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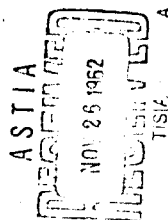
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DESIGN MODIFICATIONS AND 1962 COST ANALYSIS
FOR A STANDARDIZED SERIES OF FALLOUT SHEILDERS

by
Lewis G. Porteous

prepared for the
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DEPARTMENT OF DEFENSE



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U. S. NAVAL RADIOLOGICAL DEFENSE LABORATORY
S A N F R A N C I S C O 2 4 . C A L I F O R N I A

COUNTERMEASURES EVALUATION BRANCH
R. Cole, Head

MILITARY EVALUATIONS DIVISION
C.F. Ksanda, Head

PRICE QUOTATIONS AND MATERIAL SOURCES

An attempt has been made in this study to present factual cost data. Cost data: search provided material source information and this information has been included in the report. Because of the large number of items required for each of the sketches described in this report, time was not sufficient to permit searching out every possible supplier of the desired manufactured products. One or more product sources have been listed in Appendices A and B of the report for each item required. However, no limitation is made (1) that these are the only sources for the items listed, nor (2) that these sources in particular are approved or preferred by this Laboratory or the Navy Department or the Office of Civil Defense.

Ernest P. Cooper
D. E. P. Cooper
Scientific Director

E. B. Roth
Captain E. B. Roth, USN
Commanding Officer and Director

ADMINISTRATIVE INFORMATION

This study was conducted for the Department of Defense, Office of Civil Defense, under work order No. OSD-OS-62-40, Project 1607, dated 12 Jan 1962 (Amendment No. 5 to Agreement DDM-SR-59-54).

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ABSTRACT

Major emphasis is on recent design modifications and 1962 cost estimates for the personnel fallout shelter described in HENRIG-WR-366, Specifications and Costs of a Standardized Series of Fallout Shelters (1959). The shelter is designed to accommodate at least 100 persons for 14 days. It is believed that the shelter will provide the specified fallout and blast protection, the required interior environment, and the essential "hotel-type" equipment at minimum cost. The shelter items are specified by several packages, each having one or more different arrangements of items, depending on the degrees of protection and comfort desired. The proper selection of packages will result either in a 35-psi or 10-psi blast and fallout shelter sited above or below grade. The radiation protection factor is at least 1000. "Most austere" to "least austere" living accommodations can be selected. Average cost data for the packages by item are tabulated for quantities up to 1000. Respective costs (less overhead, profit, etc.) for four complete shelters (combinations of most austere and least austere with 35-psi and 10-psi) have been estimated and are presented graphically. Costs for shelter quantities were estimated by means of learning curves. The costs range (one-off) from \$19,800 for the least-austere 35-psi shelter to \$14,200 for the most-austere 10-psi shelter. The design modifications are based on findings of the HENRIG Shelter Research Program for the period, 1959 to June 1962.

SUMMARY PAGE

The Problem

late design modifications in the prototype shelter, constructed at Camp Parks, California, in 1959, and in the other shelter systems described in Ref. 1 (1959), in order to increase utility with emphasis on cost reductions.

evaluate protective and operational characteristics of the series of shelters and modify design as required.

Determine 1962 costs of shelter items and installation.

Findings

The shelter design given in Ref. 1 has been modified on the basis of shelter engineering evaluation, actual construction experience, and experimental firestorm and occupancy experience gained from the USMHL shelter research program. The design modifications and construction details are given in the construction drawings of Appendix "A." It is believed that the modified shelter will provide the specified blast and fallout protection, the required interior environment, and the essential living accommodations at minimum cost. The drawings are for both above-ground and belowground 100-person shelters having a shelter residual number of no more than 0.001 and a blast protection rating of at least 35-psi overpressure.

The average 1962 costs in quantities to 1000 of all items that have been specified for the standardized series of shelters have been estimated (see tables in Appendix B). These costs have been compared with 1959 estimated costs; the comparisons, with comments, are shown in Table B of Appendix B. For example, the 1959 estimated costs of the most austere 35-psi shelter for single and mass installations are \$14,100 and \$11,800, respectively, compared with the 1962 estimated costs of \$16,800 and \$12,000. During the period 1959 through 1962, the increase in labor and material costs makes one of the primary purposes of the study, namely, modifying the component design with a view to reducing costs.

The total average 1962 costs of four classes of shelters (10 and 35-psi shelters each provided with two levels of living accommodations) in quantities to 1000 have been estimated (see Fig. 2). The total average 1962 costs have also been estimated for three classes of shelters (least austere and 10-psi, most austere and 10 psi, and 35 psi) which include only the basic-shelter, entrance, and installation packages (see Fig. 3). (Such shelters could be used for civil defense control and communication centers or for military and civilian command control center having limited personnel and hence would not necessarily be equipped with such packages as the ventilation, hotel, auxiliary power, and electrical packages as proposed for the 100-man shelters.)

Recommendations

Recommendations are made for further investigation before implementing a national shelter program. These recommendations, which are discussed in detail in Section 5, include:

Theoretical analysis and field testing of single flexible steel arches under megaton-detonation blast loading.

Studies on adequate spacing between multiple flexible-steel-arch structures positioned side by side.

Studies on static and dynamic response of soils of interest under megaton-detonation blast loading.

Determination of fundamental performance specifications for a national protective shelter system.

Determination of adequate radio equipment for national and local shelter systems.

Field test of the fire protection package.

Study of shock-proofing requirements for equipment and facilities inside the basic structure and entrance way of the shelter.

Study of the effects of shock and blast loading on the small buried fuel and water storage tanks and their piping systems.

TABLE OF CONTENTS

TABLE OF CONTENTS (con't)

	Page		Page
PRICE NOTATIONS AND MATERIAL SOURCES.....	1	SECTION 4 DISCUSSION OF RESULTS.....	9
ADMINISTRATIVE INFORMATION.....	1	SECTION 5 RECOMMENDATIONS FOR FURTHER INVESTIGATION.....	12
ACKNOWLEDGMENTS.....	1	5.1 GENERAL.....	12
ABSTRACT.....	1	5.2 THEORETICAL ANALYSIS AND FIELD TESTING OF SINGLE	
SUMMARY PAGE.....	11	5.2 FLEXIBLE STEEL ARCHES UNDER NEGATION-DEFORMATION	
TABLE OF CONTENTS.....	111	5.2 BLAST LOADING.....	12
LIST OF FIGURES.....	iv	5.3 STUDIES ON ADEQUATE SPACING BETWEEN MULTIPLE	
LIST OF TABLES.....	v	5.3 FLEXIBLE-STEEL-ARCH STRUCTURES POSITIONED	
		5.3 SIDE BY SIDE.....	13
SECTION 1 INTRODUCTION.....	1	5.4 STUDIES ON STATIC AND DYNAMIC RESPONSES OF SOILS	
1.1 BACKGROUND AND PROBLEM.....	1	5.4 OF INTEREST UNDER NEGATION-DEFORMATION BLAST LOADING.....	13
1.2 OBJECTIVES AND APPROACH.....	2	5.5 DETERMINATION OF FUNDAMENTAL PERFORMANCE SPECIFICATIONS	
1.3 LIMITATIONS OF RESULTS.....	2	5.5 FOR A NATIONAL PROTECTIVE SHELTER SYSTEM.....	13
SECTION 2 DESIGN MODIFICATIONS BY PACKAGES.....	2	5.6 DETERMINATION OF ADEQUATE RADIO EQUIPMENT FOR NATIONAL	
2.1 GENERAL CONSIDERATIONS.....	2	5.6 AND LOCAL SHELTER SYSTEMS.....	14
2.2 BASIC-SHELTER PACKAGE.....	2	5.7 FIELD TEST OF FIRE PROTECTION PACKAGE.....	14
2.3 ENTRANCE PACKAGE.....	4	5.8 STUDY OF SHOCK-PROOFING REQUIREMENTS FOR SHELTER	
2.4 VENTILATION PACKAGE.....	4	5.8 FACILITIES AND EQUIPMENT ITEMS.....	14
2.5 HOTEL PACKAGE.....	4	5.9 STUDY OF THE EFFECTS OF SHOCK AND BLAST LOADING ON	
2.5.1 Bunk System.....	4	5.9 SPALL, BURIED FUEL AND WATER STORAGE TANKS.....	14
2.5.2 Furniture.....	5		
2.5.3 Water, Fuel, and Sanitary Tanks.....	5	APPENDICES	
2.5.4 Sanitary-Rack Platform and Curtains.....	5	A CONSTRUCTION DRAWINGS.....	15
2.5.5 Water and Fuel Piping.....	5	B COST TABLES.....	55
2.5.6 Emergency Exit Tools.....	5	C HISTORY OF BUNK-SYSTEM TESTING AND DEVELOPMENT.....	117
2.5.7 Habitability Equipment and Items.....	5	D DISCUSSION OF AIR-HANDLING ASPECTS TO ILLUSTRATE	
2.5 CONTROL PACKAGE.....	5	DEEDED FOR FUNDAMENTAL PERFORMANCE SPECIFICATIONS.....	119
2.6.1 Radio Transceivers.....	5		
2.6.2 Radiation Detection Equipment.....	5	REFERENCES.....	121
2.6.3 Periscope.....	5		
2.7 AUXILIARY POWER PACKAGE.....	6		
2.8 FIRE PROTECTION PACKAGE.....	6		
2.9 INSTALLATION PACKAGE.....	6		
2.10 ELECTRICAL PACKAGE.....	6		
SECTION 3 COST ANALYSIS OF PACKAGES BY ITEM.....	7		
3.1 GENERAL.....	7		
3.1.1 Scope of Cost Data Used.....	7		
3.1.2 Method of Estimating Multiple-Unit Item Costs.....	7		
3.2 COST ESTIMATES.....	8		

LIST OF FIGURES

No.		Page
1	Isometric Cutaway Drawing of Modified Shelter.....	3
2	Average Cost Per Shelter Vs Number of Shelters for Minimum and Maximum 10-psi and 35-psi Shelters.....	10
3	Average Cost of Only the Basic Shelter, Entrance, and Installation Packages Vs Number of Shelters for the 35-psi Shelter and the Minimum and Maximum 10-psi Shelters.....	11
A-1M	General Configurations.....	17
A-2M	Foundation, Floor Slab, and Deadman Arrangement.....	19
A-2M-1	Shelter Sidewall Foundation Details.....	21
A-2M-2	Shelter Endwall Foundation Details.....	23
A-3M	Entrance and Endwall Support Details.....	25
A-4M	Entrance Details I.....	27
A-5M	Entrance Details II.....	29
A-6M	Ventilation System.....	31
A-7M	Exhaust Vent Arrangements.....	33
A-8M	Exhaust Vent Details.....	35
A-9M	Hotel Arrangements and Air Conditioning Details.....	37
A-10M	Berthing Facility Arrangement and Details.....	39
A-11M	Sanitary Facility Arrangement and Details.....	41
A-12M	Electrical Arrangement.....	43
A-13M	Shelter Periscope Schematic.....	45

LIST OF FIGURES (Con't)

No.		Page
A-14M	Periscope and Antenna Mounting.....	47
A-15M	Ventilator Cap for Control Package.....	49
A-16M	Electrical Generating Plant.....	51
A-17M	Water and Fuel Tanks.....	53
	(Note: Suffix M denotes modified Ref. 1 drawing. Suffix N denotes new drawing.)	

LIST OF TABLES
(Appendix B)

LIST OF TABLES (con't)
(Appendix B)

No.		Page	No.		Page
1	1962 Material and Labor Costs by Items for Basic-Shelter Packages	57	19	1962 Material and Labor Costs for Fire Protection Package Items	103
2	Unit Cost Differentials for Basic-Shelter Package Items	58	20	Unit Cost Differentials for Fire Protection Package Items	104
3	1962 Summary Costs for Basic-Shelter Packages	59	21	1962 Summary Costs for Fire Protection Packages	104
4	1962 Material and Labor Costs by Item for Entrance Package	60, 61	22	1962 Material and Labor Costs for Installation Package Items	105, 106
5	Unit Cost Differentials for Entrance Package Items	62, 63	23	Unit Cost Differentials for Installation Package Items	107, 108
6	1962 Summary Costs for Entrance Packages	64, 65	24	1962 Summary Costs for Installation Packages	109
7	1962 Material and Labor Costs for Ventilation Package Items	66, 67	25	1962 Material and Labor Costs for Electrical Package Items	110, 111
8	Unit Cost Differentials for Ventilation Package Items	68, 69	26	1962 Summary Costs for Electrical Packages	112, 113
9	1962 Summary Costs for Ventilation Packages	70-73	27	Electrical Package for a Given Combination of Hotel and Ventilation Packages	113
10	1962 Material and Labor Costs for Hotel Package Items	74-79	28	Percentage Contributions of Packages to Total One-Of Shelter Cost for Four Package Combinations	114
11	Unit Cost Differentials for Hotel Package Items	80-85	29	Comparison of 1959 and 1962 Total Shelter Costs	115
12	1962 Summary Costs for Hotel Packages	86-90			
13	1962 Material and Labor Costs for Control Package Items	91, 92			
14	Unit Cost Differentials for Control Package Items	93			
15	1962 Summary Costs for Control Packages	94			
16	1962 Material and Labor Costs for Auxiliary Power Package Items	95-97			
17	Unit Cost Differentials for Auxiliary Power Package Items	98, 99			
18	1962 Summary Costs for Auxiliary Power Packages	100-102			

SECTION 1

INTRODUCTION

1.1 BACKGROUND AND PROBLEM

Reference 1 describes in detail the prototype underground shelter designed by USNRDL for the Bureau of Ships and the Office of Civil Defense and constructed at Camp Parks, Pleasanton, California. This shelter was designed to provide personnel protection against radioactive fallout from nuclear detonations, with some consideration given to protection against blast, heat, and mass fire. The shelter was designed on the basis of experimental data and experience obtained up to 1959, and its unit cost was estimated with 1959 data.

