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CLASSIFICATION CANCELLED
BY AUTHORITY OF DOE/OC
3/25/92
REVIEWED BY DATE
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~~OCTP Sibert dtd 5/22/91~~
DOE-COOLING DTD 9-27-91

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SWPWT/976.5

18 SEP 1958

SUBJECT: Biomedical Project 4.2, Operation HARDTACK, Second Phase (U)

RG 374 DEFENSE NUCLEAR AGENCY

TO: Chief of Research and Development
Department of the Army
Washington 25, D. C.

Location WNRC
Access No. 63-A1783 Box 3/3
Folder 976.5 HARDTACK-PROGRAM-1958

1. Inclosed herewith for your information is a copy of Confidential letter, MEDDH, Office of the Surgeon General, Department of the Army, 17 September 1958, subject: "Reappraisal of Biomedical Project "HARDTACK", with a copy of Inclosures 1 and 3 attached.

2. The existing Project 4.2 objectives were established in a meeting with your representatives in this Headquarters on 25 August 1958. In order of priority, those objectives were:

a. To determine the immediate lethal response of swine in an environment protected by normal tactical means (foxholes, tanks, and armored personnel carriers).

b. To obtain an RBE for weapon neutrons through determination of the LD 50/30 in a biological specimen from both the gamma and neutrons and gamma and fractional neutrons.

c. To provide additional back-up information on swine, the response of small animals (mice) to both gamma and neutrons will be studied.

d. Evaluation of additional radiation measurements and safety measures.

At that meeting, it was made clear that participation would be on a development shot for which neither the yield nor the shot date could be fixed in advance with precision. However, it was considered that the first objective, stated above, was of sufficient importance to justify an attempt at the experiment.

OFFICE SYMBOL	1.	2.	3.	4.	5.
GRADE AND					
SURNAME OF					
COORDINATING					
OFFICERS					

DRAFTER IDENTIFICATION:
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SWPWT/976.5
SUBJECT: Biomedical Project 4.2, Operation HARDTACK, Second Phase (U)

3. Although it is recognized that field conditions during the HAMILTON shot will not be ideal for effects programs, I believe the original objectives to remain valid and feasible. Therefore, I see no reason to change the content or priority of objectives, or to cancel the project. I have instructed the project to strive to obtain the best possible results under the prevalent conditions.

4. I believe that we all agree that the over-all primary objectives of the HAMILTON shot is the development of a weaponized device to meet Department of Defense military requirements. After a study of your message CRD/G 11898, of which we were an info addressee, it appears that our two offices share the same opinion on the objectives of the program and the desirability of proceeding as planned.

5. This headquarters has no objection to the inclusion of the field testing of AET as outlined in Inclosure 3 to above mentioned letter.

ET2406

1 Incl
Conf ltr, (Cy)
MEDDH, The Surg Gen,
D/A, 17 Sept 58,
w/Incl 1 and 3

EDWARD N. PARKER
Rear Admiral, USN
Chief, AFSWP

M/R: This ltr is forwarded to CHR&D DA, establishing Project 4.2, Objectives for HARDTACK Second Phase.

DNA

OFFICE SYMBOL	1. SWPWT	2. SWPET	3. SWPXX	4. SWPCH	5. AG
GRADE AND SURNAME OF COORDINATING OFFICERS		Holbert			Carrell

E69034

DRAFTER IDENTIFICATION: COL [redacted] LEDFORD (Rank or Grade, Surname) dpw 19 Sep 58 (Initials of Typist) 1B680 (Rm No) 56681 (Tel Ext)

[redacted]

DEPARTMENT OF THE ARMY
OFFICE OF THE SURGEON GENERAL
WASHINGTON 25, D. C.

65152

IN REPLY REFER TO
MEDDH

SEP 17 1958

SUBJECT: Reappraisal of Biomedical Project "Hardtack"

RG 374 Defense Nuclear Agency

TO: Chief
Armed Forces Special Weapons Project
Washington 25, D. C.

Location WNRC
Access No. 63-A1783 Box 3/3
Folder 976.5 Hardtack - Program - 1958

1. As a result of the rescheduling at the Nevada Test site with a new firing date of 12 October 1958, I asked Colonel Maupin to obtain from the Project Officer, Project 4.2, a statement of his capabilities and requirements. A copy of this report is attached. I have considered the suitability of the Eddy and the Grizzly events and feel that the Eddy shot will not give data applicable to the Army weapon. Consequently, this paper assumes participation only on Grizzly.

