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Final Report

(U) TEST ADVERSE ENVIRONMENTS--PAVE PAT II (PHASE I)

(U) Function of Pave Pat II and Patricio Pavimendar in Adverse Sub-Tropical Environments - I (Louisiana Static Test Series)

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INTRODUCTION

I General

(U) During the period November 22, 1968 to December 12, 1968 a test and research task designed to further effects data on two emergency capability (EC) explosive fuel munition (EFM) devices was accomplished on the SECRET cleared and secured facilities of Gulf South Research Institute (GSRI) at New Iberia, Louisiana. The tests were accomplished on an island facility of the Institute, referred to in this report as Willow Cove Island, located 1-1/2 miles east of Miller Point, Louisiana (some 35 air miles south of the Gulf South Research Institute facility). (See Fig. 1 and Fig. 2.)

(U) Access to the island was gained by boat, helicopter, and fixed wing aircraft from an airstrip located at Patterson, Louisiana, approximately 6 miles southwest of the island. Personnel were frequently ferried from New Iberia to the strip by fixed wing aircraft, and from there to the island by light helicopter.

(U) Boat transportation required use of the Charenton landing at Charenton, Louisiana. The boat trip required from 22 to 40 minutes, depending on weather and water conditions. Because of navigation complexity in the swamp waterways, travel in cover of darkness was discouraged. In this case, boats were required to leave the island no later than 5:00 p.m. to reach the dock by dark.

II Floral Description of Test Area

(U) The flora of the island on which the test was carried out is almost entirely (95 percent) unispecific, consisting of young willow trees (*Salix sp.*). Two growth areas are present--a first year growth area and an older growth area. The test was done in the first year growth area (Fig. 3).

(U) The willow tree is common to wash areas (battures) and flood plain soils in Louisiana and, in this case, to the Atchafalaya floodway

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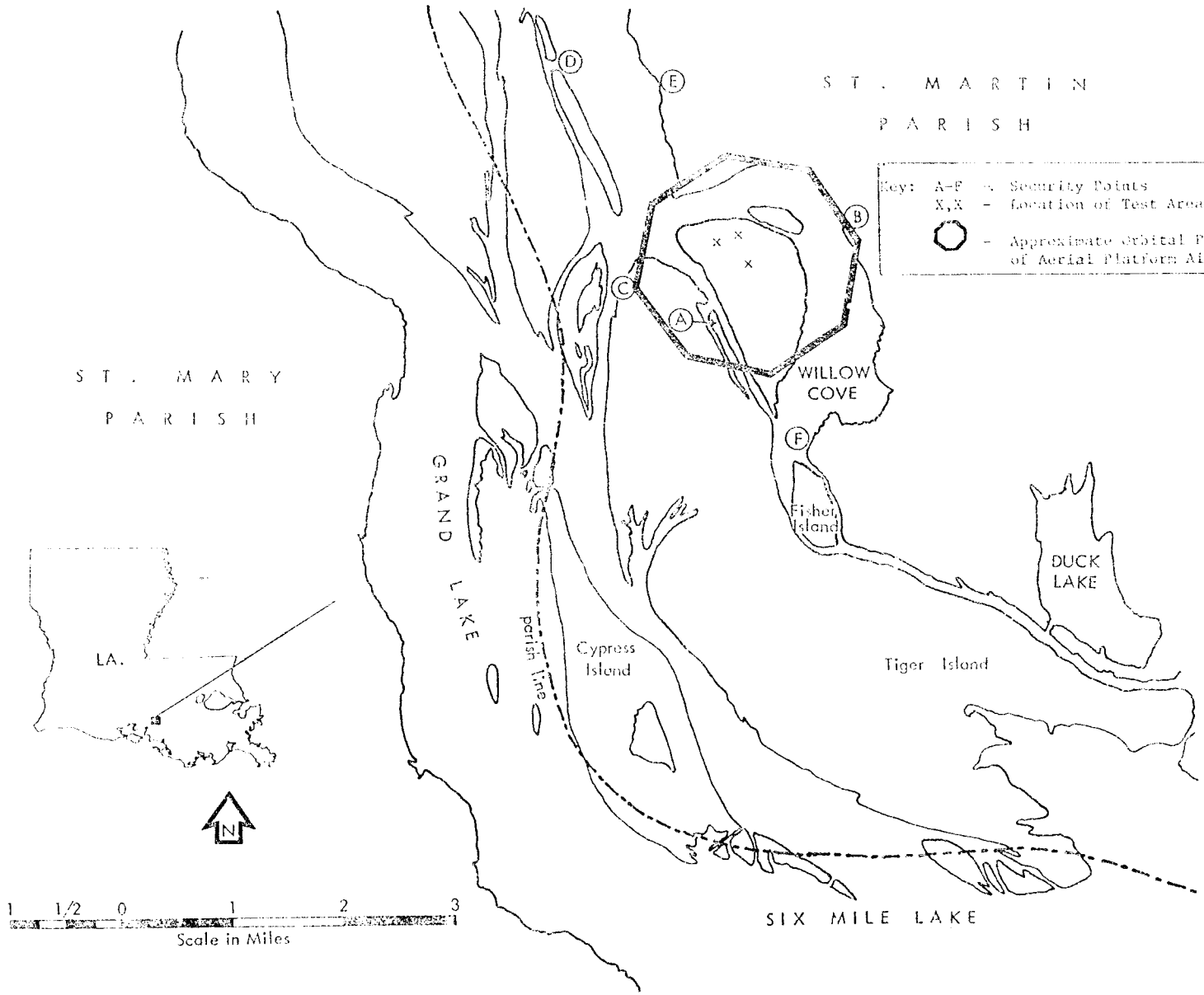

Fig. 1 Location of Willow Cove Test Area (U)

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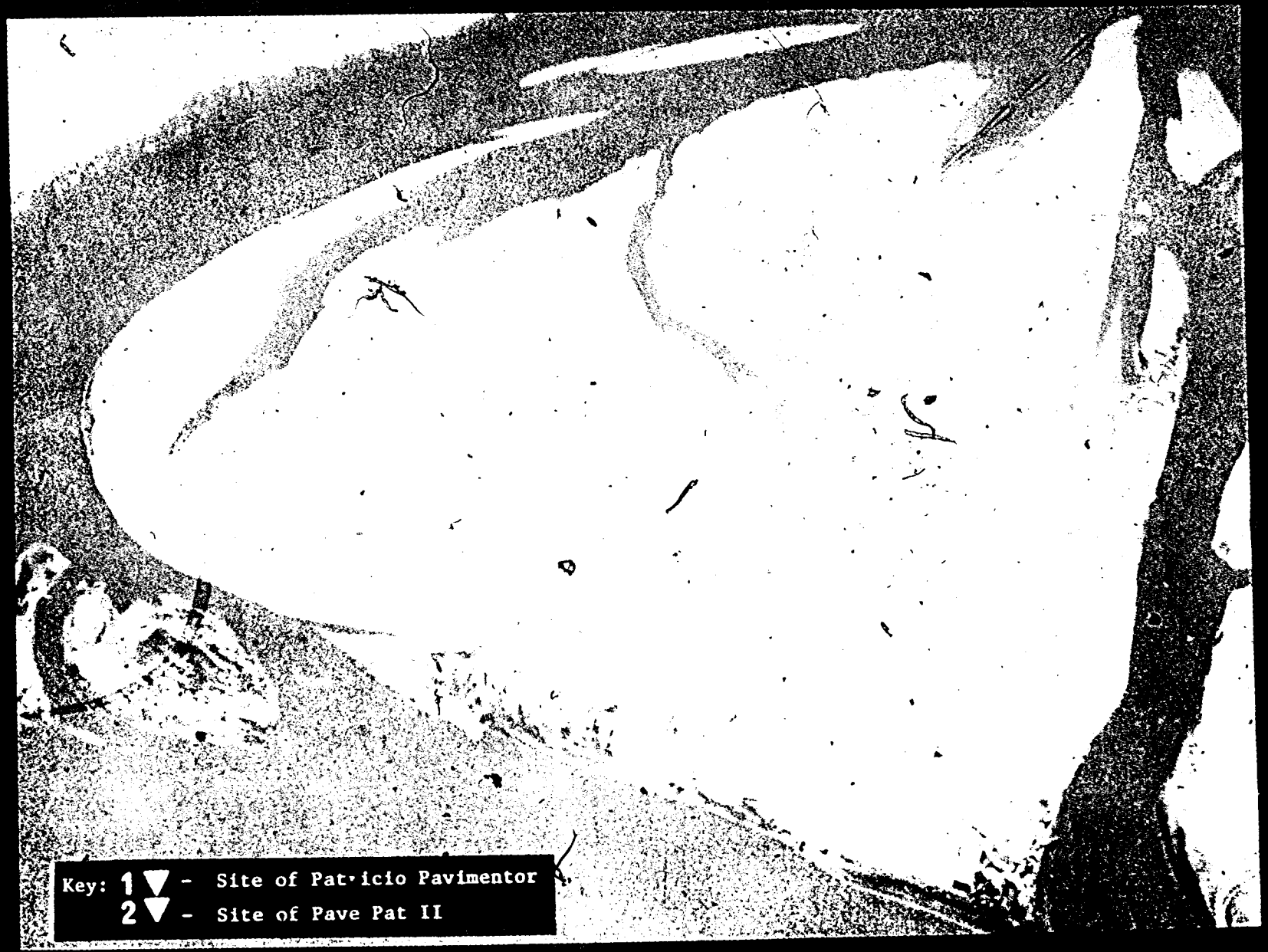

Fig. 2 Aerial Photo of Willow Cove Island (U)

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Fig. 3 Young Willow Trees (U)

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(Brown, 1945).[1] It is a deciduous tree; however, almost all of the saplings in the test area still had a large proportion of living leaves.

(U) The first year growth area is probably subject to inundation by waters of the Atchafalaya several times during the year and consists of willow saplings less than one year old. Two layers of saplings were distinguishable; one layer consisted of individuals less than 1/2 inches in diameter and approximately 3 to 4 feet in height, and the other layer consisted of individuals 1 inch to 2 inches in diameter and approximately 8 feet to 12 feet in height. Overall, individuals were very dense (approximate measurements computed about 13 saplings per square foot).

III Ecological Comparisons Between Test Area and South Viet Nam

(U) Southeastern Louisiana, in which the test was carried out, can be generally characterized as a warm temperature rain forest. This is defined as an area where rainfall is plentiful and somewhat evenly distributed throughout the year. Total rainfall is between 150 and 300 cm. per year. Frost in this area is mild and occasional; the average number of days without a killing frost is 290 to 300 days.

(U) The climaxic or stable flora of the test are bald cypress swamps, consisting of bald cypress, tupelo gum, swamp red maple, drummond red maple, water ash, pumpkin ash and a few small shrubs. Drier areas have a different species composition dominated by oaks with the willow species mentioned above (Brown, 1945[1]; Polunin, 1960[2]). Most of these species are deciduous.

(U) South Viet Nam can be generally characterized as a tropical rain forest. This is defined as an area where rainfall is heavy and the humidity and temperature tend to be high (200 to 400 cm. rainfall per year; 80 percent humidity; mean annual temperature around 25 to 26°C). It has a

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[1] Brown, C. A. (1945). "Louisiana Trees and Shrubs", Louisiana Forestry Commission, Bulletin No. 1, 262 pp.

[2] Polunin, N. (1960). Introduction to Plant Geography and Some Related Sciences, McGraw-Hill Book Company, Inc., New York, 640 pp.

[redacted]

tree canopy with no seasonal changes affecting the entire vegetation. Several (?) strata can be distinguished in the forest profile. Dominant species include palms, bamboos, tree ferns with high densities, and numerous epiphytes and lianes (climbers; ibid.).

(U) The test area is unlike South Viet Nam in that it is characterized by deciduous tree species, less rainfall, more seasonal changes, less luxurient epiphytes or climbers (no climbers were in the immediate test area), and the presence of conifers; the leaves tend to be smaller and the canopy is less dense. However, the test area does have some similarities with South Viet Nam. These similarities are best developed during the growing season of Louisiana. Briefly, the two areas are alike in that both have a large flood basin area (Atchafalaya: Mekong), strata in the forest profile (though not evident in the immediate test area), epiphytes and climbers, and a lush and dense undergrowth makes traverse difficult.

IV Island Security

(U) After transfer of equipment and the Pave Pat II and Patricio Pavimentar devices to the island, strict security was required to prevent accidental or purposeful intrusion by unauthorized personnel. For this purpose, a hunter's camp was rented approximately one mile from the site. Security forces were housed here for the duration of the project. The security force consisted of four men operating on 16-hour per day shifts such that three men were on duty at any one time on holidays and weekends. During security shift hours two men patrolled the water access to the island by boat while in radio contact with the radio base station in the large boat or the rented camp. The island was appropriately marked with large signs, visible at 1/2 mile at all possible approaches. Major navigable channels were appropriately marked to discourage intruders. During working hours (7:00 a.m. to 6:00 p.m.) all field personnel were alerted to intruders in the ar[illegible] staff were required to wear orange fluorescent vests and soft c[illegible] protective helmets at all times for recognition. Radio contact [illegible] maintained at all times with CB 7 'walkie talkie" units. An amplified receiver-transmitter unit mounted on a large

[redacted]

cabin boat permitted better than average CB operating distances. A UHF radio-telephone unit also located on this boat permitted emergency contact with standby New Iberia facilities. Routine UHF radio-telephone contact with New Iberia was difficult because of radio-telephone interference from ship and oilfield traffic in the area.

(U) Test security is outlined below in the device test section of this report.

V Project Photographic Coverage

(U) All aspects of the test program were documented photographically. Area photographs were made to document handling, delivery and emplacement of the devices by both GSRI and Sandia Corporation photographers.

A. Test Photography

(U) As mentioned elsewhere in this report, aerial photographic (movie) coverage was employed by Sandia Corporation photographers before the test sequence, in coordination with the final countdown and test of both devices, and after each test. Some camera malfunction was experienced during the Pave Pat II test, reducing available photographic coverage. Still coverage from aerial platforms was accomplished by both Sandia and GSRI photographers. Some difficulty was experienced in aerial photographic coverage due to incidental light reflection from the water surrounding the test area.

B. Post-Test Photography

(U) Photography consisted of 35 MM and polaroid still photography only, as accomplished by GSRI photographers. All exposed 35 MM film was surrendered to Sandia representatives at the conclusion of the series.

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PREPARATION OF THE SITES

(U) The ground zero sites selected for each device were located approximately 2,000 feet from the north end of Willow Cove Island. (See Fig. 1 and Fig. 2.) The two sites selected were approximately 700 feet apart, located in similar willow thickets as previously described. A path was cut through the willow thicket approximately 4 feet wide to allow personnel and equipment access. An area approximately 6 feet in diameter was opened to ground level at each ground zero (Fig. 4). A 6 inch in diameter hole, 4 feet deep, was prepared to receive the probe on each device. Particular care was taken to preserve surrounding vegetation for proper documentation of expected defoliation effects of the devices.