Reference 1 also discusses the importance of protective shelters, the basic concepts and factors that were considered in designing the prototype shelter, and the experimental and calculated data that were used. In addition, this reference presents, for the prototype shelter, the performance specifications, the design drawings for the several "packages" composing the shelter, and detailed cost estimates for the items in each package. Each package provides a choice among several alternative arrangements of items depending on the protection and comfort levels desired.

The shelter performance specifications are summarized as follows:

1. Shielding against residual (fallout) gamma radiation, with an attenuation factor of at least 1000.
2. Protection against 35-psi side-on blast overpressure from a nuclear air burst of at least 40-KT yield.
3. Protection for 100 people of all age groups and both sexes.
4. An entrance way permitting entry of 100 people within 5 minutes, and an adequate emergency exit.
5. Capability for manual seal-up of the shelter for a 24-hour period.
6. Adequate living accommodations and facilities for 100 people for 14 days:
 - a. Bunk-type beds for a planned maximum of 96 people (the other 4 persons being on night watch).
 - b. Food and drinking water.

- c. Provisions for heating soup, milk, coffee, and C-type rations.
- d. Minimum dining facilities, with water for minimum sanitary use.
- e. First-aid medical supplies.
- f. Toilet facilities.
- g. Air-handling equipment with filter having capability of removing particulate to 0.3-micron size.
- h. Electric light and power.
- i. Citizen band-type radio transmitter with standard AM broadcast receiver.
- j. Radiological instrumentation.
- k. Periscope for visual contact with above ground area.

The basic design of the prototype shelter includes the following combination of packages:

- Basic-shelter package No. S-2.
- Entrance package No. E-2.
- Ventilation package No. V-1B except that the air conditioner was not installed
- Hotel package No. H-1C.
- Control package No. C-2.
- Auxiliary power package No. P-5.
- Fire protection package F-1.
- Installation package No. I-3.

After the shelter was constructed in August 1959, it underwent the following tests:

1. August 1959: simulated occupancy test with 100 simulated shelterees to establish ventilation adequacy.
2. November 1959: preliminary human occupancy test in which 17 men lived 2 days in the shelter to check out equipment and experimental plan.
3. December 1959: first full-scale human occupancy test in which 100 male volunteers lived 14 days in the shelter.
4. April 1960: a firestorm experiment in which 300 tons of fuel on 4 acres around the shelter were burned to determine protection needs under mass-fire conditions.

5. May-June 1960: simulated occupancy tests to collect data on ventilation needs.

6. July 1960: second full-scale occupancy test with 100 male volunteers living 5 days in the shelter in hot weather.

7. September 1960: a radiation shielding experiment to check the shielding of the entrance way and the exhaust ventilator.

8. November 1960: a mixed population occupancy test with 100 men, women, and children living 2 days in the shelter.

9. January 1961 and later: fallout ingress experiments to determine whether filtering is needed in the ventilation system.

Questions requiring the present study were: How do the 1959 cost estimates of Ref. 1 compare with actual construction costs? What design improvements could be made, as indicated by test results and construction experience? What cost reduction could be realized by such design improvements? How do the 1959 cost estimates of Ref. 1 compare with 1962 costs?

1.2 OBJECTIVES AND APPROACH

1. Evaluate the protective and operational characteristics of the Camp Parks prototype shelter, based on occupancy experience and experimental work, and modify the design as necessary to improve usefulness and/or reduce cost.

2. Make a cost analysis to include: (a) updating the 1959 one-off costs of Ref. 1 on the basis of design modifications, construction experience, and 1962 material and labor cost; (b) analyzing the one-off cost differences between the 1959 costs and the 1962 modified-design costs, and determine the current total cost of the shelter; and (c) if time permits, extending the analysis to include determination of the average cost per shelter in quantities of 10, 100, and 1000.

1.3 LIMITATIONS OF RESULTS

For shelter construction, the design modifications made are adequate for the purpose the shelter was designed for. However, during the course of this study, several areas of improvement became clear and have either been incorporated in the design drawings or will be described in forthcoming reports. The cost data are as accurate and detailed as it was possible to make them, based on contractors' estimates or quotations and other available information. Again, as in Ref. 1, the costs do not include such items as general overhead expenses of the general contractor and subcontractors, profits, and miscellaneous site expenses.

SECTION 2

DESIGN MODIFICATIONS BY PACKAGES

2.1 GENERAL CONSIDERATIONS

Evaluations were made of the design features of all the components in each of the shelter packages to determine modifications that could be made to improve utility and/or reduce costs. Construction materials and items were judged and selected on the basis of economy, durability, availability, proved performance, and ease of fabrication and installation.

The design drawings, presented in Appendix A, have been updated to show the modifications made and to clearly show all the pertinent design features, the material specifications, the fabrication and installation procedures, and the tests and specific treatment of certain selected materials required by the contractor. The items in the shelter packages remain largely as they are described in Ref. 1 with the exception that the electrical arrangement and design have been moderately modified and the required items grouped into a new Electrical Package with six arrangements. This package consists of miscellaneous electrical items required for specific combinations of hotel package (including food-heating appliances), ventilation package, air conditioning, and auxiliary power package.

The remainder of this section briefly discusses the modifications of the various packages essentially in the order the packages are discussed and described in Ref. 1. The drawings of Appendix A, which give the modifications, supersede the drawings of Ref. 1. (The suffix M (appearing in the drawing title block) denotes a modified drawing K, a new drawing.) A cutaway drawing of the modified shelter is presented in Fig. 1.

2.2 BASIC-SHELTER PACKAGE

1. Notes have been added to the drawing on general configurations (Fig. A-1W) specifying the detailed procedure for the contractor to follow to ensure adequate burial of the shelter. Installation details have been included for adequate burial of the 35 psi basic structure and entranceway when construction may be required on sites where bedrock or ground water is near the surface.

2. The expansion joint filler now specified (Fig. A-2M) is just as adequate as that formerly specified in Ref. 1, but it is less costly.

3. A procedure has been included (Figs. A-2H-1 and A-2H-2) for determining the design and construction details of the sidewall and end-wall foundations for both 10-psi and 35-psi shelters to cover the range of soil types that may be encountered in the United States. This procedure was developed through the design analysis based on parameters defined in para. 5.

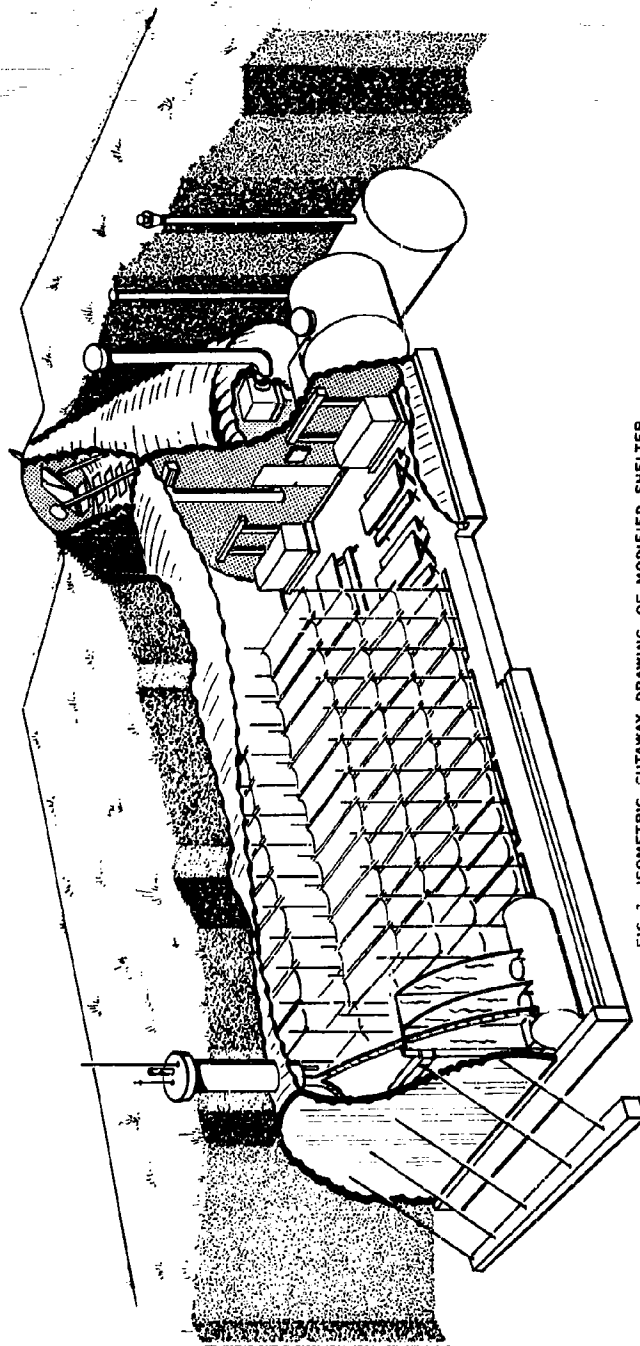


FIG. 1 ISOMETRIC CUTAWAY DRAWING OF MODIFIED SHELTER

3. Notes have been added to the drawing (Fig. A-3M) on entrance and endwall support details specifying (a) the base metal to be used in fabricating the basic arch structure, the endwalls, and the entranceway; (b) the manufacturing tolerances; (c) the erection procedure to be followed by the contractor; and (d) the basic quality control of workmanship in fabrication and erection.

3. The design of the endwall supports has been modified to reduce costs without decreasing the structural strength.

In order to design suitable blast-resistant foundations for the flexible-steel-arch shelter when it is sited on soils varying from hardpan to compact inorganic sand and silt, the author reviewed available data that disclosed the performance of this type of basic-shelter structure when subjected to blast. Considerable pertinent theoretical and experimental information was found in Refs. 2 to 6.

In brief, it was determined from Refs. 2 and 3 that specific experimental data relating to the dynamic response of the foundation of the flexible-steel-arch structure is available for one environmental condition, namely, when the foundation is placed in a "clayey silt" soil having the following characteristics: dry density, 77 lb/ft³; water content, 13%; angle of shearing resistance, 30°; cohesion, 2400 lb/ft² average; modulus of elasticity, 6400 lb/ft²; Poisson's ratio (assumed), 0.3; and seismic velocity of backfill, 2300 ft/sec. The designs of the sidewall and endwall foundations were similar to those indicated as type 4, Fig. A-2N-1 and type 1, Fig. A-2M-2, respectively and the overpressure blast wave resulting from the low-yield nuclear detonation had a positive overpressure duration of about 0.35 sec. The cited field experiment subjected three flexible-steel-arch structures to blast overpressures of 60 psi and 100 psi. Brief construction details of the three structures are as follows:

Structure 3.3a, subjected to 100 psi; A Navy stock No. 10 gage, steel-arch, ammunition storage magazine modified as follows: the end bulkheads were of 3-gage corrugated steel plate supported by tiebacks and deadmen, and steel curved-arch ribs were placed at 4-ft intervals.

Structure 3.3b, subjected to 60 psi; A Navy stock No. 10 gage steel-arch magazine modified as follows: the end bulkheads were of 8-gage corrugated steel plate supported by tiebacks and deadmen.

Structure 3.3c, subjected to 60 psi; A Navy stock No. 10 gage corrugated steel plate supported as follows: the end bulkheads were of 3-gage corrugated steel plate supported by tiebacks and deadmen and steel curved-arch ribs were placed at 4-ft intervals.

Analysis of the foundation behavior of the three structures² indicated that (1) nearly the full effective overpressure was acting on the footings, and that it was, in all cases, great enough to cause local shear failure; hence, the permanent footing vertical displacement, which varied from 1.5

to 3 inches;² (b) for structure 3.3a, this full effective overpressure was also great enough to probably cause general shear failure of the soil to start with; and (c) the comparatively short duration of the pressure pulse (0.35 sec) did not allow the development of complete failure; however, the general vertical displacement of the footings was about 3 inches.² For negative-detonation overpressure pulses, one can expect the pulse duration to be about 5 seconds, and effects should be similar to those of static loads. This fact was then the basis for the design modifications of the sidewall and endwall footings. The footings were designed on the basis of the following:

1. The foundation load was computed for the full effective overpressure (static conditions).
2. The foundation load was limited to the values of general shear failure for the respective soils (Figs. A-2M-1 and A-2N-2).
3. Permanent footing displacements of 1-1/2 inches are expected.
4. Increase in soil strength due to dynamic consolidation was disregarded.
5. Resistance due to earth and footing mass inertia was disregarded.

2.3 ENTRANCE PACKAGE

1. With the installation as shown in Ref. 1, investigation revealed that about 50% of the ventilation air was being short-cycled and did not reach the shelter interior. To correct this condition, weather stripping was added to the entrance endwall door, and flashing was installed at the connection between the entry tube and the endwall (Fig. A-5M).