2. I believe that, inasmuch as additional swine can be obtained if contracted for this week, the Project can mount an effort which may secure useful data on all objectives provided the yield lies within the range of 15 ± 10 tons.

3. It is recognized that any other factors in addition to yield variability, such as postponements, failure in logistical support, additions to or around the device which would disturb radiation effects, will further reduce the probability of obtaining useful data.

4. Inasmuch as the Project is already in the field, the necessary animals can be obtained, and the experiment is well designed, I think participation should continue with a view toward obtaining any data possible under the circumstances.

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5. I concur in the requirements contained in the Project Officer's report and urge your assistance in meeting them. In addition, I am convinced of the feasibility, desirability and importance of the AET subproject requested in paragraph 2 of his recommendations. I request, therefore, that it be included, subject to non-interference with other projects.

6. With respect to recommendation number 1 in the attached report, I believe that the Project should proceed on the assumption that the requirements will be met to the extent that useful data may be obtained. I concur in recommendation number 3.

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MEDDH
SUBJECT: Reappraisal of Biomedical Project "Hardtack"

7. I am convinced of the capability of the medical unit under the Project Officer to take maximum advantage of all opportunities to effect a successful experiment. Nevertheless, there are additional factors, as mentioned in paragraph 3, above, and in the Project Officer's report, which may result in failure. A full knowledge and awareness of those factors must be recognized. Failure for any of those reasons lies beyond my control and responsibility.

8. I believe and hope that the Project will yield vital data applicable to this category of weapons as well as basic information of critical importance to the understanding of biomedical effects of nuclear weapons in general.

S. B. HAYS
Major General
The Surgeon General

3 Incls
1. Cy of Memo fr Proj Off 4.2 to Col Maupin subj "Capabilities of Proj 4.2 to Meet New Objectives and New Shot Date, Operation HARDTACK -- Phase II", dtd 15 Sep 58
2. Rpt 2, Proj 4.2, dtd 12 Sep 58, cy
3. Initial rpt, Proj 4.2, dtd 12 Sep 58, cy

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4

Project No. 4.2
Report No. 2
Date 12 Sep 5(

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EXPERIMENTAL PLAN

The DAVY CROCKETT weapon system was assembled to meet a specific tactical requirement - that of putting into the hands of the front line soldier a weapon that would reduce strong points which from past experience had not proven vulnerable to HE and at the same time would not deny extensive ground areas to our own troops. It was felt that these areas could be reduced by using radiation as the principle lethal factor. With the development of the weapon system it became a necessity to evaluate from the user's standpoint:

1. Can the weapon do what it is expected to do - deliver a lethal dose of radiation inside a protected environment, and

2. Is there safety for the "user" within the system?

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A. Objectives.

Previous field experimentation has developed the fact it is difficult to extrapolate from a physical measurement to a predicted biological response, particularly in a large animal, without considerable experience in correlation of these responses. It was therefore elected to evaluate this particular weapon system using biological specimens, and specifically to:

a. Determine the immediate lethality response of swine in protected (from blast and thermal) environment. (Sub-project 4.2.1)

b. To obtain a relative biological effectiveness (RBE) for weapons neutrons through determination of the mid-lethal dose of fifty percent of the animals exposed after thirty days ($LD_{50/30}$) in a biological specimen from both gamma and neutrons and gamma and fractionated neutrons. (Sub-projects 4.2.2 and 4.2.3)

c. Bonus radiation measurements are to be carried out; specifically:

1. Induced activity in Nevada soil, and

2. Chemical dosimeter calibration.

(Sub-project 4.2.4 (Program 2))

B. Background and Theory.

What is the immediate lethal dose for man? Most individuals refer to this dose synonomously with the immediate incapacitating dose for man. In a biological experiment, using large animals, this immediate incapacitating dose is extremely difficult to attain in the laboratory and is reported on by very few workers -- none of whom have used the swine as the experimental animal. In addition, any information on clinical incapacitation in a large animal would be very difficult, if not impossible, to extrapolate to man. Because of this we have selected the immediate lethal 5