(U) After placement of the devices and vertical support was accomplished, 20'-1" diameter steel pipes (fitted with 3' x 5' tin markers, with the upper surface painted white or yellow to reduce glare for aerial photography) were emplaced (Fig. 5). The yellow markers were placed 4 feet from each ground zero and others were situated as shown in Figs. 2 and 3. Electronic fire-set equipment positioned in plywood insulated boxes was emplaced at 50 feet from each ground zero in a subsurface prepared hole. Sandia Corporation supplied electronic cable which was set between the respective ground zeros and the control bunker (a distance of 3,800 feet from Patricio Pavimentar and 4,100 feet from Pave Pat II).

Control Bunker Fabrication

(U) The control bunker was fashioned from plywood and 2" x 4" lumber stock, and was earth-covered to a minimal depth of 2 feet. This bunker is shown in Fig. 6. Its location with respect to the ground zero locations is shown in Figs. 1 and 2. The bunker was fabricated to protect occupants from shock and any shrapnel resulting from testing of the devices. Access was gained by boat, requiring location of a boat at the bunker at all times for personnel transportation to and from the test area.

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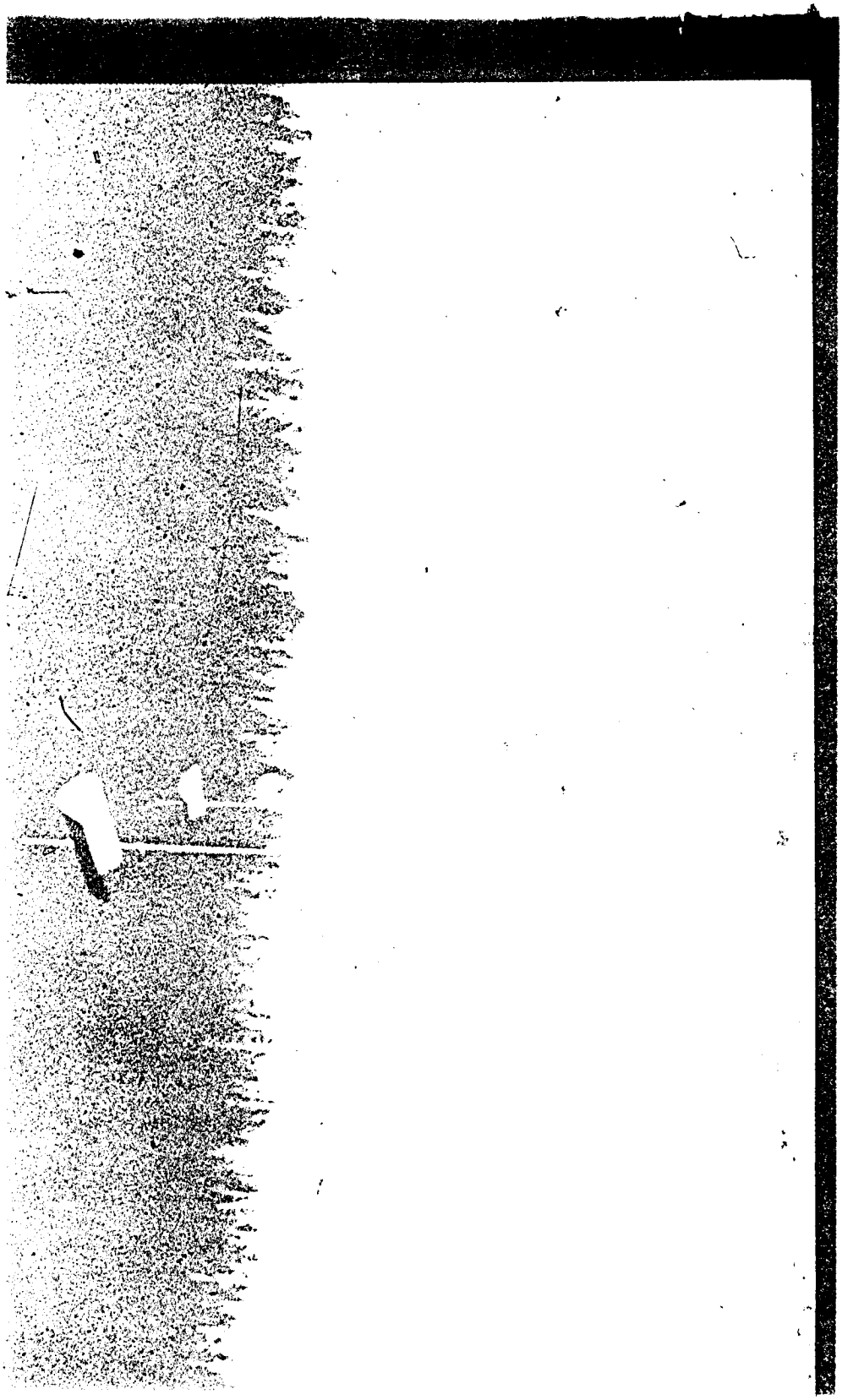
Fig. 4 Patricio Pavimentar - Path to Ground Zero (U)



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(U) Both devices arrived at New Iberia, Louisiana, via the contractor's C-47 aircraft.[1] The aircraft taxied to a secured parking zone near the operations building for project personnel. The devices and other equipment were off-loaded on to a 2-1/2 ton flat-bed truck with fork lift assistance and trucked to the GSRI ammunition storage bunker area. The truck and devices were positioned inside a drive-in bunker and covered with a canvas. Armed special security was placed on the bunker facility 24 hours a day while the devices were in the area. Other equipment was stored in a secured GSRI facility known as the commissary.

(S) Both devices were filled with M&PP fuel[2] by Sandia personnel the next day with assistance from GSRI personnel, and the devices (and truck) were moved back into the bunker. The devices were covered with the canvas at all times to prevent recognition from low-flying aircraft.

I Delivery to the Test Site

(U) Both devices were air-lifted from the bunker area to the test site utilizing a Bell 205-A helicopter supplied by arrangements with Petroleum Helicopters of Lafayette, Louisiana and of New Iberia, Louisiana, near the GSRI facilities. Slings were fabricated for each device, consisting of 1/2 inch steel cable assembled on a 1 inch steel "O" ring for attachment to the remotely-controlled belly hook on the helicopter. On Monday, November 25, these devices were lifted from the truck bed and carried to Willow Cove Island by a predetermined route over unpopulated marshland and water (Fig. 7 A, B, C. D). Abort locations were predetermined by Sandia Corporation personnel and GSRI staff on an earlier flight in the event of necessity for emergency release of the devices from the helicopter.

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[1] Carco Company, Albuquerque, New Mexico.

[2] Supplied by Dow Chemical Company, Plaquemine, Louisiana.

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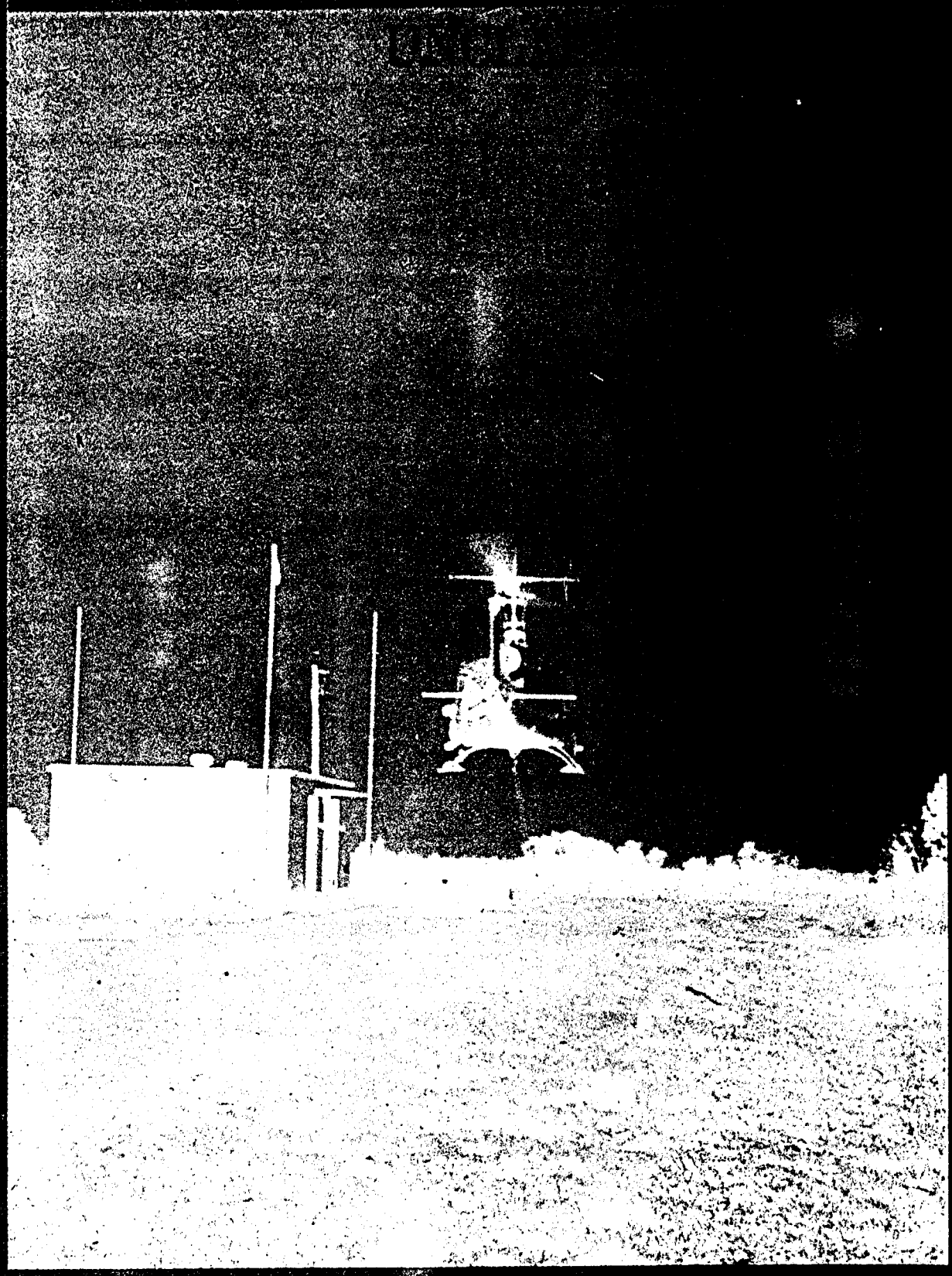

Fig. 7 A Patricio Pavimentar - Airlifting of Device (C)

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Fig. 7 B Patricio Pavimentar - Airlifting of Device (C)

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Fig. 7 D Particio Pavimentar - Airlifting of Device (C)

II Placement on Prepared Sites

(U) To facilitate location of the ground zero from the air, large limed arrows were located in cleared areas adjacent to the ground zero radii (Fig. 8). In each case, the devices were directed immediately over the ground zero by air-ground radio and by visual contact. Personnel directly below the helicopter directed the probe into the prepared 6 inch hole and the devices were secured by means of 4 (2" x 6" stock) wooden triangular braces (previously prepared) 8 feet tall by 4 feet at the base and attached at two points to the devices for vertical support by means of 1/4 inch steel cable and clamps. Guy wires (1/8 inch in diameter) were also attached to tree roots 20 feet out (small unit) (Fig. 9) and 1/4 inch cable guy wires were attached to the large unit (Fig. 10). Steel armor plate (1/4 inch thick) supports were prepared and made available for placement (on ground surface) if the devices appeared to sink into the soft, sandy soil. These plates were not used. The carriage slings were dropped from the helicopter when the devices were secured in a vertical position. All personnel were required to wear protective headgear while working under the helicopter. Other heavy equipment was airlifted from the beach or boats to the respective ground zero as required by helicopter. To accelerate site preparation, both sites were prepared and ready for test within 148 hours after contract initiation.

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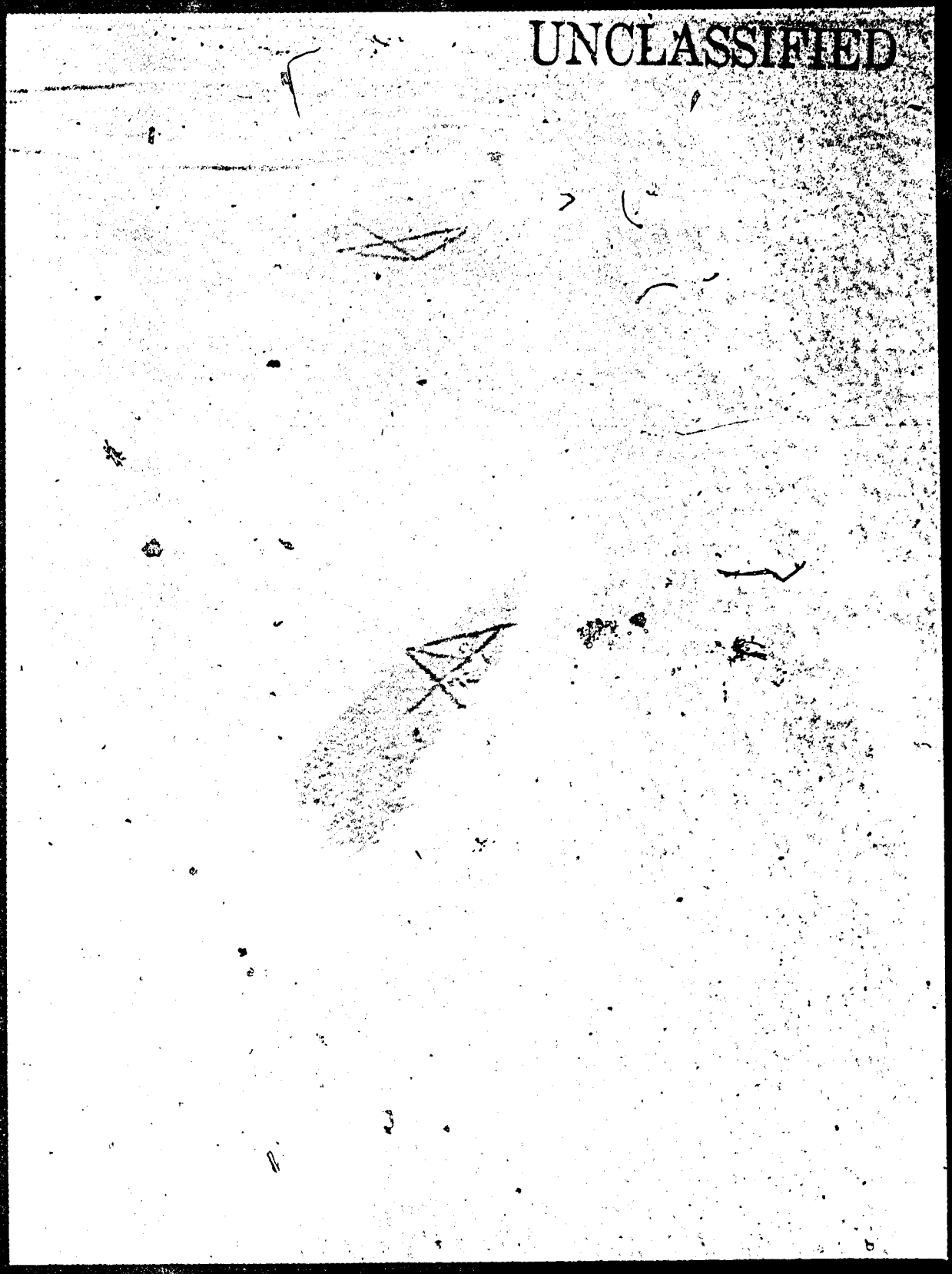