2. The design of the shelter endwall entry door was modified (Fig. A-5M) to obviate its fabrication in strict accordance with the Federal specification. Commercial-grade doors, which can be fabricated at less cost and are satisfactory in performance, can now be installed.

2.4 VENTILATION PACKAGE

Minor modifications have been made in the exhaust vent design to reduce costs. Refer to Figs. A-7M and A-8M for details.

2.5 HOTEL PACKAGE

Certain miscellaneous minor items of the hotel packages listed in Ref. 1 have been grouped into lots to simplify the presentation. Modification of specific components and items are described below.

2.5.1 Bunk System

The bunk system described in Ref. 1 has been extensively tested, as outlined in Appendix C. The test results pointed to many required design

changes, which have been incorporated in the present design (see Fig. A-10X). These changes, described in detail in Appendix C, have resulted in a new bunk system that is quite satisfactory and less costly.

2.5.2 Furniture

The design of the wooden tables and chairs that were specified to be used in Ref. 1 has been modified to reduce cost without affecting the 14-day usability period required of this furniture. See Fig. A-9M.

2.5.3 Water, Fuel, and Sanitary Tanks

The design of these tanks has been modified to decrease their cost without affecting their performance in the intended environment. See Figs. A-11M and A-17M.

2.5.4 Sanitary-Tank Platform and Curtains

The design of these units has been modified to decrease their cost without affecting their performance for the use intended. See Fig. A-11M.

2.5.5 Water and Fuel Piping

The design of these systems has been modified to decrease the possibility of the water and fuel piping connections breaking at their point of entry to the shelter during the positive blast pulse. See Fig. A-7M.

2.5.6 Emergency Exit Tools

Reference 1 specified the use of a small wrecking bar only for emergency use. Consideration in this study was given to the need for tools for emergency use in the shelter and it was determined that an 8-pound sledge hammer and a 4-foot-long wrecking bar would greatly increase the possibility of shelteree survival in the event that exits were covered with debris. This equipment has been specified in this report to be furnished in every hotel package.

2.5.7 Habitability Equipment and Items

The following miscellaneous items have been added to the hotel packages. The need for these items was revealed during the various MRL shelter habitability experiments:

- Recreational equipment (included in Hotel Packages H-1C, H-2C, and H-3C).
- Waterless hand cleaner (added to all Hotel Packages).
- Plastic soup spoons (added to all Hotel Packages).
- Paper food plates (added to all Hotel Packages).
- Disposable diapers (added to all Hotel Packages).
- Sanitary napkins (added to all Hotel Packages).

2.6 CONTROL PACKAGE

2.6.1 Radio Transceivers

Reference 1 specified the use of the Vocaline Model JRC-400, or the equivalent, for use as a low-power transceiver, and the Comset 3025, or the equivalent, for the high-power "transceiver."

Investigation revealed that the citizens-band JRC-400 low-power transceiver is a line-of-site unit and that its performance would be unsatisfactory even for a distance of a few hundred feet if obstructions, such as hills or buildings, were between it and the intended receiver. In addition, the manufacturer reported that his plant no longer produces the unit, since its carrier frequency oscillator was found to be unstable according to FCC regulations.

The investigation also revealed that the most dependable low-cost commercial transceiver is the Vocaline Comsair Model ED-27M, or the equivalent. This unit transmits in the 27-MC band, which is in the citizens band. Experience with this type of unit is that it is dependable in a hilly and/or hilly area to a range of about 5 to 6 miles. The unit comes equipped with a 4-channel selector switch and can be purchased equipped with 1 to 4 channels. Therefore, because of these advantages and because of the lack of an adequate nationwide disaster communications system that would enable specification of adequate shelter transceiver equipment, this unit has been specified in this report. The unit equipped for 1-channel operation has been specified for use in the personnel shelter, while the unit equipped for 2-channel operation has been specified for use in the sector shelter. (Refer to Sec. 5 for further discussion on radio communication equipment.)

2.6.2 Radiation Detection Equipment

Reference 1 specified that this equipment consist of a 1-to-200-mr dosimeter, a 1-to-100-r dosimeter, and a dosimeter charger. The present study revealed that commercial purchase of these items would cost about \$15.00 each or a total of \$45.00. The study also revealed that many large commercial radio companies were selling a radiation-detection package that meets OGD specifications and consists of a dosimeter having a 0-to-120-r range (this scale is calibrated as a rate meter), a dosimeter with a 0-to-600-r range, and a charger for a total of \$26.00. Therefore, this is specified in the present report.

2.6.3 Periscope

The periscope specified in Ref. 1 required that a lens system be provided that had a 40° solid angle field of view. Experiment performed during the MRL shelter test program revealed that this angle could be reduced to 17° without any sacrifice of usability. Based on this finding, a periscope was developed (in collaboration with the Tinsley Laboratory, Inc. of Berkeley, Calif.) that is satisfactory for use in shelters and is less costly. See Fig. A-13M.

2.7 AUXILIARY POWER PACKAGE

Reference 1 specified an electric-starting engine generator. The present study revealed that a manual-starting engine generator is preferable because its use will eliminate the problem of a discharged battery after the long period that this unit will be on standby (idle). The manual-starting unit will also cost less for initial purchase and installation, as well as for maintenance when on standby.

The fuel tanks have been modified to get more efficient use out of the basic sheet metal stock as "provided to the fabricator by the steel manufacturer." Also, the dished tank heads specified in Ref. 1 have been replaced by flat, flanged tank heads. Both changes will result in considerable savings in tank costs.

(Greater reliability has been ensured for proper starting of the motor generator after a long standby period by including the installation of a small gravity-feed day tank at the engine proper. The fuel in the day tank will be sufficient to ensure an adequate supply of fuel in the carburetor for starting the engine after a long standby period.

The rating of the auxiliary power package for a given combination of ventilation and hotel packages is specified in Table 28.

2.8 FINE PROTECTION PACKAGE

Two items specified in Ref. 1 for this package have been changed:

1. The pelleted carbon dioxide absorber (Baralyme) has been substituted by a more efficient granular absorber (Baralyme) (or equivalent).
2. The two-stage oxygen bottle regulator has been substituted by a single-stage regulator.

2.9 INSULATION PACKAGE

Considerable adjustment has been made in the volume values of Table 3-13 for excavation, backfill and compaction, and backfill, as well as in the respective material and labor costs (see Table 22). (Adjusted costs per cubic yard for these operations are given in Table 23.) For detailed instructions for carrying out the above operations and for erecting the steel work, see Figs. A-1M and A-3M, respectively.

2.10 ELECTRICAL PACKAGE

The design of the electrical lighting and power system of Ref. 1 has been modified as shown in Fig. A-12N. The design was dependent on the maximum electrical load that would result when the electric equipment specified in the various shelter packages were energized. Governing equipment were lighting, control equipment, food immersion heater, hot plate, vent fan, and air conditioner. A study of the probable combination

of the shelter packages indicated the need for three separate electrical lighting and power distribution systems, as shown in detail on Fig. A-12N as Arrangement A, Arrangement B, and Arrangement C.

Arrangement A is the most austere electrical system; it provides lighting in the messing and reading area equivalent in intensity to that of normal street lighting. Minimum acceptable lighting has also been provided in the entry way and toilet area. The power distribution system provides power to the ventilation blower motor, to 3 duplex receptacles (one serving the shelter control equipment), and to the air conditioner if it is used.

Arrangement B provides lighting in the messing and reading area equivalent in intensity to that found normally in hallways of office buildings (5 foot-candles). The bunking and recreational area is provided with a light intensity of 2 foot-candles, which is equivalent to that found in a restaurant dining area having a subdued environment. Lights have also been provided in the entry way and toilet area. The power distribution system provides power to 4 duplex receptacles, the ventilation motor, and the air conditioner if it is used.

Arrangement C provides lighting in the messing and reading area equivalent in light intensity to 15 foot-candles. The bunking and recreational area has been provided with 5 foot-candles. The 15-foot-candle illumination level is equivalent to that usually provided in office and hospital waiting rooms. Lighting has also been provided in the toilet area and entry way. The power distribution system provides power to 5 duplex receptacles, to the ventilation motor, and to the air conditioner if it is used.

Auxiliary electrical systems have been provided for both the air conditioner and the service equipment required for a specific auxiliary-power package.

The electrical items required for various combinations of ventilation and hotel packages have been grouped into 6 electrical packages: M-1 to M-6. All the items are described in Table 25, the items in a given electrical package are listed by number in Table 27, and the electrical package for a given combination of ventilation and hotel packages is specified in Table 28. Figure A-12N gives the installation arrangement of electrical items.

SECTION 3 COST ANALYSIS OF PACKAGES BY ITEM

3.1 GENERAL

This section is concerned with the second objective stated in 1.2. The 1959 costs given in Ref. 1 were based on the Federal Stock Catalogue costs and the manufacturer's prices (contractor's costs) for mass-produced items, and on MRE cost estimates for other items. Both the 1959 cost data and the available 1962 cost data were limited (as explained in 3.1.1). The analysis was extended to include multiple-unit item costs (3.1.2). Cost estimates are briefly discussed in 3.2 and are presented in tables in Appendix B.

3.1.1 Scope of Cost Data Used

Material and labor costs of constructing the prototype shelter have been analyzed for the items in the various shelter packages used. However, a detailed analysis proved difficult because the general contractor and his subcontractors had not set up a sufficiently detailed cost-accounting system. It was determined that most general contractors and subcontractors consider a detailed cost-accounting system too expensive and hence are reluctant to, or do not, allocate the necessary funds to support such a system. In addition, a general contractor will usually not award a specialized job to a subcontractor on a competitive basis; he will place such a job with a subcontractor whose past experience he has approved.

Another difficulty was trying to determine "hidden" costs. Therefore, the cost estimates resulting from the analysis do not include the following:

GENERAL DESCRIPTION	DETAILED DESCRIPTION
General overhead expenses of general contractors and subcontractors prorated for a specific job.	Office rent, fuel, lights, telephone, stationery, other miscellaneous office supplies, advertising, trade journal magazines, donations, legal expenses not chargeable to a specific job, fire and liability insurance on office, contractor association fee, and salaries of office employees, such as clerks and estimators.
Specific job overhead.	Salaries of foreman and timekeepers, cost of temporary toilet, construction-site buildings, tool sheds, field

GENERAL DESCRIPTION (Cont.)

DETAILED DESCRIPTION (Cont.)

telephone, temporary light and power, cleanup of premises, inspection fees, building permits, site surveys, tools and equipment amortization, contractors insurance and other coverage for a specific job, bid bonds, performance bonds, joint industry bond payments, employer's liability and auto insurance, motor vehicle and heavy equipment operation and maintenance, and employees' welfare fund, vacations, paid holidays, overtime, pensions, hospitalization, convalescent fund payments, apprenticeship payments, and unemployment compensation insurance.

Profits

General contractor and subcontractor profits.

Miscellaneous site expenses.

Site acquisition, relocating existing utilities, actual electrical and water connections, hand material encountered during excavation (such as ledge rock, boulders more than one-half cubic yard in volume, and cemented material requiring blasting for removal), requirement for select material due to native soil not being suitable for backfill, additional costs due to strikes.

Purchase of nondomestic construction materials.

As per requirements of "Buy American Act" (U.S. Code 10a-d).

3.1.2 Method of Estimating Multiple-Unit Item Costs

Although this objective was mainly to analyze the one-off item costs, it became apparent as the study progressed that additional investigation would be rewarding from the point of view of estimating with a good degree of accuracy, the multiple-unit costs for single-shelter installations (that is, not a shelter-zone system). This extension of the analysis was done, and the method of estimating the multiple-unit costs is described in the following paragraphs.

The direct one-off labor costs by items were projected to multiple-unit labor costs by means of the 80% learning curve, which is expressed by:

$$y = ax^b$$

where y is the average direct man-hours, x is the cumulative item output, and a and b are parameters. The value of a is the direct man-hour cost for unit number one, and the value of b defines the slope of the cost versus cumulative output curve. For an 80% learning curve, the value of b is taken as minus $1/3$. Under this condition of learning, the reduction in direct labor cost is 20% with each doubling of cumulative output. In the author's opinion, this curve best represents the learning experience that can be expected in building trades that are involved with the construction of a shelter of this type.

In applying this curve to the basic costing problem, it was necessary to determine the learning level for each purchased item as well as the direct labor required for the assembly, fabrication, and installation of the item. Information presented by David Wyrick of the Rand Corporation in his report, "Use of the Learning Curve," proved invaluable.

At the outset of this cost investigation, it was decided to use purchased-item cost data furnished by the actual manufacturer of the specific item whenever possible. This approach was taken so that actual in-plant experience levels would be incorporated in the final results. It is hoped, then, that the final results reflect minimum errors due to the following pertinent problem areas:

1. Limited knowledge of the accumulation of prior related learning for the applicable item.

2. Accounting for the fact that every item being considered must be produced before the cumulative improvement embodied in the last produced item can be utilized in the cost study. Data submitted by the actual manufacturer of the purchased item proved of special significance because the data reflect factual improvements that can be contributed by management and by equipment and direct-labor improvements.