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dose in the experimental animal as the criterion of tactical effectiveness of the system under evaluation. What is this dose in the pig? To our knowledge this is an unknown quantity. We do have data on the amount of bomb radiation - in air, plus burn - to result in lethality in the swine with a mean time of death of thirty hours. This dose was 15,050, the total rep delivered in conjunction 27.5 cal/cm^2 (ITR-1428, Operation PLUMBBOB). Massive doses, up to 46,000 r total body irradiation, have been delivered to the pig with the 2 MEV Van der Graaf at the National Institutes of Health with a dose rate of about 100 r/min. These animals have survived as long as three days.

Some programs teach 5000 r prompt whole body irradiation delivered to man is an immediately incapacitating dose. Some observers state that it might require 25,000 r to incapacitate man. No one quotes an immediately lethal dose. To evaluate the present system we have elected a minimum of 5000 r and would aim for the experimental animal to receive 25,000 r delivered to the animal in his particular shielded environment. Whether these dose levels can be achieved with the system without subjecting the environment to impossible blast over-pressures remains to be seen. It is doubted.

Bomb neutrons assume more and more importance the smaller the yield of the weapon. In the small weapons, such as we will evaluate it is of considerable importance because of the high neutron fluxes.

While the neutron RBE for acute effects for swine is not known for certain, it is known with a good degree of reliability for mice as a result of several previous field tests. The use of mice in the program will, thereafter, allow the use of a biological dosimeter as well as physical dosimeters, to measure the effective total dose of radiation delivered. The range in the literature for RBE extends from one of 0.3 to 2.0, with acute lethality as an end-point. In the swine, of the size it is projected we use, it might be as high as 1.8. To actually compute station distances from ground zero we have used an RBE of 1.3 for swine, and 1.7 for mice.

Considerable work has been done in an effort to measure separately the air dose and tissue dose due to gamma and neutron radiation. An all inclusive technique encompassing all significant variables, adaptable to field use, and of acceptable accuracy, has yet to be demonstrated. More success has been obtained in the measurement of gamma radiation than for neutron fluxes, but there remain many unsolved problems in both. (See Appendix A)

C. Operation.

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Sub-project 4.2.1. Eighty-seven swine. To determine immediate lethality it is required to observe visually these animals that are positioned in the protected - from blast and thermal - environment. "Immediate" has been said to be as soon as the observers can enter the area within the safety limits as set up by the Test Director. If it is determined that observers cannot enter the area until as long as H + 2 - 3 hours, then any finding would, of necessity, have to be extrapolated.

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Sixty foxholes -- 24 open foxholes (()- Fig 1), 24 two-thirds closed foxholes (# - Fig 2) and 12 off-set foxholes (O - Fig 3) will be positioned from 5 yards to 40 yards from ground zero. At these distances it is calculated these fortifications will receive inside 25,000 rem -- using a weapon yield of 10 tons -- spread from 5 to 20 tons. There are five M-46 tanks positioned at 25, 35, 45, 55 and 65 yards from ground zero. Two M-59 armored personnel carriers are positioned at 60 and 70 yards from ground zero. These armored vehicles are positioned such that the calculated dose delivered inside the vehicle is 25,000 rem. Each of these shelters will contain one instrumented pig (See Appendix A), and others if available.

To evaluate protection for the user, animals are stationed in open pens at 650, 700, 750, and 800 yards from ground zero. Simple clinical evaluation for a minimum of 21 days post-exposure is carried out.

Sub-project 4.2.2. Three hundred and sixty swine. Swine weighing 70 to 90 pounds are exposed on two axes from ground zero in such a fashion that one axis (south) is to receive a high neutron flux -- gamma ratio dose (3:1) and the other (west) is to receive a low neutron flux -- gamma ratio dose (1:2). (See D. Shot Participation) The animals are exposed as on previous field experiments in aluminum cylinders at 15 yard intervals on the west line and 20 yard intervals on the south line and at such distances that the animals exposed receive from 300 - 700 rem in air. There are fifteen points on each line and ten of the fifteen points have three internally dosimetered animals (Appendix A) to correlate with measured air dose. After exposure the animals are observed clinically for a minimum period of thirty days. Swine receiving lethal levels of radiation will be observed at four hour intervals, and all others are observed on an eight hour schedule.