Fig. 8 Limed Aerial Markers (C)

Fig. 9 Patricio Pavimentar - Secured by Guy Wires (C)

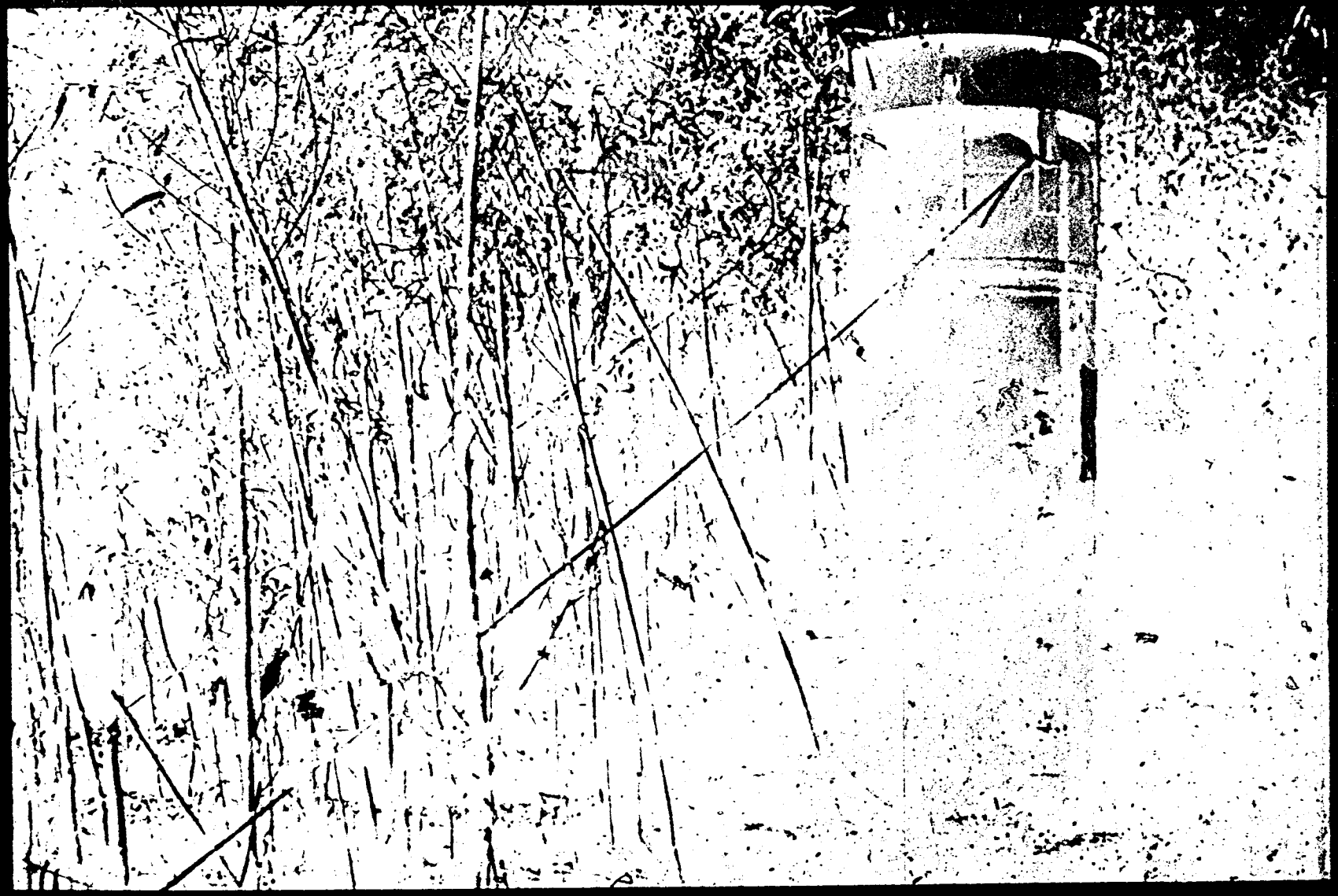

Fig. 10 Pave Pat II - Secured by Guy Wires (C)

FINAL SITE PREPARATION

I. Patrick Equipment

A. Sensor Placement

(U) Standard tin cans such as soft drink and beer cans were supplied as overpressure sensors by Sandia Corporation (Fig. 11, below). The cans were marked as to number designation and distributed in circles at 50 feet and 100 feet, roughly equidistant from each other within the prescribed circle. Numbers and locations of these cans were documented. Radial distribution was as described in the "effects" section of this report (Fig. 12).

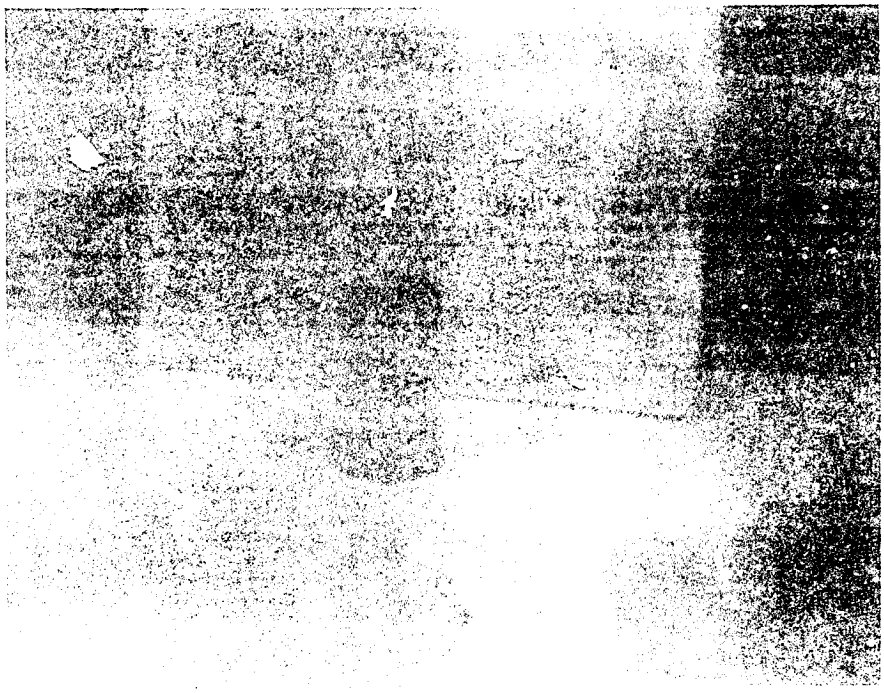

Fig. 11 Overpressure Sensors (Tin Cans) (U)

B. Initiator Placement

(U) Cloud initiators were placed as shown in Fig. 13 A, B, D, E. The initiators consisted of 3-pound blocks of compound C-4. These were taped to small trees just above the ground at respective locations (Fig. 14). These initiators were not placed until all personnel other than EOD personnel were out of the area. Controlled detonation of these charges was

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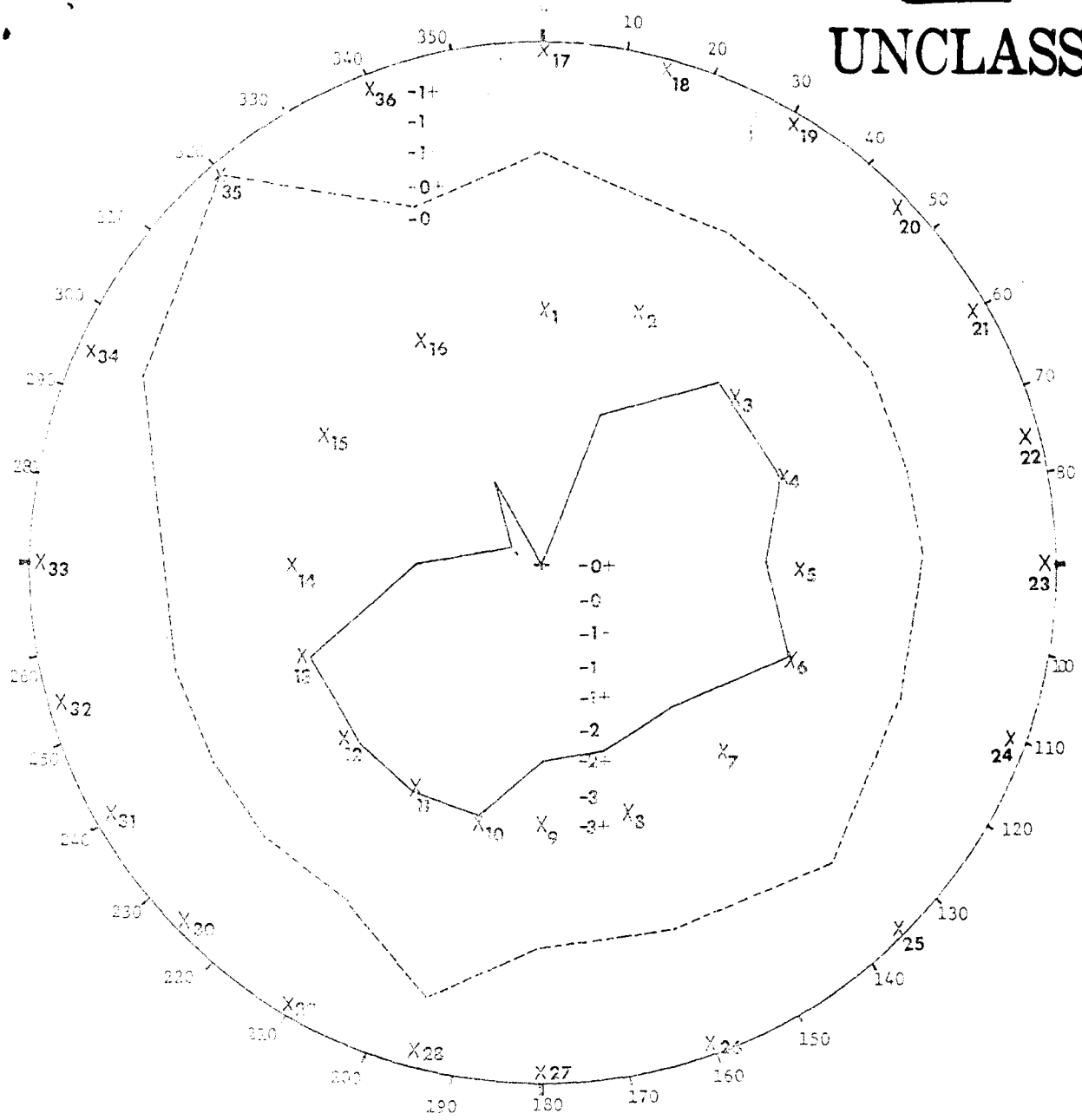

X = LOCATION AND NUMBER OF CAN SENSORS AT 50 AND 100 FT.
X = CAN NOT RECOVERED
—— ESTIMATED OVER PRESSURE, 50 FT. RADIUS CANS
- - - ESTIMATED OVER PRESSURE, 100 FT. RADUIS CANS

OVER PRESSURE CAN EFFECTS

0 = NO DAMAGE
0+ = DISCERNABLE DAMAGE
1- = MINIMAL DAMAGE
1 = MINIMAL DAMAGE PLUS
1+ = SLIGHT DAMAGE
2 = MODERATE DAMAGE
2+ = MODERATE - SEVERE
3 = SEVERE DAMAGE
3+ = CRUSHED

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Fig. 12 Patricio Pavimentar - Can Sensor Data (S)

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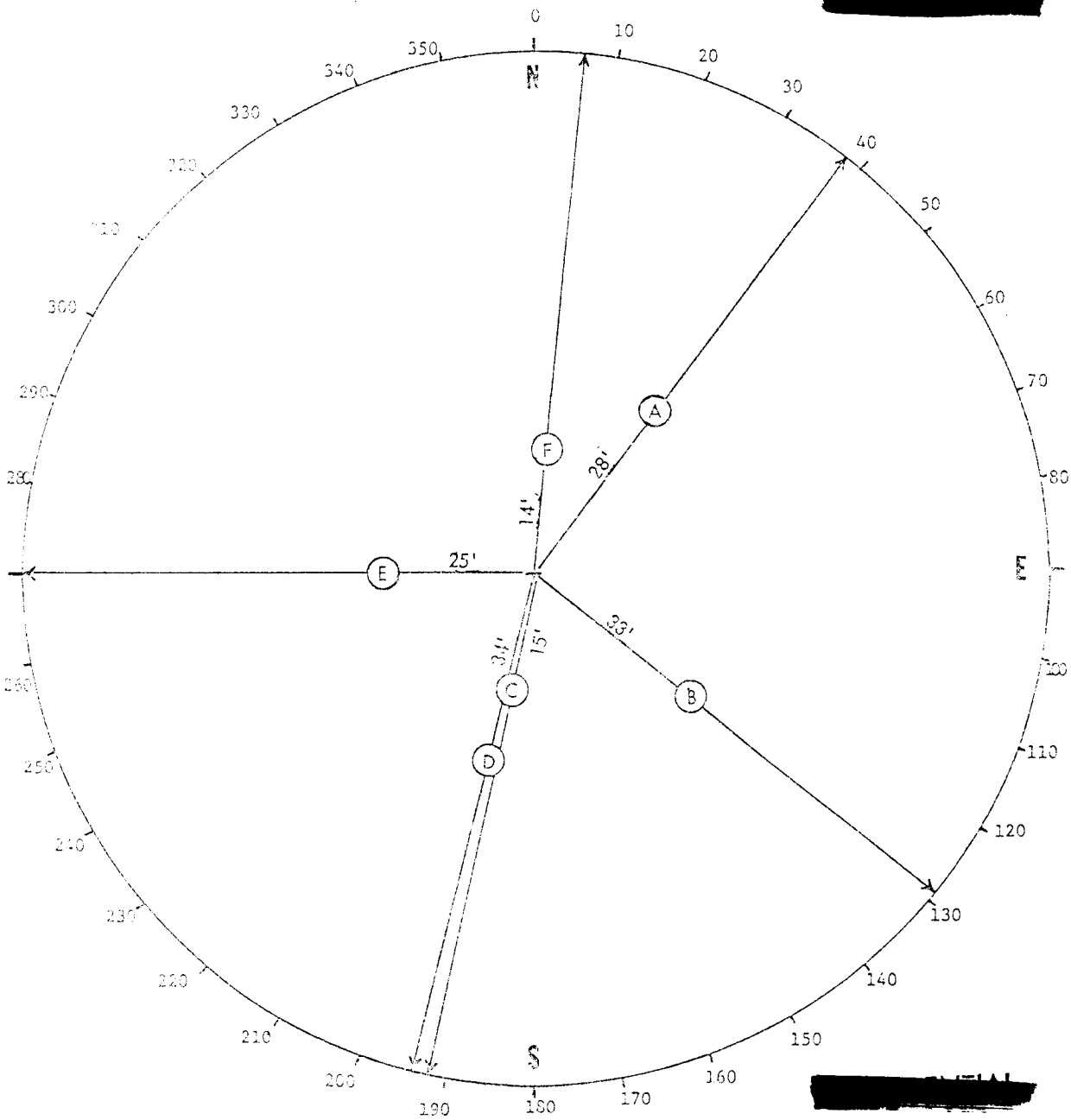
PATRICIO PAVIMENTAR TEST GZ #1 - INITIATOR CRATER DISTRIBUTION [redacted]



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A - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 38°
B - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 129°
C - IRREGULAR CRATER, EXTENDING INTO SURFACE FAULTS, 3 FT. DIAMETER, AZIMUTH 192°
D - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 194°
E - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 270°
F - SINGLE UNIFORM CRATER, 1 FT. DIAMETER, 16 INCHES DEEP, AZIMUTH 6°

Fig. 13 Patricio Pavimentar - Cloud Initiator Location (C)

[redacted]

Fig. 14 Patricio Pavimentar - Initiators Taped to Trees (U)

accomplished through electronic circuitry allowing a 3-second delay following "cut-line" detonation of the Patricio tank.