The multiple-unit costing projection is based on the condition that single units only are to be installed in one local area. For instance, one can visualize a national shelter program in which specific central groups would be given the job of installing single shelters at various strategic locations in a suburban area. It was assumed that each group would be responsible for installing as many as 10,000 such units; however, it was further assumed that the average contractor would not be involved in the installation of more than 1000 units.

As stated previously, this analysis did not include an investigation of the cost of multiple-shelter installations (shelter-maze system) based on common shelter components (such as an entryway, engine generator room, water system, sanitary system, and ventilation system) and/or an increase in room length. Time and funds did not permit investigation in this area, and reliable cost data cannot be worked up until a specific design has been developed. It is obvious, however, that maze-type shelter configurations offer many advantages, for example, a considerable reduction in the cost per shelteree.

3.2 COST ESTIMATES

The cost estimates resulting from this analysis have been tabulated (see Appendix B) for each shelter package. For each package, there are three tables: a table giving the material and labor costs of the package by items, a table giving the cost differentials between 1959 and 1962 costs for each item in the package, and a table that summarizes the individual cost for each of the package arrangements. These tables are presented in the order the shelter packages are discussed in Section 2.

By examination of the tables for a given package, one can find the increase or decrease in costs by item. Also, one can find the significant cost changes. For example, for the ventilation-package blowers, an important finding of the cost analysis is that the 1959 ventilation blower prices listed in Ref. 1 were excessive, and that savings per unit shelter -- based on 1962 prices and considering what the increase in the 1959 prices would have been over the past 3 years -- are \$107, \$63, and \$39, respectively, for the 675-cfm 0.2-MG, the 675-cfm 0.7-MG, and the 1600-cfm 0.2-MG vent blowers.

SECTION 4

DISCUSSION OF RESULTS

The design of the shelter specified in Ref. 1 has been modified to include current shelter development and engineering experience (see Sec. 2 for details), and modified and new construction drawings have been prepared accordingly (see Appendix A).

Material and labor costs for the items in the various shelter packages have been updated to 1962 (see Tables of Appendix B). These costs represent the range of actual costs to a greater degree of accuracy than costs that might be obtained from an individual contractor on a bid basis.

To illustrate the cost range of the various shelters that are possible by combining different packages, four combinations of shelter packages have been selected. The average 1962 costs per shelter unit for each of these combinations is shown in Fig. 2 in quantities of 1, 10, 100, and 1000. The percentage contributions of the packages to the total one-off cost for each of these combinations are given in Table 28. Comparisons of the 1959 and 1962 total costs for the four combinations are listed in Table 29.

Prospective shelter builders have shown interest in the use of the basic structure and entrance way for nonpersonal purposes, such as underground control centers for civil defense. Therefore, Fig. 3 has been included to show the average 1962 cost just for the basic-shelter package installed with an entrance way only.

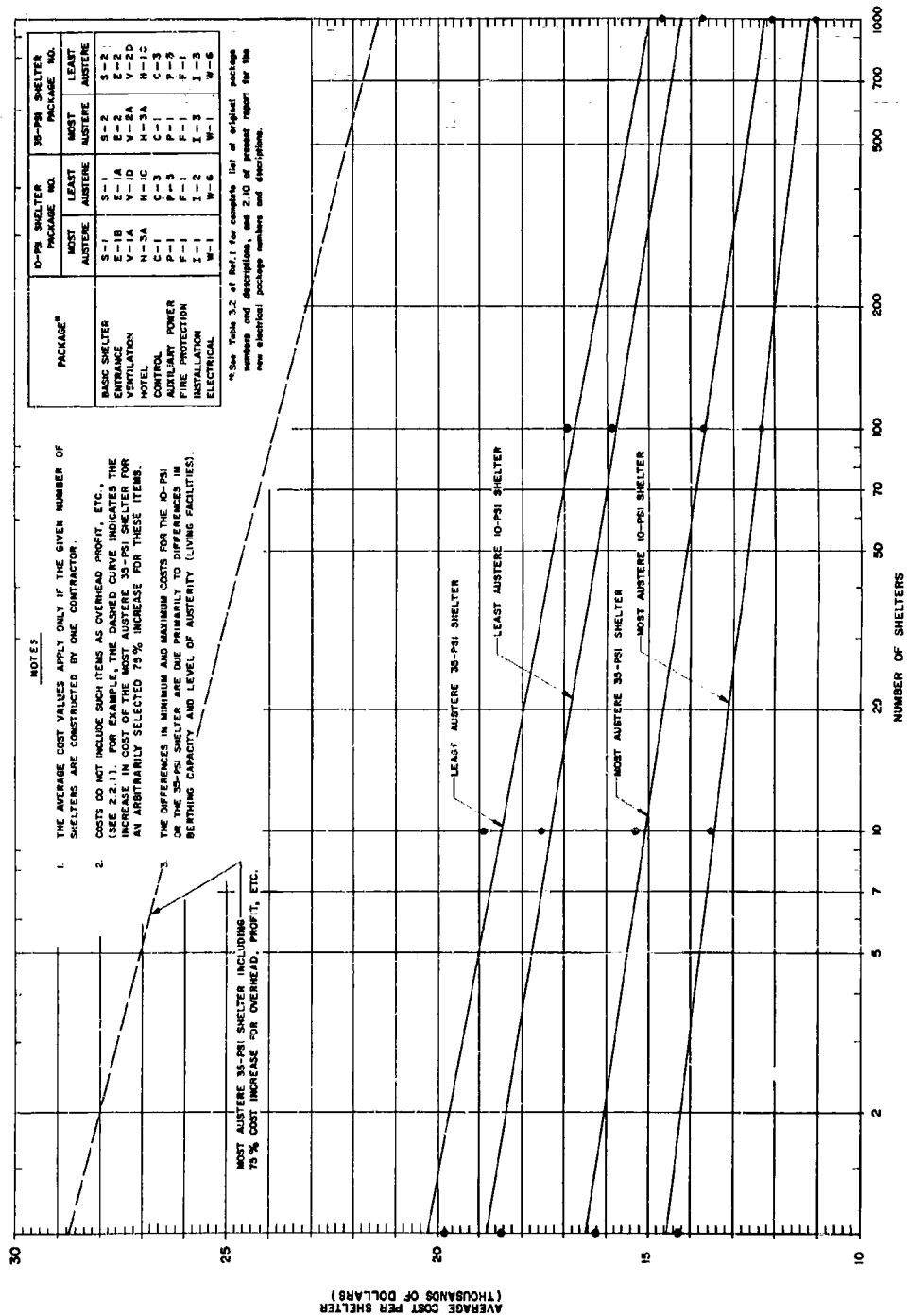


FIG. 2 AVERAGE COST PER SHELTER VS. NUMBER OF SHELTERS FOR MINIMUM AND MAXIMUM 10-PSI AND 35-PSI SHELTERS.

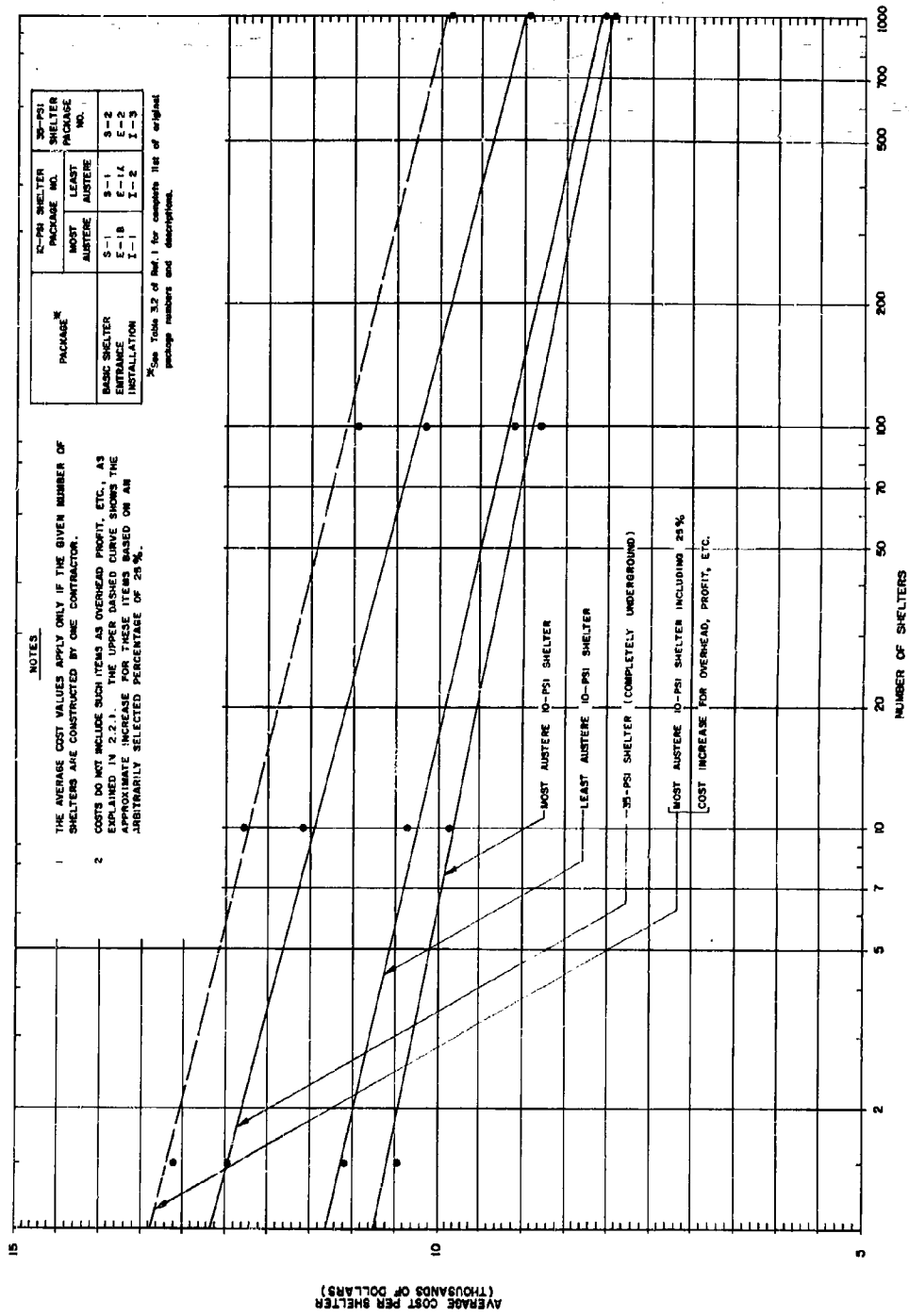


FIG. 3 AVERAGE COST OF ONLY THE BASIC-SHELTER, ENTRANCE, AND INSTALLATION PACKAGES VS. NUMBER OF SHELTERS FOR THE 35-PSI SHELTER AND THE MINIMUM AND MAXIMUM 10-PSI SHELTERS.

SECTION 5

RECOMMENDATIONS FOR FURTHER INVESTIGATION

5.1 GENERAL

The results of this study point up the need for the following:

- Theoretical analysis and field testing of single flexible steel arches under megaton-detonation blast loading.
 - Studies on adequate spacing between multiple flexible-steel-arch structures positioned side by side.
 - Studies on static and dynamic responses of soils of interest under megaton-detonation blast loading.
 - Determination of fundamental performance specifications for a national protective shelter system.
 - Determination of adequate radio equipment for national and local shelter systems.
 - Field test of the fire protection package.
 - Study of shock-proofing requirements for equipment and facilities inside the basic structure and entrance way of the shelter.
 - Study of the effects of shock and blast loading on the small buried fuel and water storage tanks.
- 5.2 THEORETICAL ANALYSIS AND FIELD TESTING OF SINGLE FLEXIBLE STEEL ARCHES UNDER MEGATON-DETONATION BLAST LOADING
- The corrugated flexible steel arch that has been selected for use as a blast and fallout shelter has successfully withstood blast loading of nuclear bombs in the kiloton range. However, it is obvious that any civil defense personnel shelter designed for blast should be able to withstand blast-overpressure pulses resulting from megaton detonations.
- Review of the design theory of the operation of the unreinforced corrugated arch under blast loading indicates that flexural deformation of the arch must be fully inhibited by the static and dynamic resistance of the soil. This condition can be achieved when the arch structure has been properly buried; that is:

1. An adequate foundation has been provided.
2. The arch is totally below grade or provided with adequate berm and has been nested in structurally adequate soil.
3. Adequate cover has been provided over the crown of the arch in order that the passive resistance of the soil is sufficient to prevent flexural deformation.

In the opinion of the author, the third requirement above must be investigated further--both theoretically and experimentally--to determine cover depths and/or structural stiffness of the arch crown so that it will resist megaton-detonation blast loading. Such investigation should terminate in full-scale field tests that subject the finally designed arch structure to such loading. In addition, each test arch structure should be provided with different types of endwalls, entrance way, blast door, and necessary shelter protrusions.