These animals which have been altered by having been internally dosimetered are evaluated with peripheral white blood count (WBC) and differential. Examinations are made pre-irradiation, for back-ground, and at least on the 2nd, 4th, 6th, 8th and 10th days after exposure to the weapon. Additional counts are made up to 21 days post-irradiation dependent upon the response observed during the 10-day post-irradiation period. All WBCs are by the "pin-head" technique. In addition a parallel study of the blood from at least one animal from each point will be evaluated by the standard chamber counting method.

All swine are weighed prior to exposure and on the 3rd, 7th, 10th, 14th and 21st days after irradiation.

Irradiated swine from all stations are observed at least twice daily for signs of epilation, melena, hematemesis, central nervous system disturbances and other untoward clinical symptoms.

All animals dying during the observation period will have as sophisticated a post-mortem study as is required to estqblish the cause of death for support of the program.

Concomitantly, a control $LD_{50/30}$ study is carried out at Walter Reed Army Institute of Research. Sixty animals, of the same group utilized at

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the NTS, are exposed to high energy x-irradiation at six exposure points straddling a previously determined $LD_{50/30}$ of 500 rep. Animals are exposed at the National Institutes of Health under the 2 MEV Van der Graaf unit at the time the animals are exposed to weapon irradiation.

Sub-project 4.2.3. Nineteen hundred and twenty Walter Reed - BAGG strain of mice. Only female mice are exposed, weighing approximately 25.0 grams at exposure. The axes for animal placement parallel that for the swine, and, as such, on one axis the total dose of irradiation consists of at least 80% neutron flux (south axis). This is feasible on the basis of weapon geometry and without sophisticated shielding other than to avoid the thermal flux and to prevent blast injury. The second axis for animal placement is such that the total dose of irradiation delivered consists of 80% gamma with 20% neutron flux contamination (west axis). Animals are exposed in aluminum and lead hemispheres (ITR-1167, Operation TEAPOT-Classified) in such a fashion that there are fifteen aluminum stations on each axis and on the south axis there are fifteen lead hemispheres. Disposition is such that the stations cover a dose range of 300 to 1000 rem, with forty mice at each point.

As soon as possible after exposure the mice are recovered and returned to the animal facility. Twenty mice from each point will be simply observed, with death as an endpoint, for thirty days ($LD_{50/30}$). Ten mice from each point are to be sacrificed at 96 hours, and ten mice sacrificed serially over the 30 day observation period. At sacrifice the following are carried out:

1. net spleen weight
2. thymus weight
3. small intestine weight
4. total peripheral white cell count
5. differential white cell count
6. gross body weight
7. total bone marrow count of the right femur
8. and appropriate histological sections are fixed as demanded.

Control mice for serial sacrifice are given identical field handling and exposure conditions, but without actual radiation exposure. At Walter Reed Army Institute of Research, after return from NTS, mice of the same strain, age, weight, etc. are to be subjected to an $LD_{50/30}$ study with analysis of parameters identical to the field study. This should make RBE estimates even more reliable.

Sub-project 4.2.4. See Program 2 experimental plan.

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D. Shot Participation.

Ideally any biomedical effects program must have a predictable yield to obtain significant data. In addition, to obtain a fractionated neutron-gamma flux a shield is placed on the low neutron flux axis (west) to get radiation levels that contribute to an RBE program. Because of the requirement to visually observe the animals in the protected environment, and to document with photography, if possible, their clinical course, time of detonation of the weapon is such that there will be daylight for recovery. Because excessive periods without water alters the experimental animal, he tolerates it very poorly, and it contributes significantly to morbidity, and maybe mortality.

We position the animals for exposure at a maximum of H - 5 hours. Repeated handling and excessive travelling in vehicles is poorly tolerated by the swine, and if the animals are transported and positioned more than twice on successive days they must be allowed a four to five day period to recover. In the event the device detonates "one-point", with resultant contamination of the area, or the device detonates with an insignificant nuclear yield some animals will be available to participate on an extremely limited scale, within 10 days.