II Pave Pat II

A. Sensor Placement

(U) As in the Patricio site, standard tin cans properly marked were distributed as shown in Fig. 12.

B. Initiator Placement

(U) Although technical description of devices is not intended or implied in this report, such description as follows is necessary for comprehension of the report. Documentary technical descriptions of these devices are available through the Office of Division 1513, the Sandia Corporation.

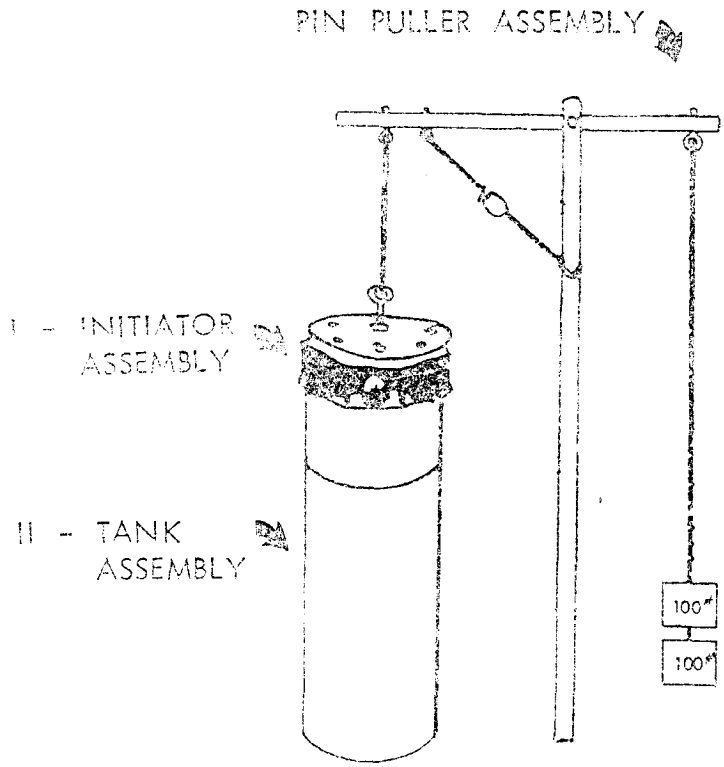

Fig. 13 Pave Pat II - Graphic Illustration of Initiator Pin Release System (C)

(U) The initiator unit of this device is octagon-shaped and is an integral part of the device itself; in the vertical device as shown in Fig. 16, it is the uppermost unit. In this test, six initiator units were in place, with the opposing units left out. At a distance of 55 feet at Azimuth 246°, and in the direction of one of the opposing unit voids, an additional initiator unit was placed, consisting of 3 pounds of compound C-4 in an assembly similar to those in the initiator unit. This unit was wired through electronic circuitry to allow a 5.5-second delay (integral units are designed to function at a 5-second delay from the time of discharge from the initiator assembly). Primary charges within the device are designed to cut the tank and lift the initiator unit into the air, simultaneously releasing the initiator grenades to begin a 5-second pyrotechnic delay. In the direction of the opposite initiator blank, a 16-foot "T" bar and plate system was arranged to substitute for the grenade pin release system provided for the parachute-dropped device. (See Fig. 15, preceding page.) Fire set devices were placed 50 feet from the device (Fig. 17).

III Device Test Implementation

(U) In test design and function, three test control personnel units were necessary: ground control, air control, and security control.

A. Ground Control Unit

(U) It was the responsibility of the ground control unit (Sandia Project Engineer, Fire Engineer, and EOD personnel) to initiate the test countdown and electronically fire the devices from the control bunker on final countdown from air control with concurrence of security control. EOD responsibility (including final placement and fusing of initiators, post-test clearance, air-ground radio contact, security control radio contact, and radio control between the control bunker and the ground zero while EOD personnel were in the area) was also the ground control unit's responsibility.

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Fig. 16 Pave Pat II - Initiator Unit Prepared with "T" Bar and "Pin Puller" Assembly (U)

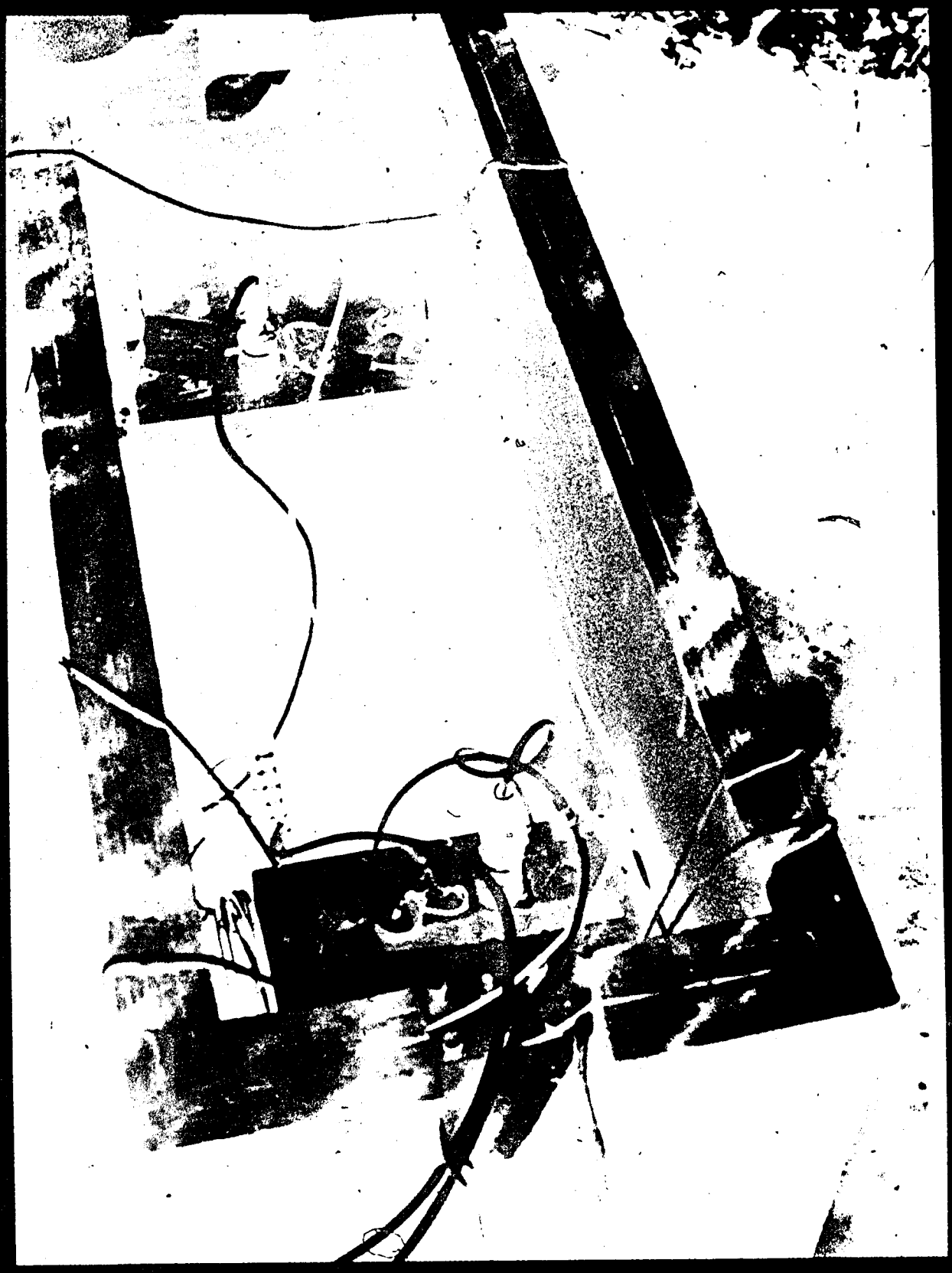

Fig. 17 Fire Set Box Employed in Both Test Situations (U)

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B. Air Control Unit

(U) Aircraft used by this unit were the GSRI-leased aircraft (one Cessna 170), the GSRI-leased helicopter (Bell 205A or Bell 47G4A), and the USAF-supplied "O-2" (military version Cessna Skymaster).

(U) Aircraft were based at the GSRI facility in New Iberia until they were required at the test site. Aircraft departure and function during the test sequence is outlined in Exhibit I. Fixed wing aircraft were used on test days only. The Bell 205A aircraft was used for heavy equipment transfer, while the 47G4A was used for test and personnel transportation. Radio-telephone contact was possible, for field operation emergency situations, from the GSRI marine command vessel to the GSRI base station and airstrip in New Iberia.

(U) During the test, aircraft were used to ferry personnel from New Iberia to Patterson, Louisiana. Aircraft then remained in Patterson until called for orbital flight. The Patterson airfield is situated approximately 6 miles from Willow Cove Island, facilitating rapid air access to the test area and thereby reducing flight time of all aircraft. The approximate orbital flight path of fixed wing aircraft, as shown in Fig. 1 was an octagon 1 mile in diameter at an altitude of 3,000 to 4,000 feet.

(U) Air control was responsible for the final 30 minutes of countdown, as directed by Sandia photographers in the fixed wing aircraft. An additional responsibility of air control was cognizance of boat traffic moving in the direction of Willow Cove Island and the reporting of this traffic to security control. The helicopter was used for aerial still photography by the GSRI photographer before, during, and after test and as a close surveillance craft for security control (to alert or remove hunters from nearby islands, or identify boats which had violated the water security perimeter by way of small seminavigable waterways).

C. Security Control Unit

(U) Security control was implemented through radio control of eight powered boats. Project coordination and security control was established through a civilian band radio amplifier unit located in the GSRI command

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EXHIBIT I

Test Schedule (U)

A.M.

07:30 1. Helicopter leaves New Iberia to Willow Cove Island
   a. GSRI Pilot
   b. Sandia Corporation Test Engineer
   c. Sandia Corporation EOD Engineer

2. Autos depart for Charenton (GSRI Staff)
   a. Project Leader
   b. Project Coordinator
   c. Security Supervisor
   d. Security Staff
   e. Technical Photographer

3. Sandia Project Engineer and Sandia Photographers (2) await Cessna at 08:15

4. Base Coordinator - keys to commissary, runway control

5. GSRI field crew begins finish work at Willow Cove Island

08:15 1. Cessna arrives (GSRI Pilot) and departs for Patterson airstrip for rendezvous with helicopter
   a. GSRI Pilot
   b. Sandia Project Engineer
   c. Photographers (2)

2. Base Coordinator awaits "O-2" arrival (Air Force Test Representative and Pilot) and directs them to Patterson airstrip

08:30 Boats leave Charenton for Willow Cove Island (GSRI Staff)

08:45 Helicopter back to Patterson from Willow Cove Island. Picks up Sandia Project Engineer and Sandia Photographer and transports them to island and waits. (Photographic coverage - Sandia)

09:00 Boats arrive at Willow Cove Island. GSRI photographic coverage (still)

09:15 Helicopter, Sandia Photographer return to Patterson. Sandia Project Engineer to control bunker. Helicopter to Morgan City for refueling and returns to vicinity of island for ground air radio check (approximately 10:00 a.m.), returns to Patterson to have Cessna and "O-2" radio contact.

09:30 All security boats and GSRI personnel assemble on Fatboy Able for final security review and assignment (Per map, Fig. 1 and protocol, Exhibit II)

10:00 Boats depart for security stations for dry run

10:15 Aircraft and photographers (Sandia) airborne to begin island flight pattern for dry run, helicopter picks up GSRI Photographer at island as orbit begins

10:30 Begin dry run, merge into condition Red at command of ground control (Sandia Project Engineer) and concurrence of air control (Sandia Photographer) and security control (GSRI Project Leader)

NOTE: DEPENDENT ON WEATHER CONDITIONS, SCHEDULES MAY BE ALTERED BY AIR CONTROL, GROUND CONTROL, OR SECURITY CONTROL FOR SAFETY OR OTHER REASONS. SECURITY, ONCE POSTED FOR THE DRY RUN, WILL REMAIN POSTED UNTIL RECALLED BY SECURITY CONTROL - FATBOY ABLE.

[redacted]

vessel (Able--Exhibit II) with all boats and the ground control bunker. Air ground radio communication was thus established through the radio at ground control.

(U) It was the responsibility of security control to maintain constant surveillance of all approaching waterways to prevent accidental or purposeful violation of the test area by powered boats. Distribution of control craft are shown in Fig. 1. The security test protocol used in these tests is shown in Exhibit II. The term "Fatboy" was the CB radio call signal used by GSRI security units.

(U) At zero minus 5 minutes, a 30-second siren blast occurred aboard "Able", in the event any radio contact was insufficient for alert.

(U) All units (ground control, air control, and security control) above were simultaneously in control of the final countdown for security and safety reasons.