The following three types of flexible-arch configurations are suggested for theoretical analysis and test purposes:

Structure A: An unreinforced structural-plate arch (multiple plate or equal). This test should include various arch-plate thicknesses, say 10 gages, 7 gages, and 1 gage. Variations in the number of longitudinal plate-connecting bolts per foot should also be incorporated in the test. This variation should be 4, 6, and 8 bolts per foot. This test will not require the installation of different structures, since all the variations specified can be included in a single structure having sufficient length. The possible combinations of the 3 types of bolting and 3 different thicknesses of arch ring are 9. Consequently, a test structure having at least 9 rings will be required. The test of bolted connections is required to gain sufficient knowledge to properly design a yielding foundation. This principle suggests that the arch footings be designed so that the minimum vertical soil resistance under the footings will be enough to support the structure, its cover, and such incidental live loads as may be applied. The maximum vertical reaction pressure of the soil against the bottom of the footings should be no more than the horizontal bolted-arch strength in order that the foundation may yield when subjected to blast loading without the horizontal seams fracturing.

Structure B: A corrugated metal arch reinforced peripherally at intervals by curved I-beams which are located either inside or outside the structure. Variations in the size and spacings of the I-beams should be included in this test structure. Variations in arch-plate thickness should also be included.

Structure C: A corrugated metal arch reinforced by curved I-beams (located either inside or outside the structure) occupying about the central top third of the arch periphery. This field test will develop data that can be used for the purpose of designing arch reinforcements that may be necessary as a result of inadequate soil pressure on the top of the arch.

5.3 STUDIES ON ADEQUATE SPACING BETWEEN MULTIPLE FLEXIBLE-STEEL-ARCH STRUCTURES POSITIONED SIDE BY SIDE

When these shelters are placed close together side by side, they are not in as favorable a situation as a single arch structure that is fully supported by the surrounding earth. As noted in 5.2, theoretical studies and field-test results indicate that an underground arch with adequate earth cover has its flexural deformations almost totally inhibited by the static and dynamic resistance of the soil. When this is the case, the design engineer neglects flexure in the underground arch.

When the arch is subjected to blast loading, it becomes essential that no major flexural moments be developed in the structure. Loading of the soil around the arch will develop highly concentrated reactions near the foundations of a very closely adjacent arch structure. Consequently, the soil resistance in the vicinity of the arch foundations must completely inhibit flexural deformations of the arches. Therefore, the allowable minimum distance between adjacent arches in order that this condition exist must be determined.

5.4 STUDIES ON STATIC AND DYNAMIC RESPONSES OF SOILS OF INTEREST UNDER MECHAN-DETONATION BLAST LOADING

Construction capable of protecting personnel from the effects of nuclear weapons is greatly dependent on the dynamic response of the structure's foundation. The numerous dynamic-response investigations to date have been mainly directed toward analytical and experimental work, the purpose having been to determine the response of structural materials, structural components, and total structures to blast-type loading. These investigations were started with well-defined building materials, such as steel, wood, and reinforced concrete.

No great amount of effort has been made to determine the dynamic response of nonhomogeneous materials, such as soils. In recent years, however, the need for knowledge of the dynamic properties of soils has increased. Currently, the knowledge of the dynamic response of foundations is greatly behind that of the superstructures. To emphasize the present "state of the art" of soil dynamics, the following quote from Ref. 6 is given: "The primary objective of developing a mathematical expression for the displacement of long footings based on a punching failure and applicable to any soil type has been met. However, the theory as defined by the derived equations cannot be regarded as more than a preliminary attempt to theorize a very complex physical phenomenon. The assumptions have been restrictive to the extent that precise correlation between the predicted and measured values of footing displacement should not be expected. At this time, even the magnitude of the deviations cannot be assessed because of the lack of experimental data."

In view of the foregoing, it is recommended that theoretical study of soil dynamics be continued and be followed with a comprehensive laboratory and field-test program.

5.5 DETERMINATION OF FUNDAMENTAL PERFORMANCE SPECIFICATIONS FOR A NATIONAL PROTECTIVE SHELTER SYSTEM

It is strongly recommended that the general approach to shelter design be improved. The task faced by the shelter design engineer can best be illustrated by an analogy. He faces a task similar to a bridge engineer who is told to design a bridge to span a body of water at minimal cost. No specific information is given on parameter values to which he must adapt his design -- length of the span, depth of the water, knowledge of the bordering terrain, type and magnitude of expected traffic, etc. Before the bridge engineer can develop a design, he must be furnished with specific information of the values of such parameters.

Similarly, at present, the shelter engineer is told to design a shelter at minimal cost, and very little other information is clearly stated. The environment the shelter engineer has to contend with are as complex as the one in the bridge design case. He is faced with a wide range of parameters and their combinations -- blast overpressure effects, thermal effects, initial and residual radiation effects, etc. These effects in turn vary with the weapon yield; for example, if a structure is built to withstand 35 psi from a 40-KT detonation, it may not be able to withstand 35 psi from a 10-megaton detonation because of the difference in the blast pulse shape. The shelter engineer is not qualified to specify design criteria for a national shelter system; others are better equipped to do this. He can design adequate minimal-cost shelters only after detailed specifications have been furnished in clearly stated terms to meet each particular situation. To indicate how the basic problem might be solved, a general scheme for designing shelters on a large scale is briefly outlined below.

In the first step, a group, made up probably of weapon-effects and intelligence experts studying possible patterns of attack on the United States, should determine the most probable weapons effects, their combinations, and the degree of protection required for each locality in the United States. The problem is complex, but it must be solved as a first step in this type of planning.

In the second step, contact would be made between this first group and the shelter design engineers, and they would decide on the number and types of shelter designs (say, 10 or 20) required to cover the full range, or a fraction of the range, of the weapons effects and the national protection desired. Specific design criteria would then be furnished the shelter engineer.

In the third step, the shelter design engineer could then proceed in the work he is best qualified to perform: designing each of the shelters decided upon at minimal cost. An important point in this phase of shelter planning will be brought out. In standard engineering procedures, the engineer is usually required to introduce a safety factor in his design. In shelter design, the engineer should be required

to meet only the maximum criteria values set forth by the first group. At present, however, the engineer has no way of knowing the value of a reasonable safety factor in this type of design; as a consequence, if he is forced to incorporate safety factors in his design, this will conflict with his objective of designing a minimal-cost design. The concept of a safety factor can best be left to the discretion of another group mentioned next.

In the fourth step, a master control group would decide which of the 10 or 20 shelter designs should be assigned to each locality of the United States. If this group were to decide that a stronger shelter than the one indicated for the particular location was desirable then a stronger shelter could be selected from those available. This step would indirectly take care of the safety factors.

5.6 DETERMINATION OF ADEQUATE RADIO EQUIPMENT FOR NATIONAL AND LOCAL SHELTER SYSTEMS

Comments on the radio equipment specified in Ref. 1 are given in 2.6.1. The present investigation indicates that, on a national basis, the Office of Civil Defense has been assigned five broadcast channels for disaster purposes in the frequency range, 1768.5 to 1796.5 kc. In addition, the California Disaster Office has been assigned only one "Scene of Disaster" channel at 1761.5 kc. Furthermore, local city-government experience with minor local problems indicates that five channels of information will be completely inadequate to handle even local disaster conditions. A preliminary analysis of the problem indicates that, before an adequate disaster communications system can be developed, a complete national, state, county, and city organization and control system, with a dependable radio communication system, will have to be set up. The details of the communication system with its performance requirements can then be specified.

The author of this report attempted to determine (by field check) what communications problems, if any, would exist in the event of an actual local disaster. The Director of the Disaster Council and Corps, City and County of San Francisco, A.G. Cook, R.Adm. TEN (Ret.), was asked if, in his estimation, planned communication facilities were adequate to handle disaster problems that may arise as a result of nuclear detonations in the San Francisco Bay Area. He reported that "In my opinion, existing communication facilities and radio frequency channels are grossly inadequate, and in the event of a local disaster, I no doubt would resort to the use of other existing public safety communications systems."

It was also of interest to note that the law requires all operators of this type of equipment to be licensed. Further investigation of operating characteristics of existing commercial communications equipment revealed the fact that very costly equipment is necessary to cover moderate ranges, for instance, between San Francisco and Sacramento, a distance of about 75 miles.

5.7 FIELD TEST OF FIRE PROTECTION PACKAGE

The use and performance of the carbon dioxide absorber (Baralyme) should be tested under field conditions. The main purpose of such testing would be to determine whether the proposed method of using this material to absorb CO₂ generated is satisfactory over the wide range of shelter air temperatures and humidities that may be expected. The proposed method for using this material is merely to spread it out in thin layers on the bunks. However, this method may not be satisfactory in an actual shelter close-up situation, and some other method may be required, such as a more costly blower-canister system.

5.8 STUDY OF SHOCK-PROOFING REQUIREMENTS FOR SHELTER FACILITIES AND EQUIPMENT ITEMS

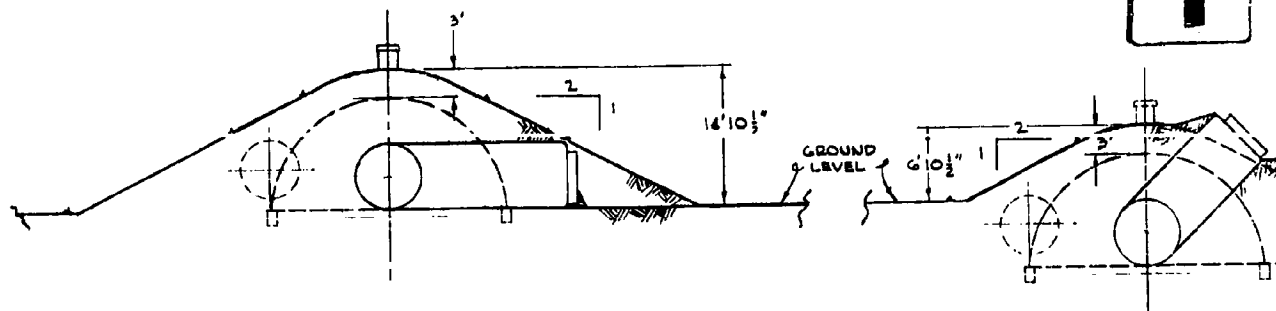
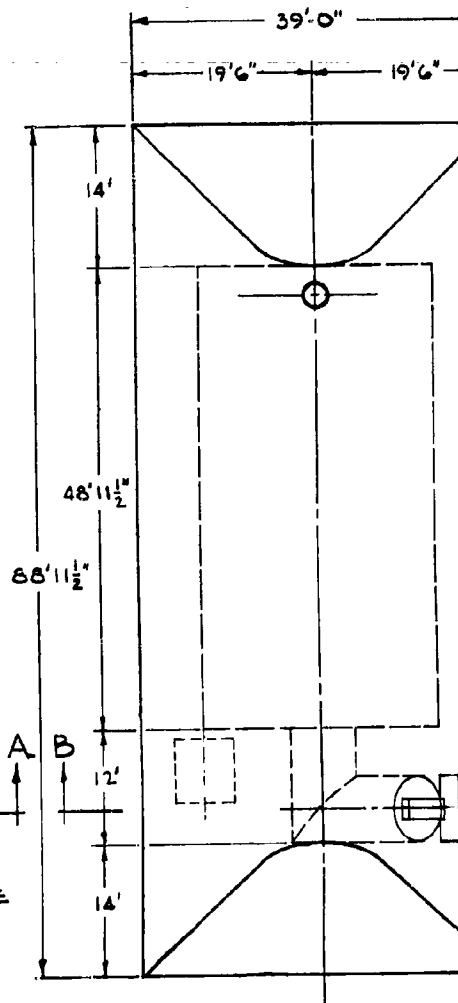
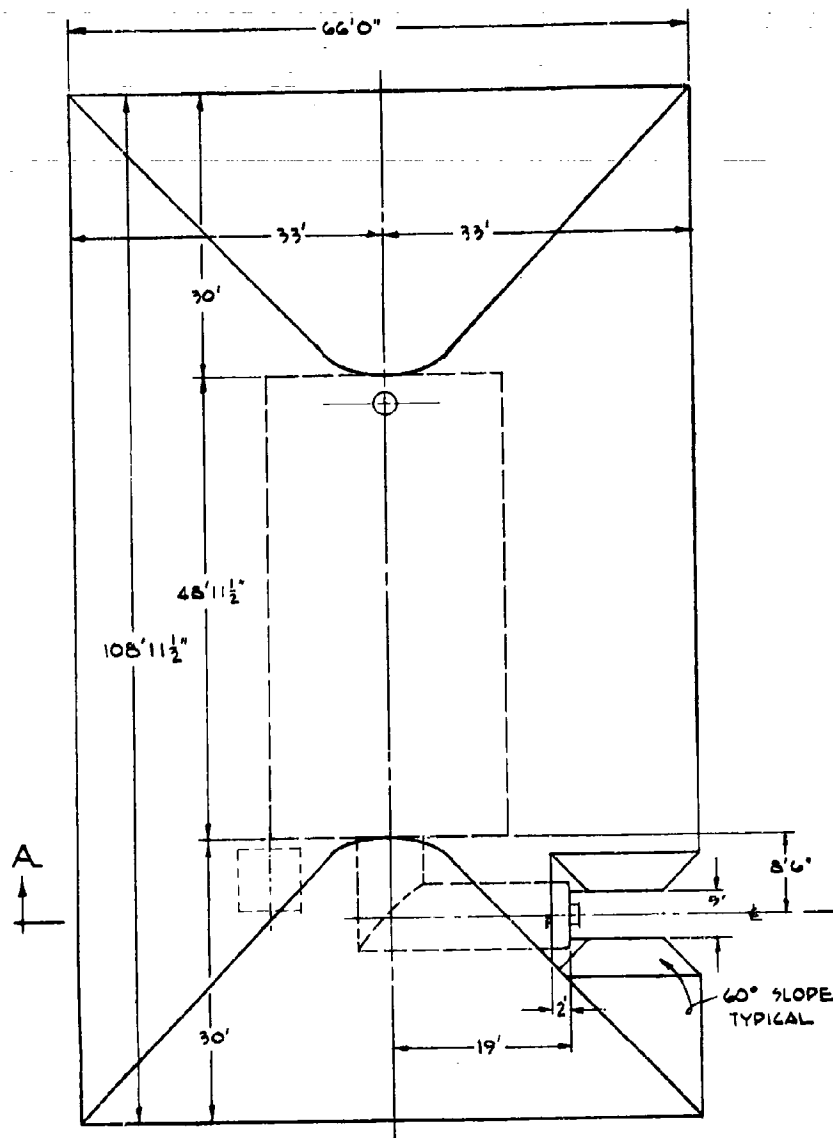
A detailed study should be undertaken to determine what shock-proofing is needed for the various facilities and equipment items specified for the shelter, and then to determine the most economical and effective method of shock-proofing them.