F. Instrumentation.

Air gamma and neutron measurements are made on three axes - north, south and west. Swine have mid-line gamma and gamma-neutron chemical dosimeter systems. (See Appendix A)

To complement visual observation of lethality in the 4.2.1 program a system of telemetering electrocardiographic (ECG) signals from fifteen selected swine at the closer in stations is considered feasible. With this method immediately post-detonation these stations are scanned by receivers and if no signal is returned the animal is presumed dead until visual confirmation is carried out. In addition, protected from blast, are transistorized direct-writer recorders recording from each of the fifteen instrumented animals pulse and respiration rates (PR & RR). At this moment of reporting, timing signals are required in support of this program.

Present Status.

Complete implementation of the experimental plan of Project 4.2 awaits only definitive weapon information and date of detonation.

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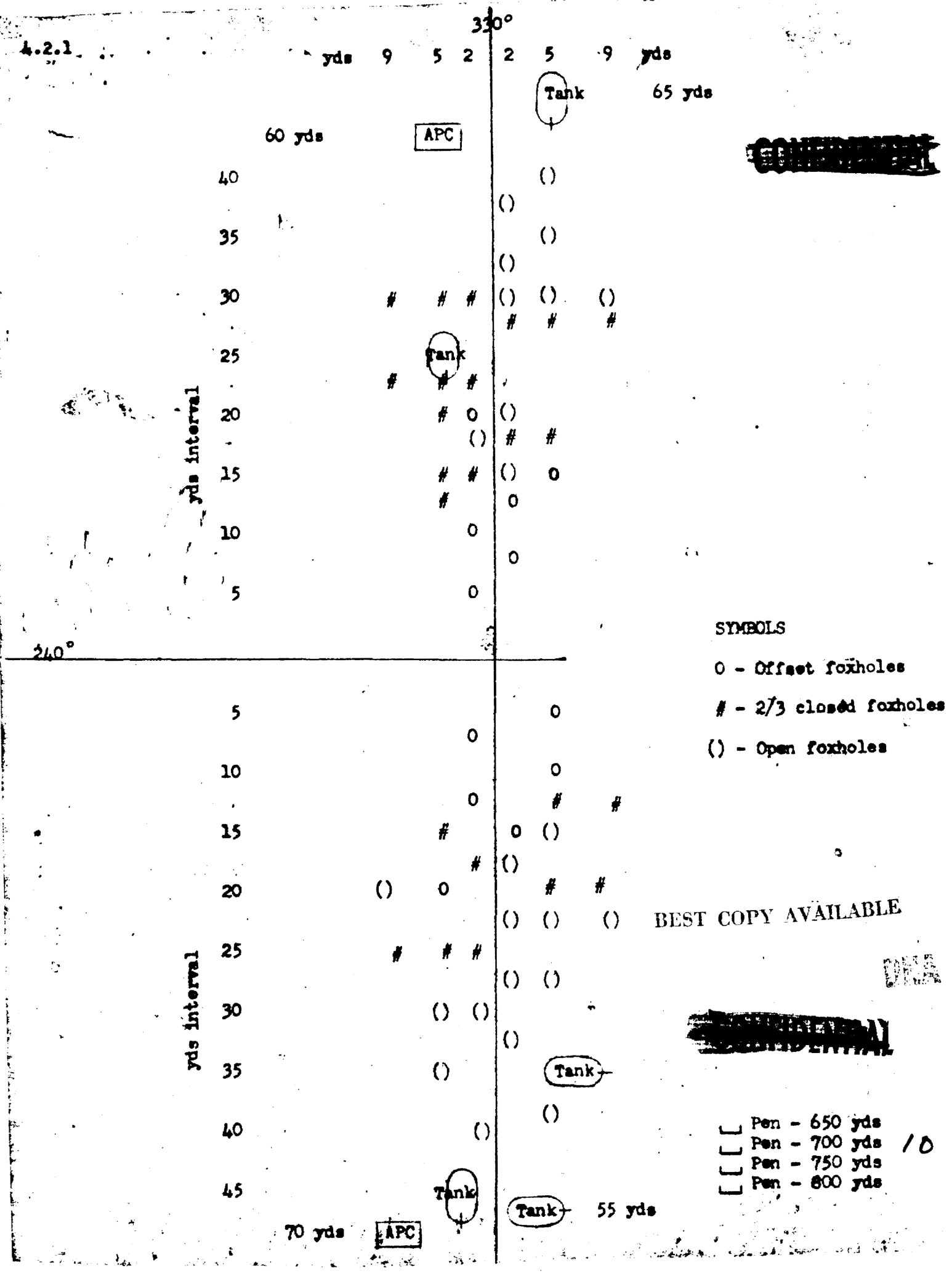
4.2.1