[redacted]

[redacted]

EXHIBIT II

Security Protocol (U)

Zero Minus One Hour

1. Assemble on Fatboy Able for security instructions and position assignments
2. Complete security radio check, CB Channel 7, and change all Walkie Talkie batteries
3. Issue or check safety equipment, flags, signs, etc. (hard hats for all personnel in open boats)
4. Assign radio call signals (below)
5. Check radio systems. VHF radio (Frequency 122.9) in Control Bunker. Walkie Talkies distributed as follows:

Security Positions During Test

Position	Location	Personnel
ABLE	Bunker Canal	⊛ Project Leader, Photographer, Project Coordination Clerk
BAKER	Little Bayou Long	* Assigned Security Staff
CHARLIE	Atchafalaya Canal	* Assigned Security Staff
DOG	Grand Lake West	* Assigned Security Staff
EASY	Grand Lake East	* Assigned Security Supervisor and Assistant
FOX	Bayou Boutte	* Assigned Security Staff
GD Control	Bunker	⊛⊛ X * Sandia EOD Engineer, Test Engineer and Project Engineer

⊛ CB 7 Control Amplifier Unit
* Location of Walkie Talkies (CB 7)
X Ground Air Radio, Frequency 122.9
⊛⊛ 2 Sandia Channel 9 Radios

Zero Minus 30 Minutes - Condition Red

1. Security will be posted for dry run and condition Red will persist until units are recalled by radio only. All boats should remain in a shielded position until 30 minutes after the second detonation. No movement will be allowed except as required by Fatboy Able by radio contact after the first detonation and 30 minutes after the second detonation. Security radio silence required except in emergency.
2. A long siren blast will occur at 5 minutes before each detonation.

[redacted]

[redacted]

TESTING OF PATRICIO PAVIMENTAR AND PAVE PAT II

(U) After successful preparation of test sites and implementation of control units, testing was attempted on November 26, 1968. Meteorological data on this day are shown in Table I, below. The first test attempt on this date was made relatively late in the day because of increasing cloud cover, difficulty with aerial photographic equipment, and increasing difficulty in adequate radio communication. The mission was consequently "scrubbed" by ground control with concurrence of air and security control.

(U) Weather conditions on the following day would not permit testing. (See Table I.)

(U) The next test day was scheduled for December 3. Morning weather conditions did not permit testing. (See Table I.)

(U) Tests were conducted in sequence on December 4, 1968. The Patricio Pavimentar detonation occurred at 13:07 hours while the Pave Pat II detonation occurred at 14:49 hours (CST). The EOD clearance of the area required approximately 1 hour after malfunction of Pave Pat II.

TABLE I

Test Day Meteorological Data (U)

Dates	Temp.	Wind Direction	Wind Velocity	Visibility	
				a.m.	p.m.
Nov. 26 (Tues.)	75°F	140°	Variable 5 to 15 knots	Unlimited	1,000 to 3,000 ft.
Nov. 27 (Wed.)	75°	160°	Variable 5 to 15 knots; gusts to 23 knots	300 ft.	300 ft.
Dec. 3 (Tues.)	63°	320°	Variable 8 to 18 knots; gusts to 28 knots	300 ft.	4,000 ft.
Dec. 4 (Wed.)	56°	270°	Variable 5 to 10 knots	4,000 ft.	4,000 ft.

[redacted]

[redacted]

[redacted]

DEVICE FUNCTION AND ECOLOGICAL EFFECTS

I Patricio Pavimentar

A. Device Function

(C) On firing impulse generation from the control bunker, all circuits were completed in this test in proper sequence (integral tank dispersion system and initiators) to include a 3-second delay between cutting of the tank and firing of the initiators. The ejection of the distal end of the tank did not occur, resulting in incomplete separation and consequent perforation of only the "cut-line" in the tank. This perforation occurred at 90°, 45°, 180°, and 300°. (See Figs. 18, 19, and 20.) Despite this apparent malfunction, dispersion of the MAIF gas and cloud initiator function was reasonably successful.

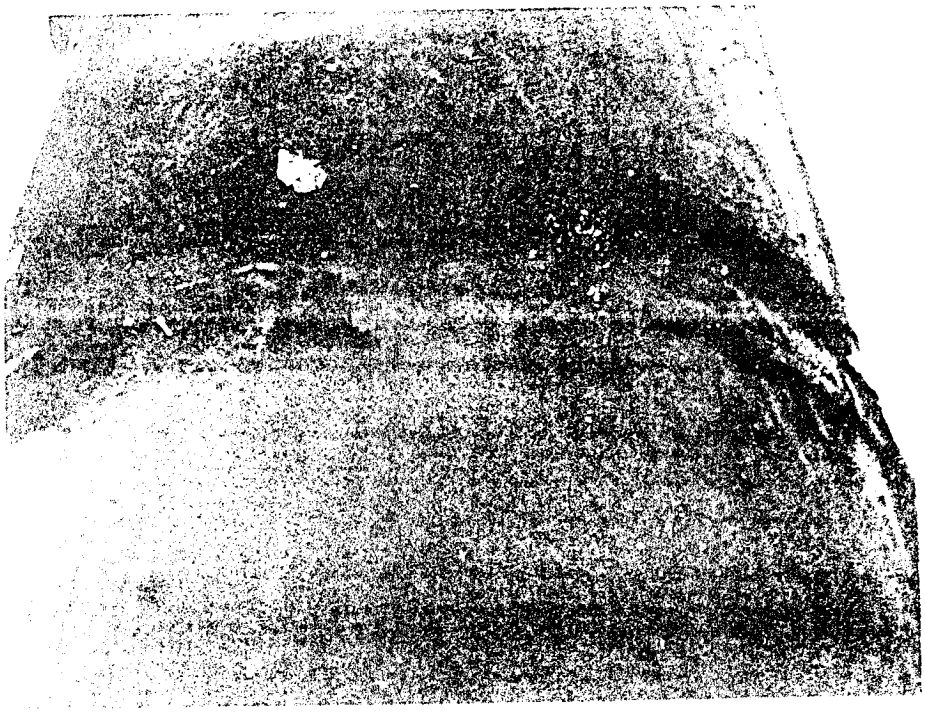

Fig. 18 Patricio Pavimentar - "Cut-Line" Perforations at 45° and 90° (C)

[redacted]

[redacted]

Fig. 19 Patricio Pavimentar - "Cut-Line" Perforations at 180° (C)

Fig. 20 Patricio Pavimentar - "Cut-Line" Perforations at 300° (C)

B. Visual Observations--Ground Level

Conference and discussion with those staff members who were in a position to observe the test and study of aerial photographic coverage revealed the following:

1. Initially, as the sequence began, a small fireball and black smoke appeared immediately above the unit;
2. Simultaneously the MAPP cloud extended relatively horizontally over an area about 100 to 125 feet in diameter and rose a few feet above the tree tops;
3. Initiator detonation followed, with complete cloud detonation.

C. Effects

1. Crater Distribution and Character

Distribution of initiator craters is shown in Fig. 13. Craters A, B, D, and E were uniform in size and depth and selectively located around the ground zero at an average distance of 30 feet (range, 25 to 34 feet). Two other craters are noted 15 feet (C) and 14 feet (F) from the device. Crater C was of irregular diameter, approximately 12 inches deep, and extended into expanded surface faults in the ground surface for 5 to 8 feet. Crater F was of a uniform diameter of 12 inches, but quite deep (16 inches), with little extension into surface faults. The cause of these craters (C and F) is unknown and any explanation would be only conjecture on the part of these investigators.

2. Defoliation Effects

TABLE II

Patricio Pavimentar - Radius of Defoliation (S)

Degree of Defoliation	Average Radius from Ground Zero
100%	0 to 58'
75%	58 to 69'
50%	69 to 78'
25%	78 to 92'
0%	92 to 108'

Due to the wind direction (Table I), the area of defoliation was of irregular shape (Fig. 21), extending primarily northwesterly, westerly, and southerly. As indicated in Figs. 22 and 23 the open gulch south of the test site reduces meaningful interpretation of the data in that area. Heavy leaf mulch did extend to the area, as shown, indicating significant overpressure. The average radius of defoliation by degree as interpreted by these investigators is shown in Table II (preceding page) and in Fig. 21. Complete defoliation (100%) is defined as removal of all leaf and fine branch structure; zero defoliation (0%) means no damage to leaf structure, even if a small amount of fresh leaf mulch was discernable.

3. Other Effects

Areas of massive carbonization and slow burning are also outlined in Fig. 23. These areas extended from the device in the general directions of the initiators (Figs. 13 and 24).

It is noteworthy that from the device outward to a radius of approximately 25 feet, the small willows were defoliated but standing at irregular angles, while from 25 feet out as far as 60 or 70 feet (the total area here is roughly 80 percent of the area of complete defoliation), trees were uprooted or stood at acute angles (Fig. 25).

The aerial markers shown in Fig. 22 were affected in various ways. The ground zero marker (yellow) remained standing, although the tin flag was complete crumpled and burned. Marker 1 south was bent at ground level at an angle of 75 to 80 degrees and pointed easterly. The flag was basically undamaged. Marker 2 south was bent at 2 feet above ground level at a 75-degree angle, pointing easterly. The tin flag was displaced 50 feet to the east and was greatly crumpled. Marker 1 west was bent at a 75-degree angle, pointing northeasterly. The flag lay directly beneath the pole base. Marker 2 west was basically undamaged, but there was some defoliation below the flag.

Although adequate combustion was apparent, the odor of unburned gas was evident--particularly in the area of crater C, Fig. 13.

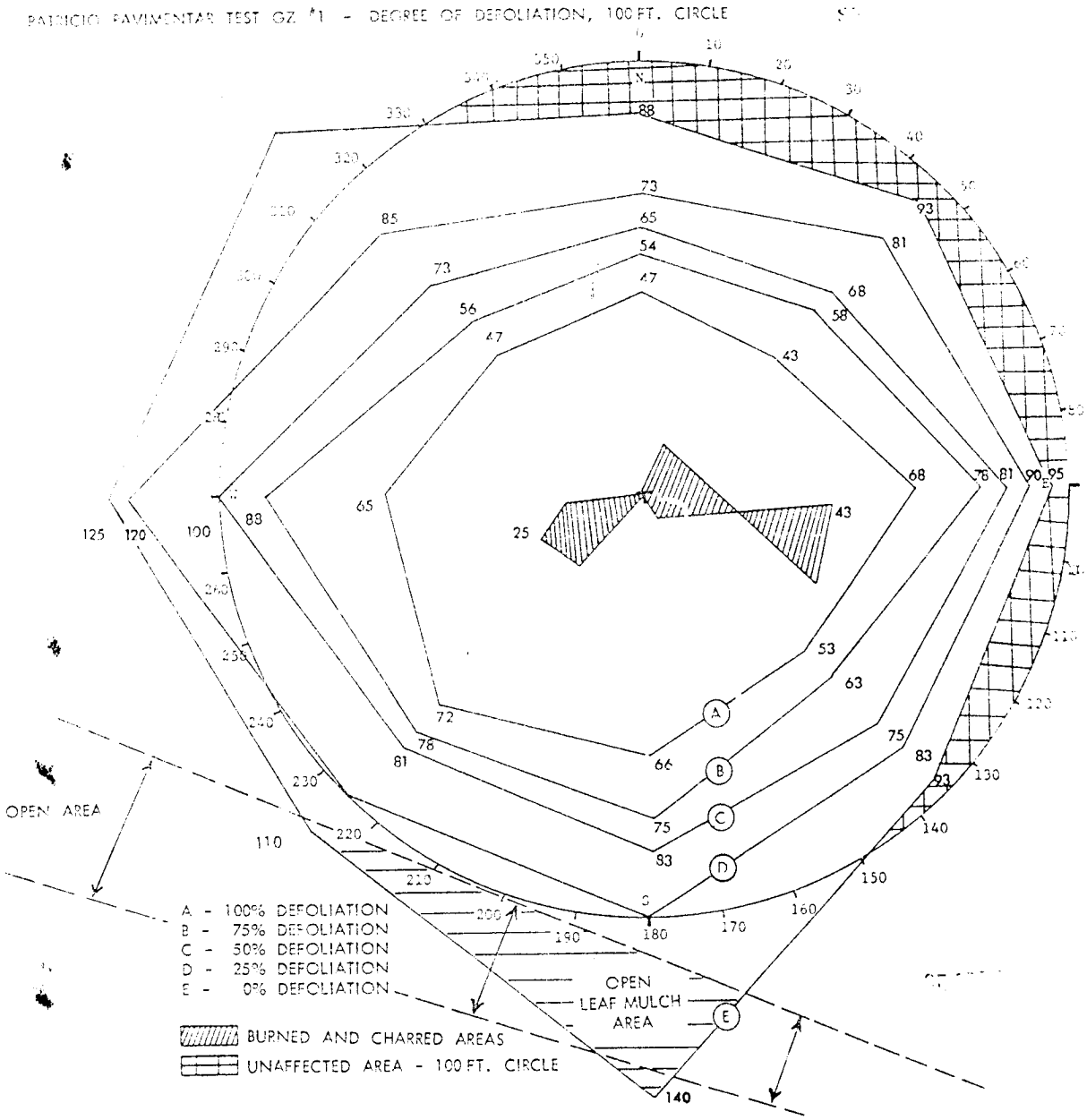

Fig. 21 Patricio Pavimentar - Degree of Defoliation, 100-Foot Circle (S)

[redacted]

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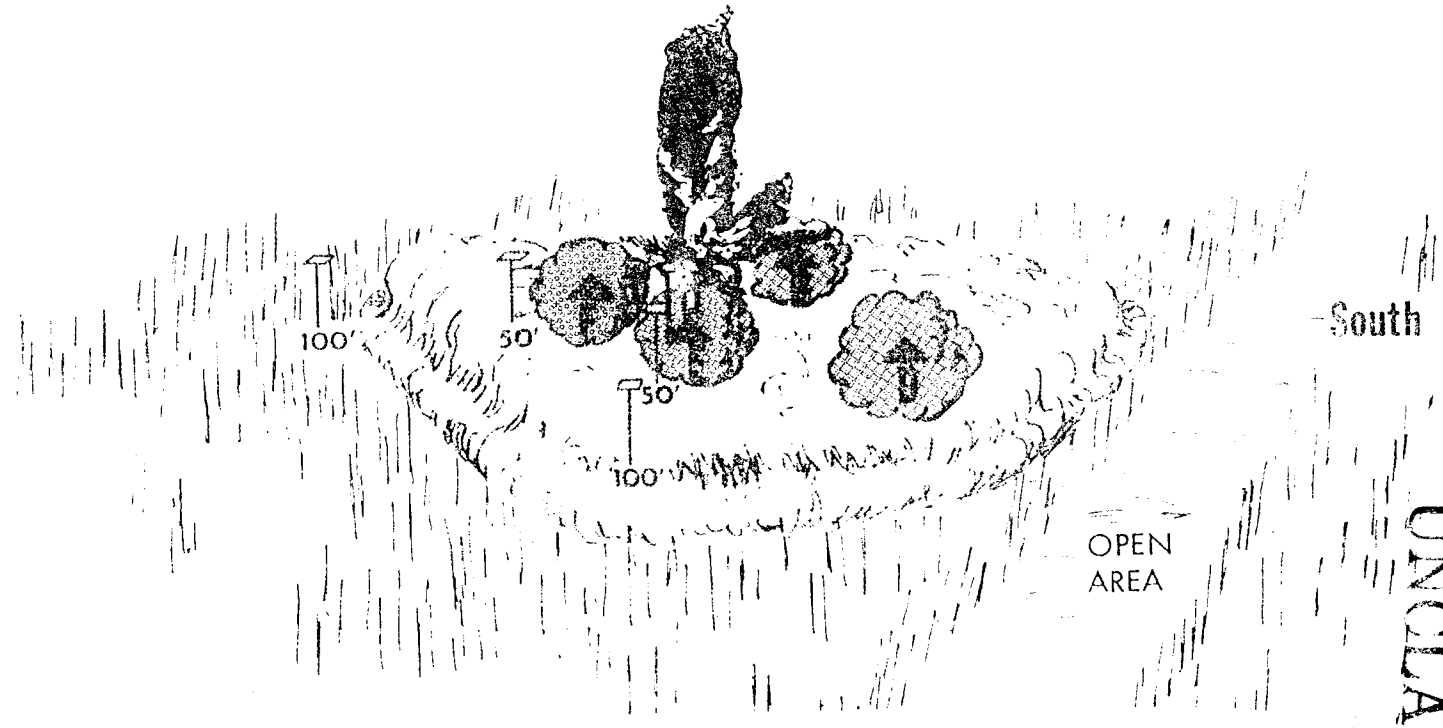

B - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 129°
D - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 194°
E - INITIATOR LOCATION, SINGLE CRATER, 2 FT. DIAMETER, AZIMUTH 270°
F - SINGLE UNIFORM CRATER, 1 FT. DIAMETER, 16 INCHES DEEP, AZIMUTH 6°
CORRUGATED TIN FLAG

Fig. 22 Patricio Pavimentar - Vertical Illustration of Blast (S)

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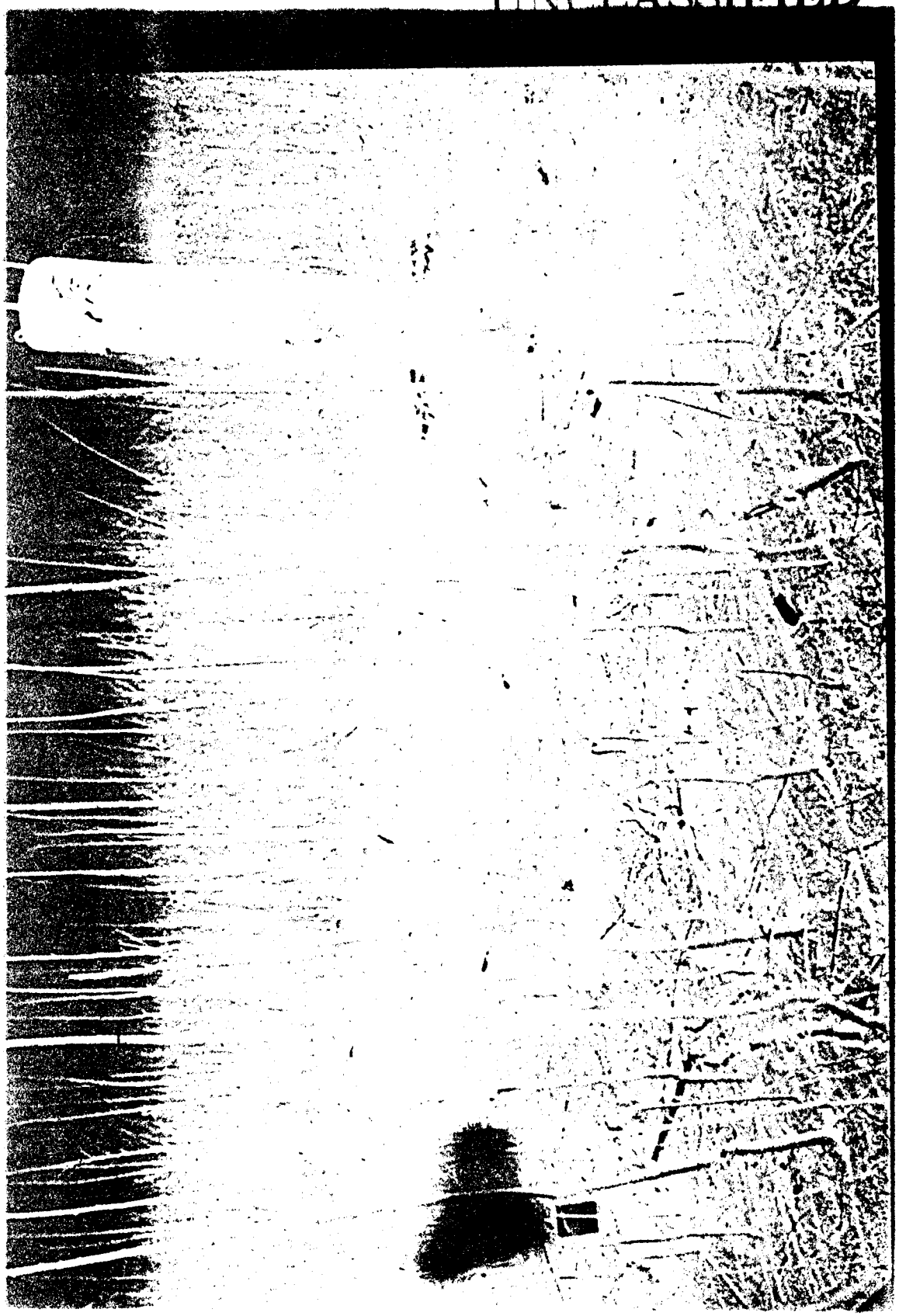


4. Overpressure Effects

Can sensors, as previously described, were randomly distributed over the test area. After collection, the amount of damage to the cans was recorded and interpreted as overpressure data. The amount of damage was scaled from "0" (no damage) to "3+" (complete crushing of the can from all directions). This information was then converted to an estimate of overpressure distribution, Figs. 12 and 26. This overpressure estimation roughly corresponds to defoliation data in Fig. 21.

D. Conclusions--Patricio Pavimentar Test

In the opinion of these investigators, the function of the device was within expected limits despite "cut-line" failure. Observations, documented photographically, confirm that:

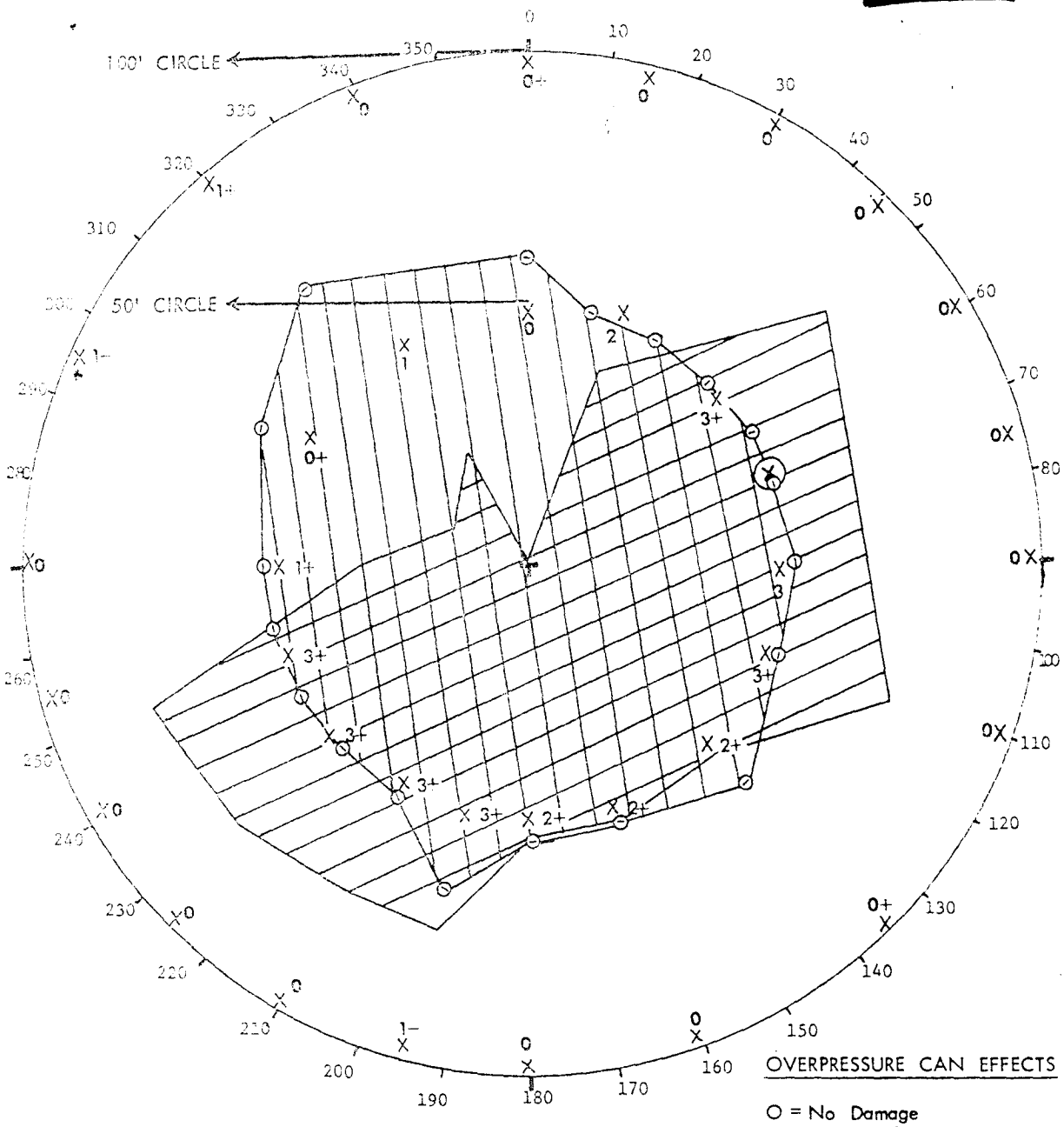
1. At remote electronic initiation, explosive charges expected to separate the distal section and release the MAPP gas contained in the tank did not function properly;
2. Cut-line charges initiated were sufficient only to open apertures as shown in Figs. 18, 19, and 20, allowing escape of the fuel within expectations and producing relatively good fuel distribution;
3. The gas cloud was in greater vertical profile than expected (20 feet), although dispersion in radius and diameter was adequate;
4. Ground emplaced initiators functioned well with expected electronic 3-second delay;
5. Craters were formed in unexpected locations--probably the unignited fuel was forced into small crevasses in the surface of the test area due to overpressures of combustion above these pockets.

II Pave Pat II

A. Device Function

The firing sequence in this test was essentially imperfect. Charges expected to eject the distal end of the tank and the initiator assembly and discharge the initiators were functional; initiator ejection and separation of the distal tank end was successful (Fig. 27). The ground emplaced initiator (5.5-second delay) did not detonate. Dispersion of the integral initiators was not as expected. Cloud formation was not as expected.

PATRICIO PAVIMENTAR TEST GZ #1 - CAN SENSOR DATA [redacted]

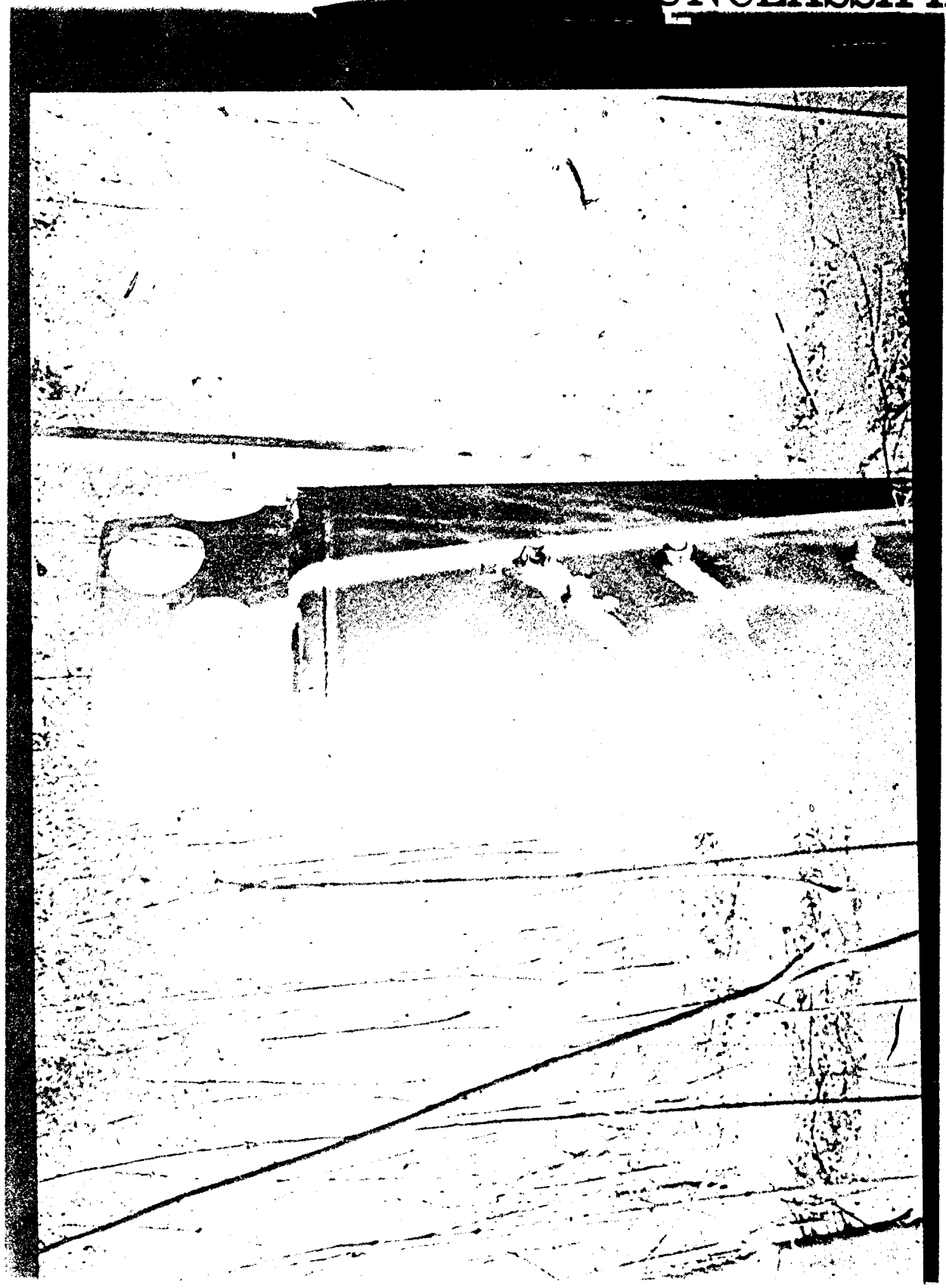


X - LOCATION OF CAN SENSORS AT 50 AND 100 FT.
(X) - CAN NOT RECOVERED
ESTIMATED OVERPRESSURE FORM, GZ AS ZERO, 50 FT. RADIUS CANS
ESTIMATED OVERPRESSURE FORM, 50 FT. AS ZERO, 100 FT. RADIUS CANS [redacted]