5.9 STUDY OF THE EFFECTS OF SHOCK AND BLAST LOADING ON SMALL, BURIED FUEL AND WATER STORAGE TANKS

Theoretical analysis and field testing are needed to (1) determine the effects of shock and blast loading on small, thin-walled buried tanks for storage of water and fuel; and (2) establish design criteria in order that the tanks can be readily designed to withstand a specified overpressure and a specified blast pulse duration which is dependent on the weapon yield.

APPENDIX A

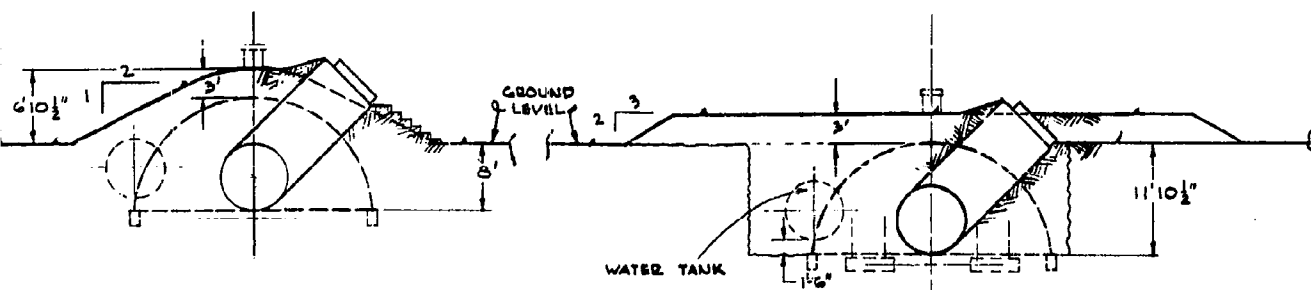
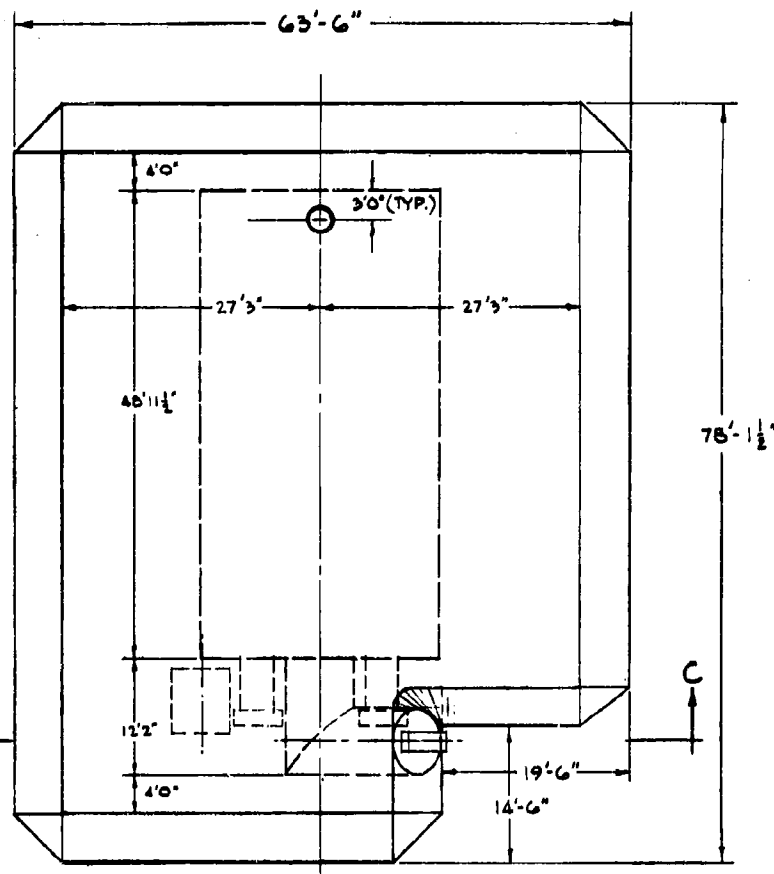
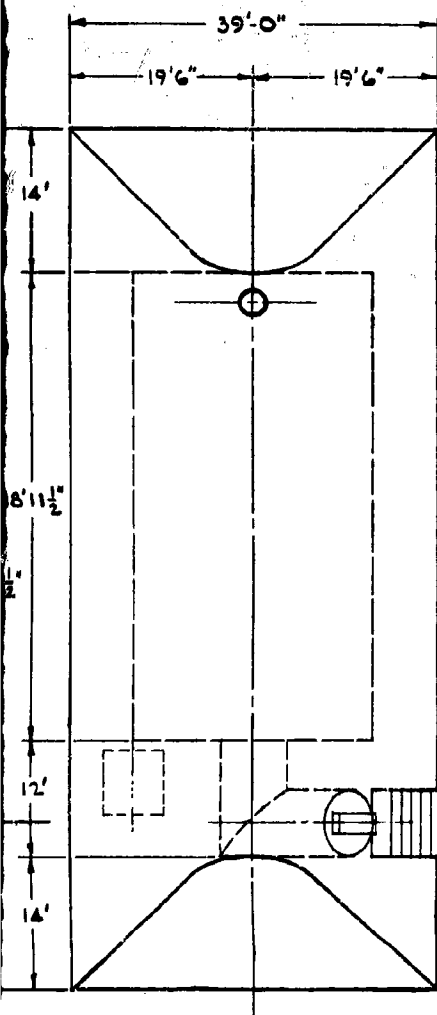
CONSTRUCTION DRAWINGS



SECTION A-A

SECTION B-B

1



1. **EXCAVATION:** Be carried below and compacted
2. **SELECT MATERIAL:** not more than not exceed 8 w Material shall
3. **BACKFILL AND C** and ends of the symmetrically ends. Care sh of the metal a
4. **BACKFILL:** Be select backfill material for t order to use n backfill under end and above than 3 inches
5. **COMPACTION:** moisture being 6 inches thick by watering s
6. **MAXIMUM DENSITY** procedure of modified as f
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 - (b) The
 - (c) The
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 - (e) All
 - (f) A s
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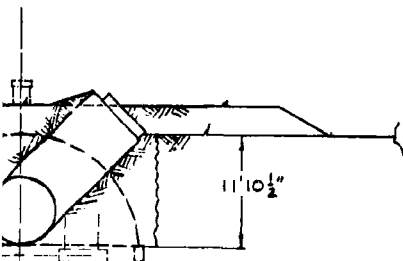
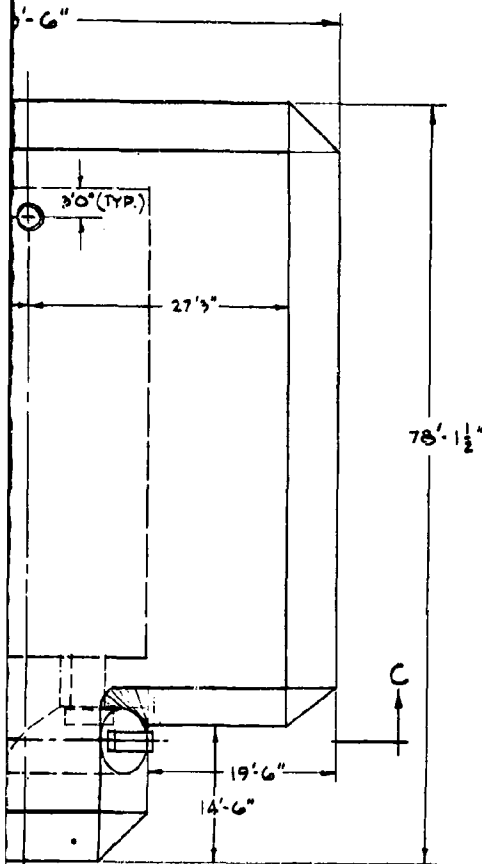
LIST OF MATERIAL

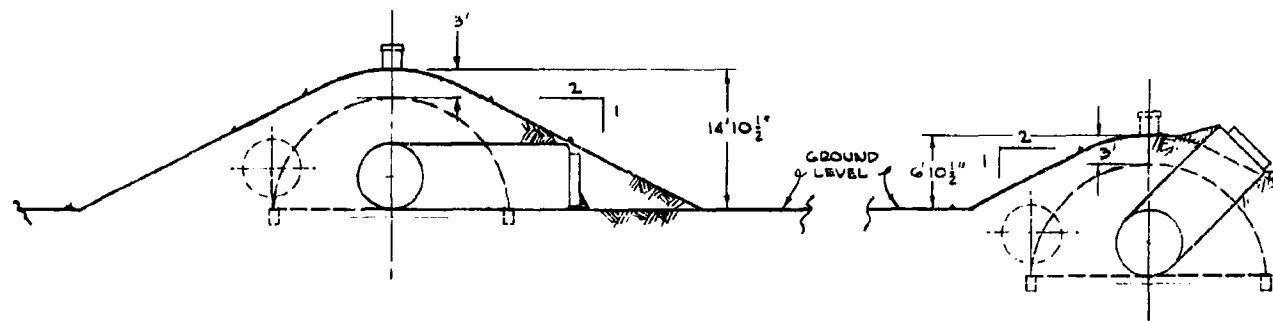
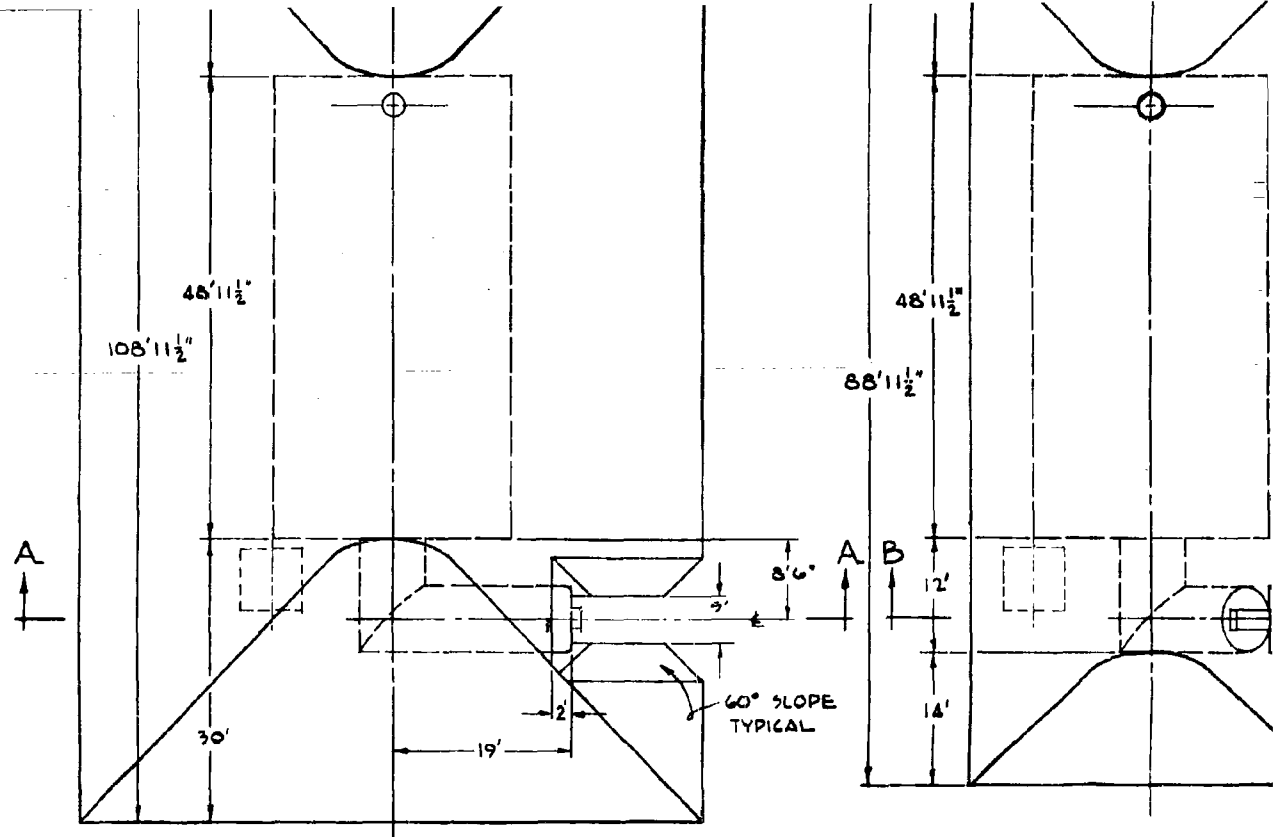
QUANTITIES SHOWN ARE FOR