SYMBOLS

0 - Offset foxholes

- 2/3 closed foxholes

() - Open foxholes

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Pen - 650 yds
Pen - 700 yds
Pen - 750 yds
Pen - 800 yds

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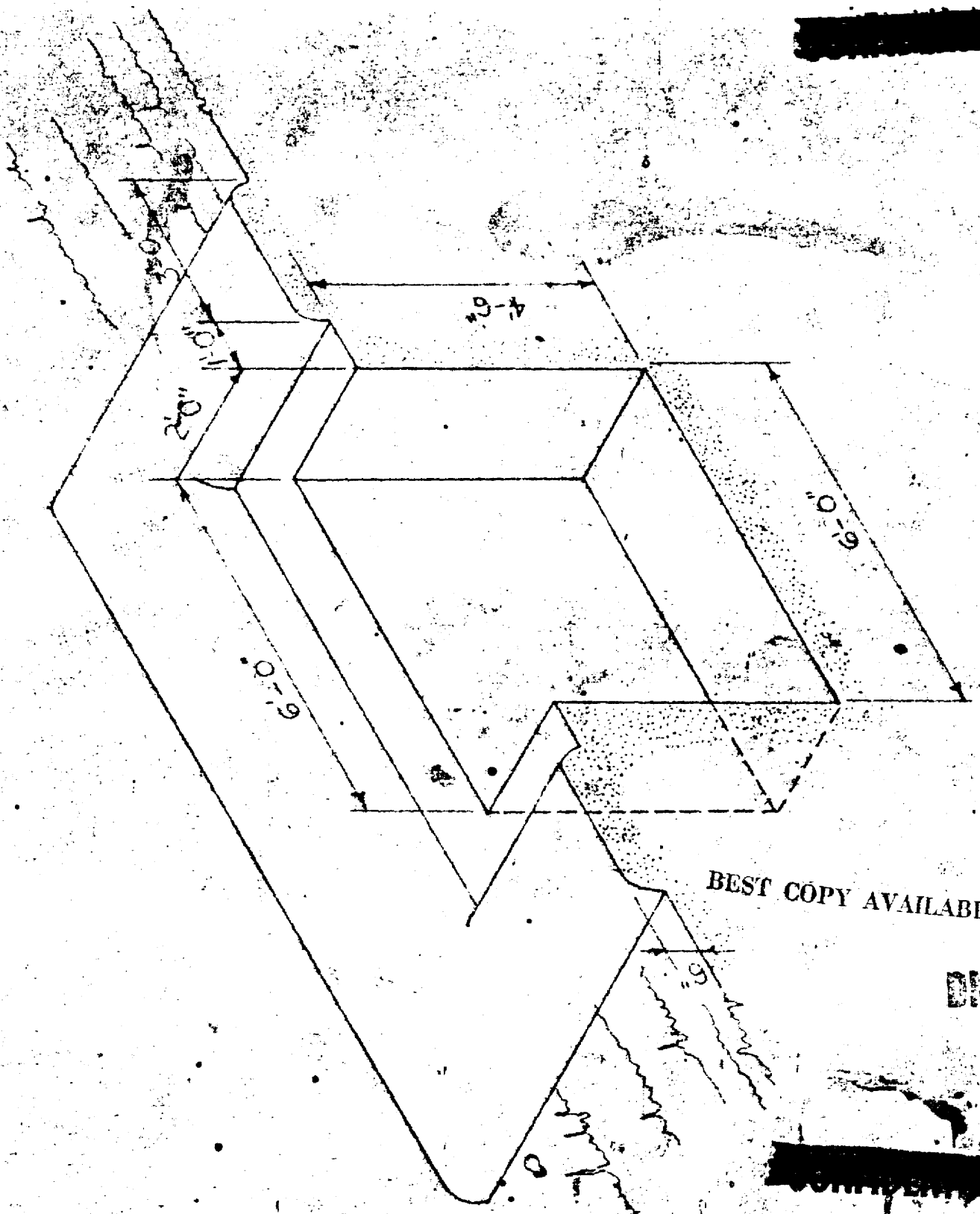