OVERPRESSURE CAN EFFECTS

O = No Damage
O+ = Discernable Damage
1- = Minimal Damage
1 = Minimal Damage Plus
1+ = Slight Damage
2 = Moderate Damage
2+ = Moderate-Severe
3 = Severe Damage
3+ = Crushed

Fig. 25 Patricio Pavimentar - Can Sensor Data (S)



B. Visual Observations--Ground Level

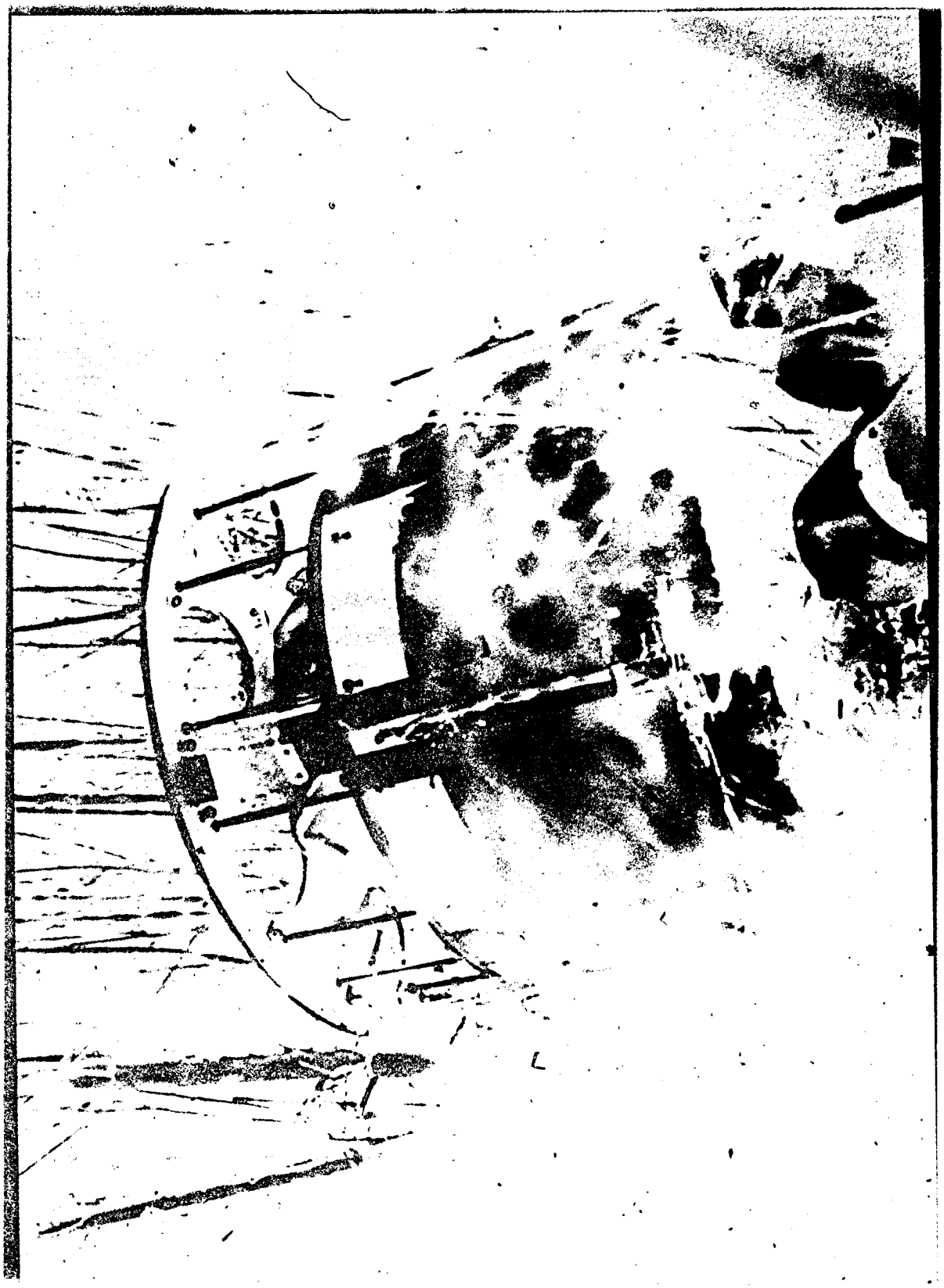
Conference and discussion with those staff members who were in a position to observe the test revealed the following:

1. The initiator assembly ejected to an altitude of approximately 200 feet (Fig. 28);
2. Simultaneously the MAPP cloud dispersed at a rapid rate, to an altitude of approximately 30 feet above the trees, with relatively horizontal distribution over an estimated diameter of 200 feet;
3. Roughly simultaneously (5-second delay) the initiators detonated with millisecond delays between detonations, such that initiator reports were heard as a brief, continuing series;
4. Three initiators detonated above the trees and foliage--one seemed to detonate in a northerly direction at an approximate altitude of 50 feet (Fig. 29 B), another detonated at approximately 25 feet in a southerly direction (Fig. 29 E), and another at an altitude of 20 feet in a westerly direction (Fig. 29 Y).

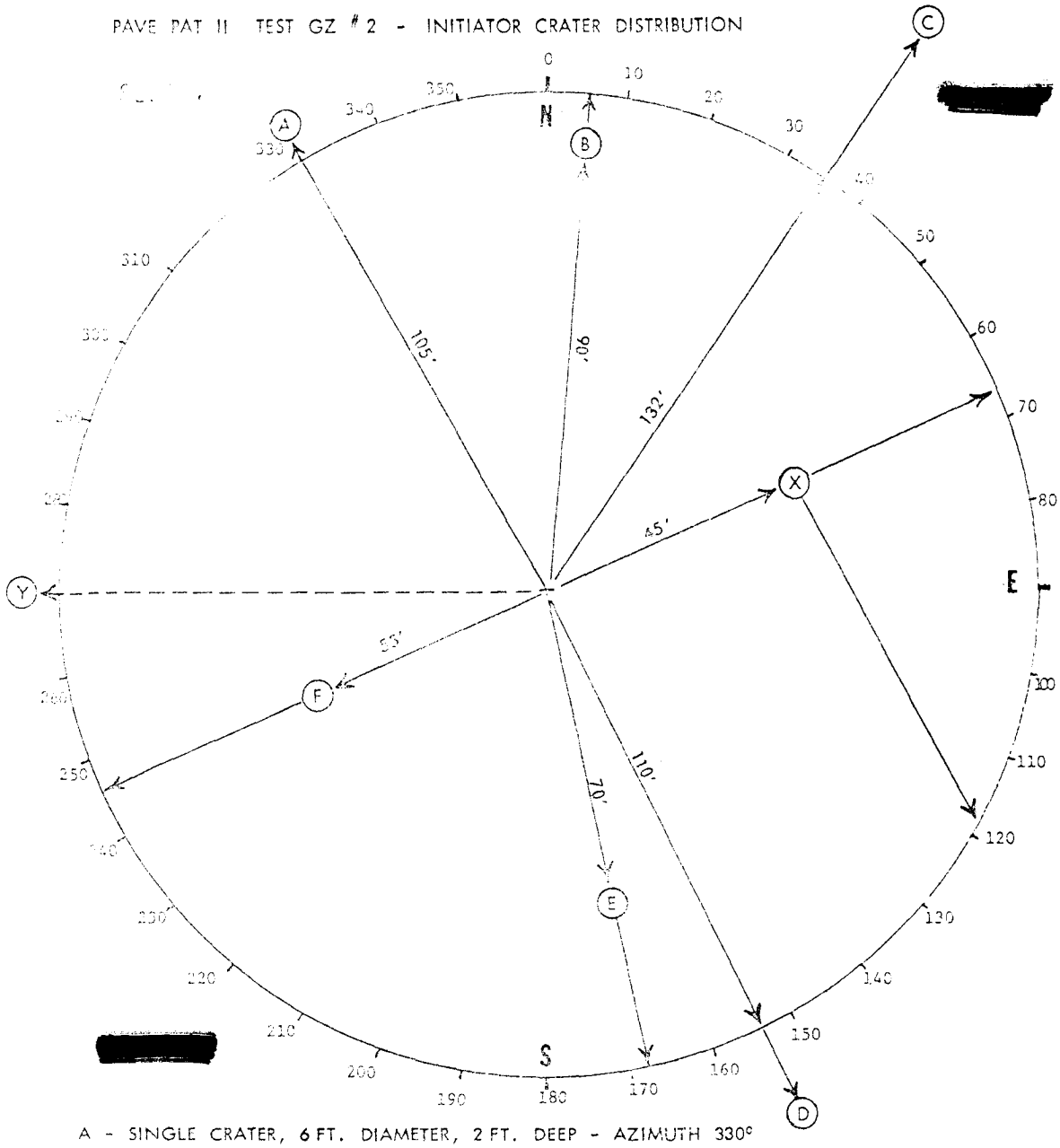
C. Physical Reconstruction of the Malfunction

1. Function of the Initiator Assembly

Craters resulting from initiator ejection and detonation are described in Fig. 29. Three single craters were located as A, C, and E. All three of these craters were at distances greater than expected; 105 feet, 132 feet, and 70 feet from the Pave Pat residual tank. The single emplaced initiator crater (Fig. 29 F) was located 55 feet from the ground zero. The two other areas of initiator detonation were not single crater effects; one was a group of small craters, ranging in size from 5 to 16 inches in diameter, 6 to 8 inches deep, spread uniformly over an area with a diameter of 9 feet (Fig. 29 D), with little defoliation or effects seen to surrounding foliage. This area was located at 05° from ground zero (essentially north, as shown on map in Fig. 1) and at a distance of 105 feet. The other crater group was at 110 feet and 154°, with small uniform craters ranging from 3 inches to 12 inches in diameter and 3 to 8 inches in depth (Fig. 30). The craters were located within an area 10 feet in diameter, where total destruction of the trees was found. An irregular area extending to 25 feet from center suffered 100% defoliation,



PAVE PAT II TEST GZ # 2 - INITIATOR CRATER DISTRIBUTION



A - SINGLE CRATER, 6 FT. DIAMETER, 2 FT. DEEP - AZIMUTH 330°
B - CRATER GROUP, SIZE RANGE 5 INCHES TO 16 INCHES DIAMETER AZIMUTH 05°, 9 FT. AREA DIAMETER
C - SINGLE CRATER, 7 FT. DIAMETER, 3 FT. DEEP, AZIMUTH 35°
D - CRATER GROUP, SIZE RANGE 3 INCHES TO 12 INCHES DIAMETER - AZIMUTH 154°, 25 FT. DEFOLIATION AREA
E - SINGLE CRATER, 6 FT. DIAMETER, 2 1/2 FT. DEEP, AZIMUTH 168°
F - IMPLANTED GRENADE LOCATION, 4 FT. DIAMETER CRATER WHEN DETONATED POST-TEST - AZIMUTH 246°
X - INITIATOR ASSEMBLY LOCATION - AZIMUTH 67° FACING 118°, HORIZONTAL MINUS 45°
Y - APPROXIMATE LOCATION OF INITIATOR AIR BURST AS PHOTOGRAPHICALLY CONFIRMED

NOTE: AREA OF 200 FT. RADIUS WAS SEARCHED FOR EVIDENCE OF 6TH INITIATOR CRATER

Fig. 28 Pave Pat II - Initiator Crater Distribution (S)

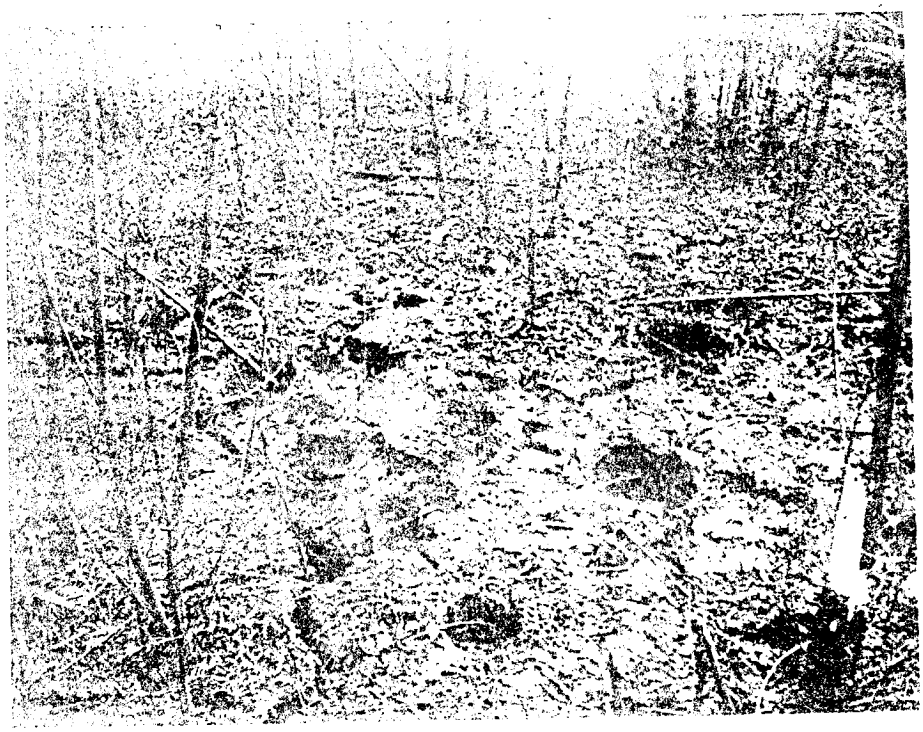


Fig. 29 Pave Pat II - Site of Initiator Airburst (S)

with gradual decrease to 0% defoliation at 35 to 38 feet from the center of the crater group (Fig. 31). Detonation of Initiator V (Fig. 29) did not result in ground cratering.

2. Dispersion of the Cloud

According to visual documentation, the MAPP cloud dispersed well over a large area, presumably above the trees. Fig. 31 describes the effects seen which can be interpreted as cloud dispersion effect. Although described as "charring", the effect seen on foliage was that of freezing rather than burning. This type of effect was most pronounced in the north, northeastern, and eastern quadrants, and extended 125 feet in these directions. Aerial photographic evidence indicates dispersion to about 50 feet prior to initiator detonation.