PG. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS
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GENERAL NOTES FOR EARTH WORK

- EXCAVATION:** Excavations shall be carried to the dimensions indicated on the drawings. Excavations carried below the depth indicated shall be refilled to the proper grade with approved material and compacted to at least 90% of maximum density. (See Note 6).
- SELECT MATERIAL:** The maximum diameter of select material (if required) shall be 3 inches, and not more than 25% shall pass a No. 200 sieve. The plasticity index of the material shall not exceed 8 when tested in accordance with ASTM tests designated J423-54T and D424-54T. Material shall be free of roots, vegetable matter, and other organic substances.
- BACKFILL AND GRADING:** Backfilling shall be accomplished essentially simultaneously on the sides and ends of the shelter, with work starting at the bottom midpoint of the sides and progressing symmetrically upward in such a manner that fill at the midsection is always deeper than at the ends. Care shall be exercised in placing and compacting the backfill to prevent deformation of the metal arch. Deformation, if any, shall not exceed 2% of the design radius.
- BACKFILL:** Backfill for the sides and entrance end shall be accomplished with either native or select backfill to a point 8 ft above the floor slab. The decision as to whether to use select material for this purpose will be based on the amount of effort and earth handling required in order to use native soil to obtain backfill compaction as specified. Sand shall be used for backfill under the storage tanks as indicated (see Fig. A-17M). Backfill at the non-entrance end and above the 8-ft level may be excavated material if it is free of rocks and clods larger than 3 inches in diameter, vegetable matter, and other deleterious substances.
- COMPACTION:** All backfill material to be compacted shall be placed at optimum moisture content, moisture being added or removed as required, and shall be deposited in layers not exceeding 6 inches thick. Backfill material shall be compacted to 90% of maximum density. Compaction by watering shall not be permitted.
- MAXIMUM DENSITY:** The maximum density shall be determined in accordance with the testing procedure of AASHTO (American Association of State Highway Officials) designation T-99-49, modified as follows:
 - The rammer shall weigh 10 pounds.
 - The rammer shall be dropped from a height of 18 inches above the sample.
 - The samples shall be compacted in 5 layers, each approximately 1 inch thick, with each layer receiving 55 blows.
 - The mold shall be 6 inches in diameter and 7 inches high, with a metal spacer disc 5-15/16 inches in diameter and 2-1/2 inches high, using a false bottom in the mold during compaction.
 - All material retained on a 3/4-inch sieve shall be removed and replaced with an equal portion of material between the No. 4 and 3/4-inch sieves.
 - A separate batch of material shall be used for each compaction test specimen. No material shall be reused for compaction.
- The most satisfactory installation for a 35-psi minimum-cost shelter is as shown. It is conceivable that construction may be required on sites where bedrock or the water table is near the surface. In this event, the shelter can be placed at grade or below (as site conditions permit) and then completely covered with an extensive fill. The earth cover over the arch is to be graded as shown on Sketch "A". Note that the earth mound over the portion of the arch structure that protrudes above grade must be shaped so that the faces of the earth mound are no steeper than 4 horizontal to 1 vertical and so that the distance from the toe of the slope (the intersection of the slope with the original grade) to the nearest point on the structure is at least four times the height of the mound. The shelter endwalls are to be covered in accordance with Sketch "B".





SECTION A-A

SURFACE

10 PSI MAX.

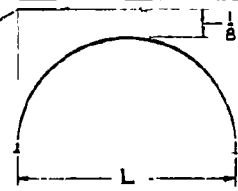
SECTION B-B

SEMI-BURIED

10 PSI MAX.

4

ORIGINAL
GRADE



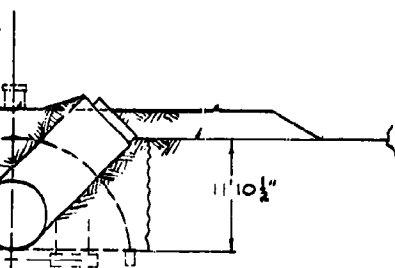
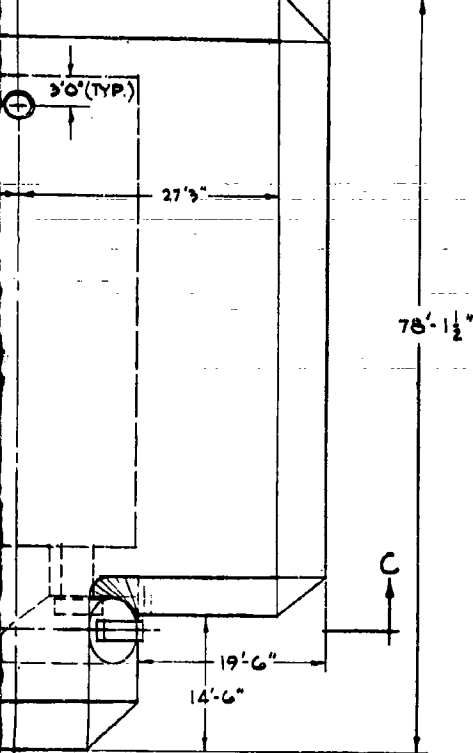
SKETCH "A"
ARCH BERM

BERM CONFIGURATION
35 PSI SHELTER WHEN
PROTRUDES ABOVE GR

7. The most satisfactory
It is conceivable
table is near to
(as site conditions)
The earth cover
earth mound over
shaped so that
vertical and so
slope with the
times the height
with Skotch "B"



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IS APPROVED BY: Lauri E. Portner



SECTION C-C

RIED - SEE NOTE NO 7
35 PSI MAX.

B	E
PT	PT
4	2
5	4
8	7
11	10
14	13
17	16
20	19

ENGINEERING & DESIGN
IS APPROVED BY: *Lewis B. Portner* DATE: 22 May 62

not more than 25% shall pass a No. 200 sieve. The plasticity index of the material shall not exceed 8 when tested in accordance with ASTM tests designated J423-54T and D424-54T. Material shall be free of roots, vegetable matter, and other organic substances.

3. **BACKFILL AND GRADING:** Backfilling shall be accomplished essentially simultaneously on the sides and ends of the shelter, with work starting at the bottom midpoint of the sides and progressing symmetrically upward in such a manner that fill at the midsection is always deeper than at the ends. Care shall be exercised in placing and compacting the backfill to prevent deformation of the metal arch. Deformation, if any, shall not exceed 2% of the design radius.
4. **BACKFILL:** Backfill for the sides and entrance end shall be accomplished with either native or select backfill to a point 8 ft above the floor slab. The decision as to whether to use select material for this purpose will be based on the amount of effort and earth handling required in order to use native soil to obtain backfill compaction as specified. Sand shall be used for backfill under the storage tanks as indicated (see Fig. A-17M). Backfill at the non-entrance end and above the 8-ft level may be excavated material if it is free of rocks and clods larger than 3 inches in diameter, vegetable matter, and other deleterious substances.
5. **COMPACTION:** All backfill material to be compacted shall be placed at optimum moisture content, moisture being added or removed as required, and shall be deposited in layers not exceeding 6 inches thick. Backfill material shall be compacted to 90% of maximum density. Compaction by watering shall not be permitted.
6. **MAXIMUM DENSITY:** The maximum density shall be determined in accordance with the testing procedure of AASHTO (American Association of State Highway Officials) designation T-99-49, modified as follows:
 - (a) The rammer shall weigh 10 pounds.
 - (b) The rammer shall be dropped from a height of 18 inches above the sample.
 - (c) The samples shall be compacted in 5 layers, each approximately 1 inch thick, with each layer receiving 55 blows.
 - (d) The mold shall be 6 inches in diameter and 7 inches high, with a metal spacer disc 5-15/16 inches in diameter and 2-1/2 inches high, using a false bottom in the mold during compaction.
 - (e) All material retained on a 3/4-inch sieve shall be removed and replaced with an equal portion of material between the No. 4 and 3/4-inch sieves.
 - (f) A separate batch of material shall be used for each compaction test specimen. No material shall be reused for compaction.

7. The most satisfactory installation for a 35-psi minimum-cost shelter is as shown. It is conceivable that construction may be required on sites where bedrock or the water table is near the surface. In this event, the shelter can be placed at grade or below (as site conditions permit) and then completely covered with an extensive fill. The earth cover over the arch is to be graded as shown on Sketch "A". Note that the earth mound over the portion of the arch structure that protrudes above grade must be shaped so that the faces of the earth mound are no steeper than 4 horizontal to 1 vertical and so that the distance from the toe of the slope (the intersection of the slope with the original grade) to the nearest point on the structure is at least four times the height of the mound. The shelter endwalls are to be covered in accordance with Sketch "B".

6

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN		FJA		
CHECKED		FJK		
ENCL. DESIGN APPROV. J.	PROJ. ENGR.	FIG. A-1M GENERAL CONFIGURATIONS		
	SUPV.			
	BRANCH HEAD			
	DIVISION HEAD			
DATE		SCALE	PROJECT	TECH MEMO
DWG. NO.		S-62-970		ALT.
DATE		19		

48'-11 1/2"

47'-9 1/2"

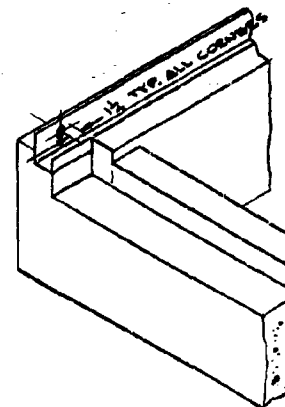
SEE DETAIL "B"

3" CONC. SLAB ON GROUND
(SEE NOTE #3)

TYP. SIDEWALL
FOOTING SECTION FOR
DETAILS SEE FIG. A-2-IN

UNBALANCED MULTI-PLATE
CHANNEL SHOE

SIDEWALLS
TYPICAL TYPE 1
SEE FIG. A-2-2N



DETAIL "B"

3/4" x 1'-0"

ENDWALL CONC. DEADMAN
ALL SHELTERS

FOUNDATION & CONC. DEADMAN PLAN

SCALE: 1/4" = 1'-0"

BREAK-OFF LIP
OF CLAY SEWER PIPE
DRAIN GUTTER

PERFORATED WOOD
PLUG

FIN. FLZ. LINE

8" DIA. CLAY
SEWER PIPE,
NON-GLAZED

3'-0"

DETAIL of
DRY SUMP

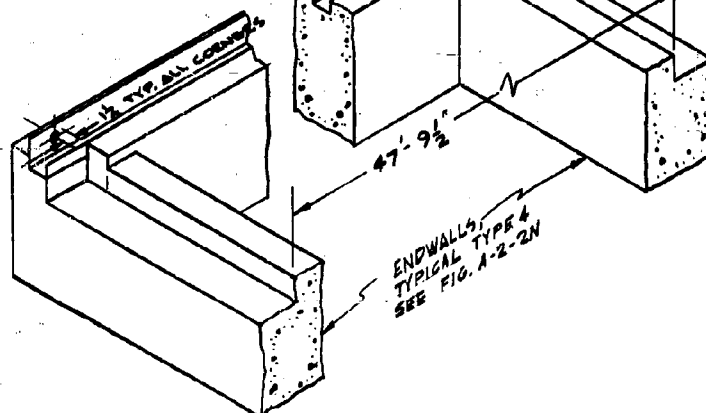
SCALE: 1 1/2" = 1'-0"

GENERAL

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

2

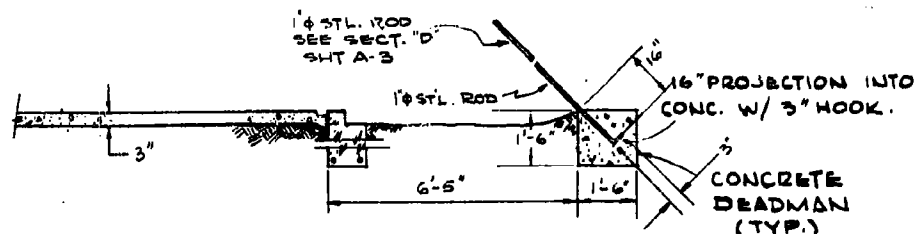
SIDEWALLS
TYPICAL TYPE 1
SEE FIG. A-2-2N



DETAIL "B"

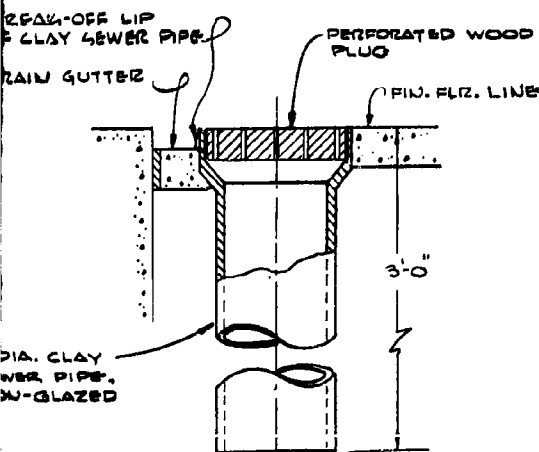
3/4" = 1'-0"