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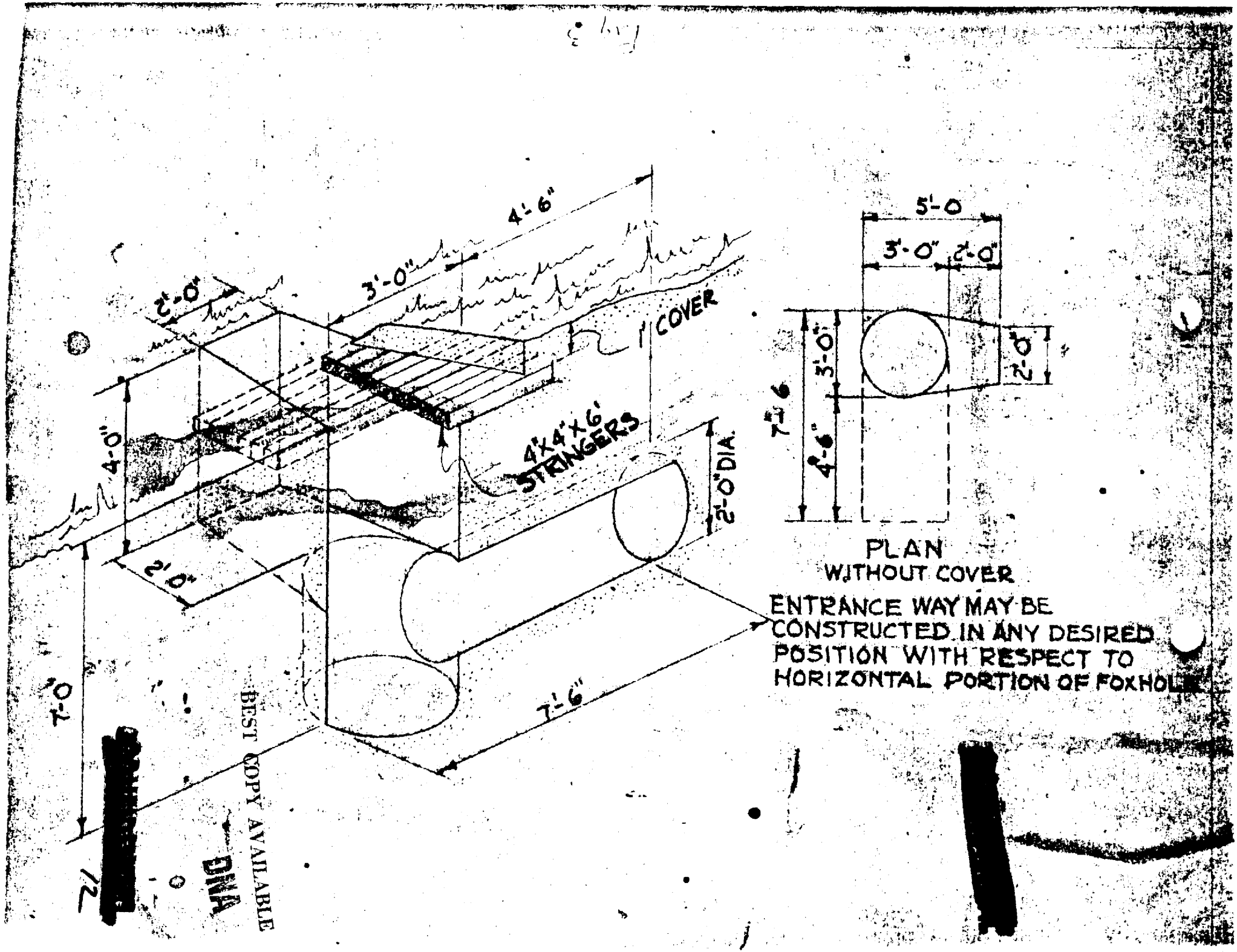