3. Specific Defoliation

As mentioned above, typical defoliation occurred only in the

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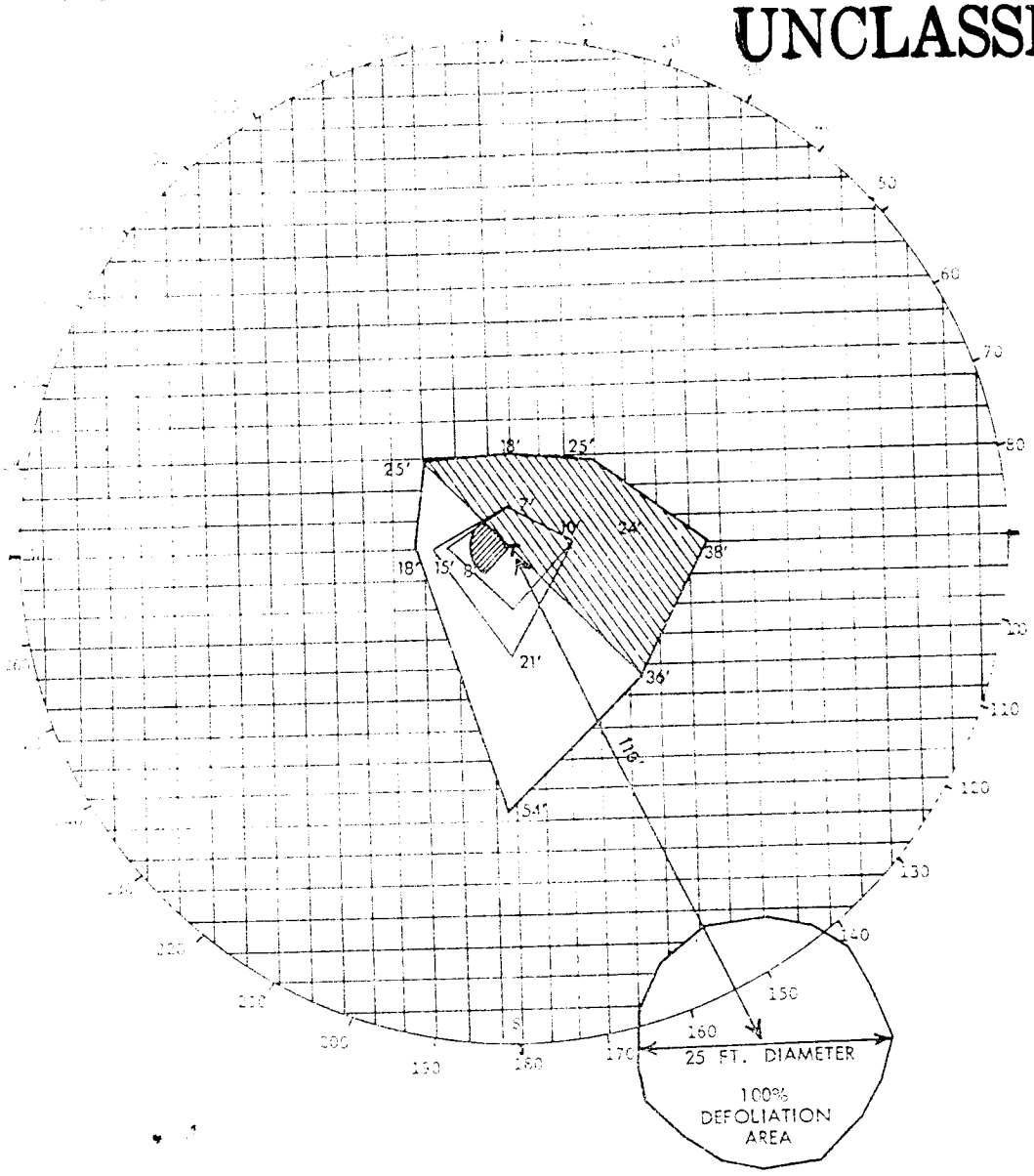

N - 80% DEFOLIATION TO 7 FT., TREETOP LEAF CHARRING TO 18 FT.
NE - TREE TOP LEAF CHARRING TO 25 FT.
E - 80% DEFOLIATION TO 10 FT., GROUND TO 6 FT. DEFOLIATION TO 24 FT., TOP LEAF CHARRING TO 38 FT.
SE - TREE TOP LEAF CHARRING TO 36 FT.
S - 100% DEFOLIATION TO 10 FEET, 50% TO 21 FT., 0% AT 54 FT.
W - 100% DEFOLIATION TO 8 FT., 80% TO 13 FT., 70% TO 15 FT., 0% AT 18 FT.
NW - TREE TOP LEAF CHARRING TO 25 FT.

NOTE: AREA OF 100% DEFOLIATION 25 FT. DIAMETER AT 110 FT. FROM GZ, 50% TO ZERO DEFOLIATION AT 35 FT. FROM CENTER

TREE TOP CHARRING OR FROSTING BURN

AREA OF COMPLETE DEFOLIATION, WITH ADMIXED CHARRING AND CARBONIZATION

Fig. 30 Fave Part II - Degree of Defoliation, 100-Foot Circle (S)

[redacted]

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southeasterly emplaced initiator area, which detonated presumably within the cloud at 110 feet (Fig. 31). This defoliation was typical of that observed with the Patricio device at the periphery, where burning did not occur and ignition was essentially complete.

[redacted] The random defoliation that occurred around the ground zero suggests proper ignition of the gas where it penetrated the foliage (Figs. 25 and 31). In this case, typical defoliation extended some 54 feet south, with 100% defoliation typically limited to 8 to 10 feet. As noted, some defoliation occurred from ground level to approximately 6 feet, suggesting dispersion of the gas some distance along the ground with consequent ignition, presumably from the tank cutting and initiator ejection charges.

D. Other Effects and Observations

[redacted] Some carbonizing and burning of the fuel was observed, as evidenced by the carbon residue at the tank unit (Fig. 25). This approximate area, although defoliated, was noted as an 8-foot triangular zone extending westerly from the tank unit (Fig. 31).

E. Can Sensor Effects

[redacted] No effects were noted out to 50 feet, which indicates that there were no overpressure changes sufficient for recording with this method of observation.

F. Vertical Reconstruction

[redacted] Fig. 32 graphically summarizes the opinion of these investigators as to the phenomena occurring at the time of the test.

1. Successful cut-line detonation allowed for dispersion of the gas over a large area; the cloud which formed was of high profile extending into the foliage little other than that observed as freezing close to the tank, and presumably little more at distances of 100 feet or more from the tank.
2. The integral initiators were discharged from the initiator assembly at the initial impulse of ejection and randomly thereafter at greater altitudes. The altitude of the initiator assembly was altered sufficiently by the pin-pulling plate and "T" bar assembly to increase the random distribution of initiators in the cloud when ejected.
3. Initiator detonation occurred

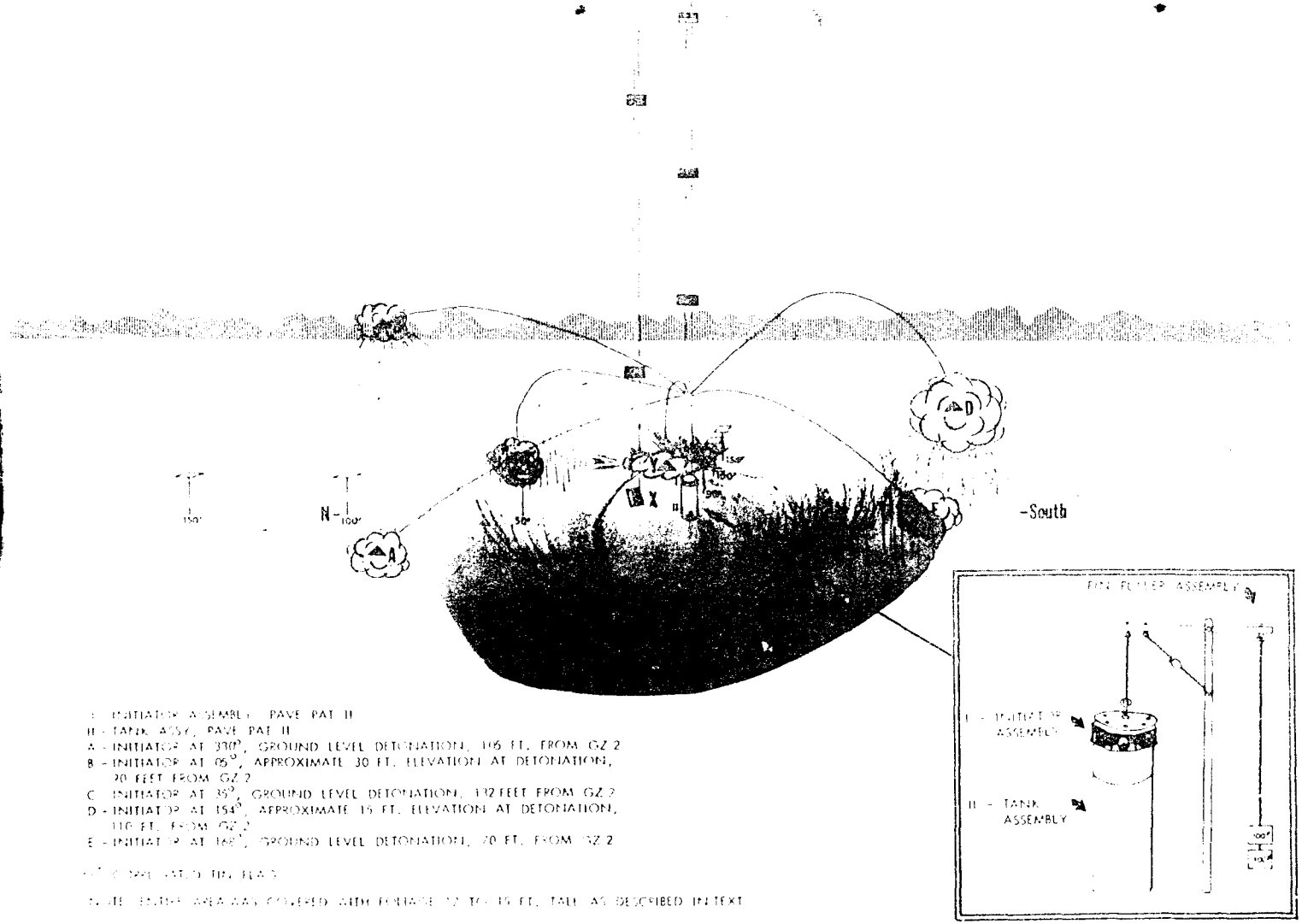


Fig. 31 Pave Pat II - Reconstruction of Test Malfunction (S)

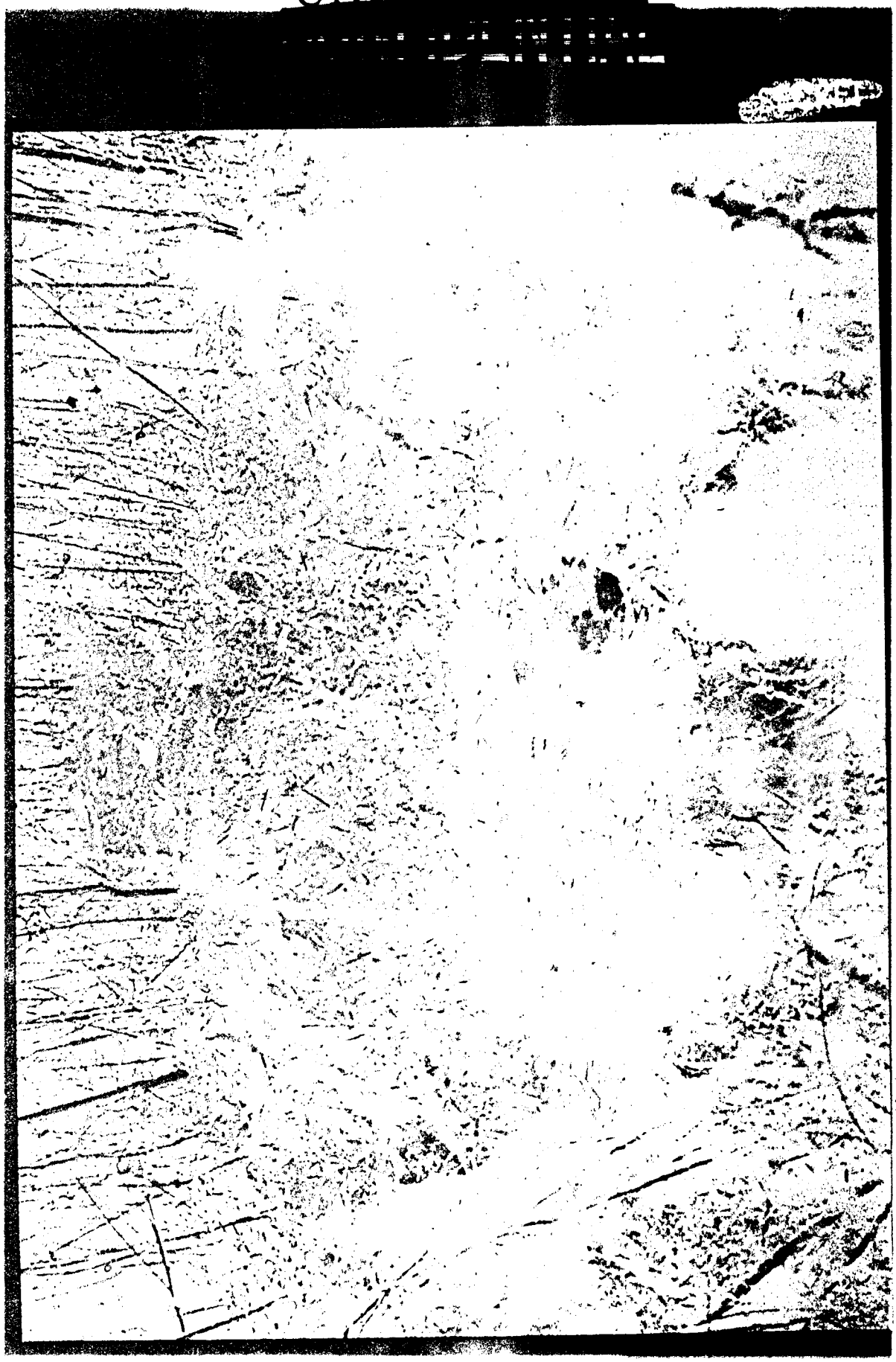
[redacted]

a. below the cloud in foliage (Fig. 29 A, C, E, and Figs. 32 and 33)

b. above the cloud, so as not to ignite the cloud (Fig. 29 B and Fig. 32)

c. essentially above the cloud, but somewhat within sufficient range to cause isolated detonation of a portion of the cloud (Figs. 29 and 32).

(U) No attempt has been made to consider the mechanical malfunction due to structural defect in the initiator assembly.

G. Aerial Marker System

None of the aerial markers (Fig. 34) was damaged as a result of the test. No other significant effects were noted.