig. 19. LOON With J-30 Turbojet Engine Installation.

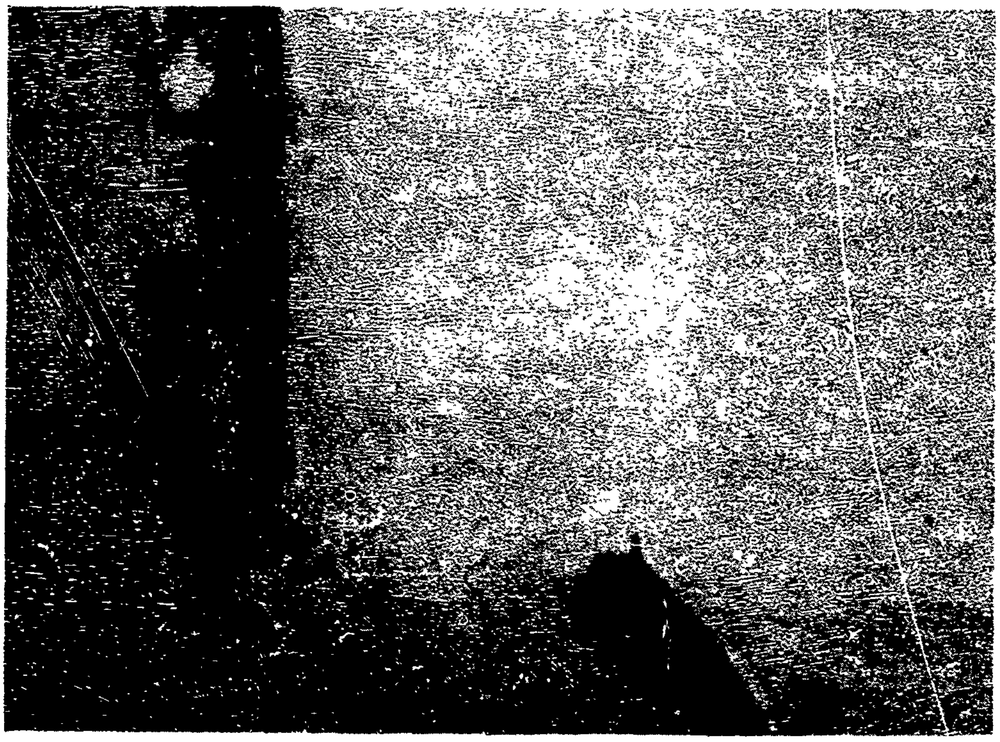

Fig. 20. Missile and Warhead Immediately After Receipt of "Dump" Command.