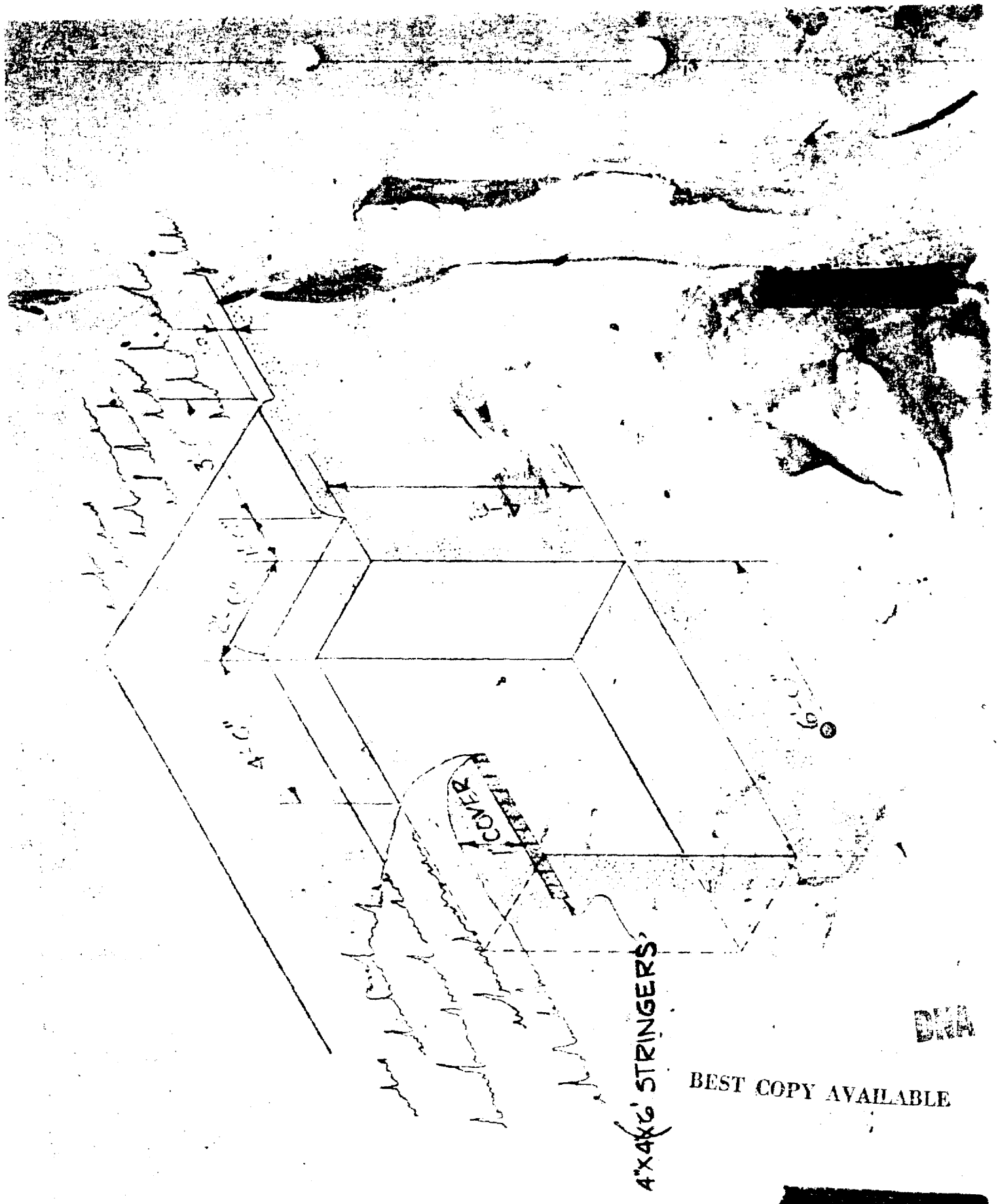

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INCOMPLETE DOCUMENT REFERENCE SHEET

The archive copy of this document is incomplete.

Pages missing _____

Enclosures missing (1) cy of Memo fr Proj Off 4.2 To Col Maupin subj "Capabilities of Proj 4.2 To Meet New Objectives + New Shot Date, Operation Hardtack -- Phase II", dtd 15 Sept. 58 (3) Initial Rpt, Proj 4.2, dtd 12 Sept. 58, cy

Attachments missing _____

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Other _____

Dick Koogle
signature

4-18-90
date

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