(A)



SECTION (A)

ENDWALL CONC. DEADMAN
ALL SHELTERS



DETAIL of
DRY SUMP

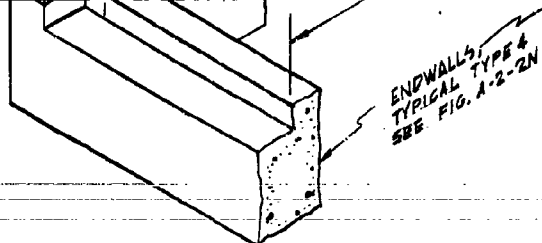
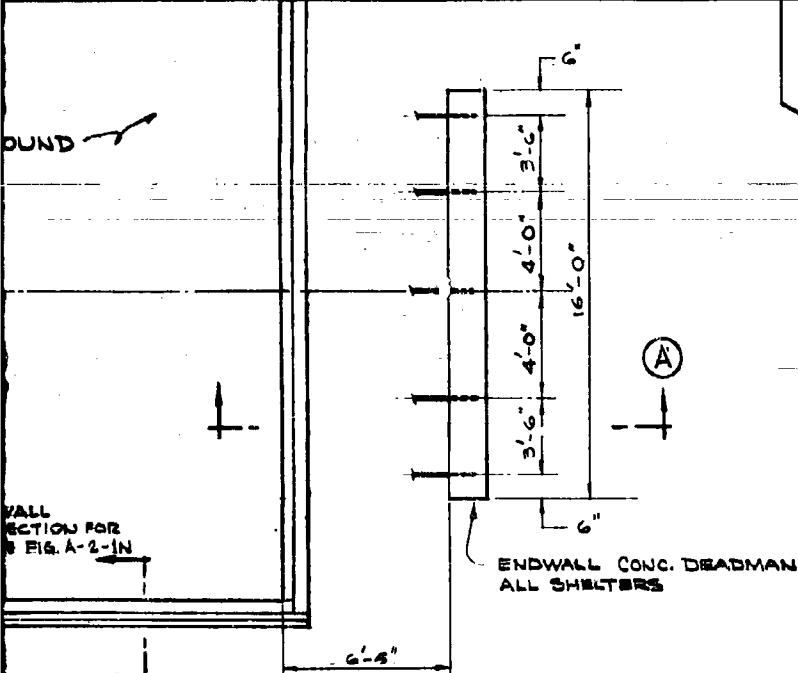
SCALE: 1 1/2" = 1'-0"

GENERAL NOTES:

1. CONCRETE SHALL HAVE A MINIMUM ULTIMATE COMPRESSIVE STRENGTH OF 2500 PSI AT 28 DAYS.
2. ALL FOUNDATIONS SHOWN ON THIS DWG. ARE SYMBOLIC ONLY. FOR ACTUAL DESIGN & CONSTR. DETAILS OF THE FOUNDATION TO SUIT A PARTICULAR SITE, REFER TO FIGS. A-2-1N & A-2-2N
3. THE SURFACE OF THE SLAB SHALL BE FLOATED TO A SMOOTH FINISH WITH A STEEL FLOAT, AND IT SHALL NOT VARY MORE THAN 1/2" WHEN MEASURED WITH A 10-FT. TEMPLATE.
4. LUMBER SHALL BE DOUGLAS FIR, CONSTR. GRADE
5. CEMENT SHALL CONFORM WITH REQUIREMENTS OF FEDERAL SPECIFICATIONS 45-C-192b, TYPE I.
6. REINFORCING STEEL SHALL BE INTERMEDIATE GRADE BILLET STEEL CONFORMING TO FEDERAL SPECIFICATION QQ-S-632, TYPE II, GRADE C.

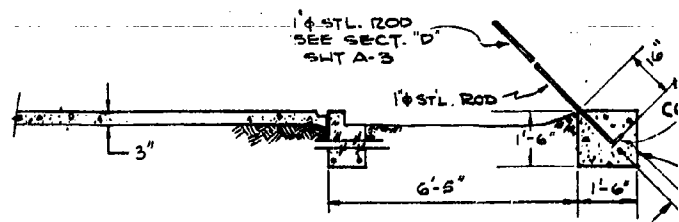
3

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 25, CALIFORNIA				

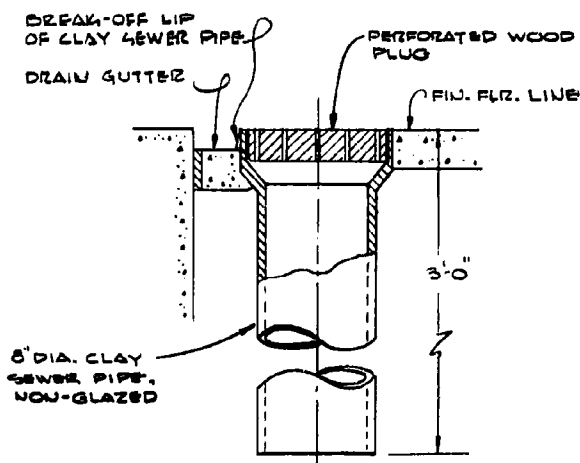


DETAIL "B"

$\frac{3}{4}" = 1'-0"$



SECTION A



DETAIL of DRY SUMP

SCALE: $1\frac{1}{2}" = 1'-0"$

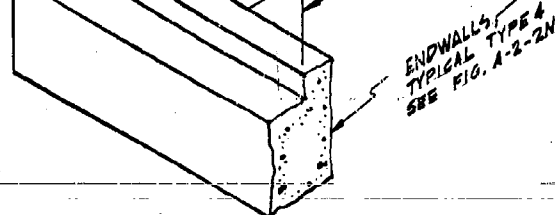
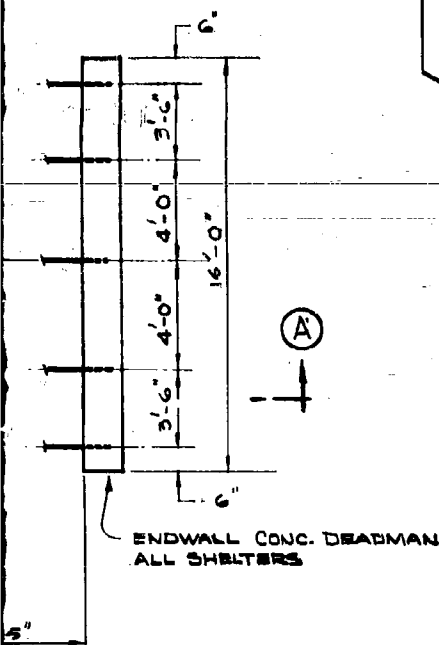
GENERAL NOTES:

1. CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 2500 PS
2. ALL FOUNDATIONS SHOWN ON THIS DWG. ARE FOR ACTUAL DESIGN & CONSTR. DETAILS OF TO SUIT A PARTICULAR SITE, REFER TO F
3. THE SURFACE OF THE SLAB SHALL BE TO A SMOOTH FINISH WITH A STEEL FLO IT SHALL NOT VARY MORE THAN MEASURED WITH A 10-FT. TEMPLA
4. LUMBER SHALL BE DOUGLAS FIR, C
5. CEMENT SHALL CONFORM WITH REQUIRE FEDERAL SPECIFICATIONS 55-C-192 b
6. REINFORCING STEEL SHALL BE INTERMEI BILLET STEEL CONFORMING TO FEDERAL 5 QQ-S-632, TYPE II, GRADE C.

4

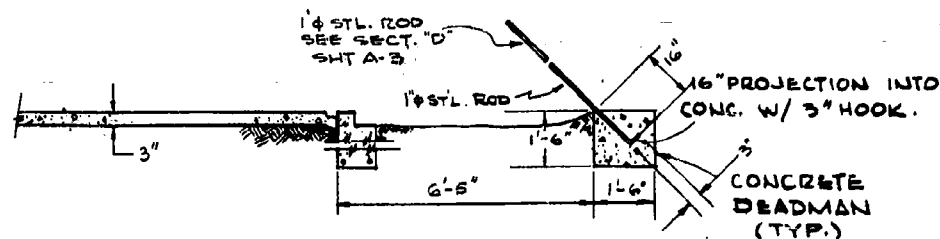
REVISION	DATE	DESCRIPTION
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LAB SAN FRANCISCO 24, CALIFORNIA		
DRAWN	FJA	FIG. A FOUNDATION, FLOOR DEADMEN ARR
CHECKED	FJA	
SECTION HEAD		
FRANCH HEAD		
DIVISION HEAD		
DATE	SCALE	PROJECT
26 FEB 62	NOTED	
SATISFACTORY TO: <i>ATP</i>		DRAWING SHEET S-62
DATE 5-22-62		

ENGINEERING & DESIGN
 IS APPROVED BY: *Lewis G. Patton* DATE: 22 MAY 62

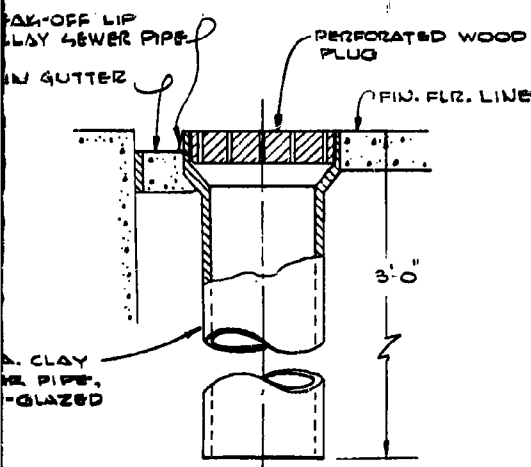


DETAIL "B"

1/2" = 1'-0"



SECTION (A)



DETAIL OF DRY SUMP

SCALE: 1/2" = 1'-0"

GENERAL NOTES:

1. CONCRETE SHALL HAVE A MINIMUM ULTIMATE COMPRESSIVE STRENGTH OF 2500 PSI AT 28 DAYS.
2. ALL FOUNDATIONS SHOWN ON THIS DWG. ARE SYMBOLIC ONLY. FOR ACTUAL DESIGN & CONSTR. DETAILS OF THE FOUNDATION TO SUIT A PARTICULAR SITE, REFER TO FIGS. A-2-1N & A-2-2N
3. THE SURFACE OF THE SLAB SHALL BE FLOATED TO A SMOOTH FINISH WITH A STEEL FLOAT, AND IT SHALL NOT VARY MORE THAN 1/2" WHEN MEASURED WITH A 10-FT. TEMPLATE.
4. LUMBER SHALL BE DOUGLAS FIR, CONSTR. GRADE
5. CEMENT SHALL CONFORM WITH REQUIREMENTS OF FEDERAL SPECIFICATIONS 45-C-192B, TYPE I.
6. REINFORCING STEEL SHALL BE INTERMEDIATE GRADE BILLET STEEL CONFORMING TO FEDERAL SPECIFICATION QQ-S-632, TYPE II, GRADE C.

5

REVISION	DATE	DESCRIPTION	BY	APP.	
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA					
DRAWN	FJA	FIG. A-2M FOUNDATION, FLOOR SLAB, AND DEADMEN ARRANGEMENTS			
CHECKED	FJA				
SECTION HEAD					
BRANCH HEAD					
DIVISION HEAD					
DATE		SCALE	PROJECT	FINISH	HEAT TREAT
26 FEB 62		NOTED			
SATISFACTORY TO: <i>[Signature]</i>			DRAWING NUMBER		ALT.
DATE 5-22-62			S-62-970		
			SHEET 2 OF 19		

ENGINEERING & DESIGN

IS APPROVED BY: *[Signature]* DATE: 22 MAY 62

BACKFILL SOIL TYPE	FOOTING LOAD - *P ₀ = 10 PSI
Gravel, sand, gravel and sand, gravel-sand-silt and gravel-sand-clay mixtures, or crushed rock	10,000 LB/L.F.
Inorganic clay, gravelly clay, sandy clay, or silty clay of medium to low compressibility and plasticity	10,000
Inorganic silt, very fine sand, fine sand and silt, or soft, plastic, compressible clay	20,000

Diagram illustrating the cross-section of a footing with reinforcement details:

- Top reinforcement: 10" dimension.
- Reinforcement bars 'A' for spacing in inches, 1 bar diameter, see Table 32.
- Depth 'D' is indicated, with a note: "SEE SCHEDULE 1'-0" MIN".
- Bottom reinforcement: 2" dimension.
- Bottom reinforcement: 3" dimension.
- Footing width 'W' is indicated, with a note: "1'4" TO 2'0"

[illegible]

SCALE: $1\frac{1}{2}'' = 1'-0''$

SIDWALL	TYPE BENEATH
HARDP GRAVE	
COARS COHES AS GR GRAVE	
FINE SOIL SAND GRAV	

FOOTING WIDTH "W" (FT-IN.) FROM TABLE III	10,000 D
1-0	-
1-4	0-10
1-8	0-10
2-0	0-10
2-6	0-10
3-0	0-10
4-0	0-10
5-0	0-10
6-0	0-10
8-0	0-10

1

1. Normal safe bearing capacity
2. Bearing values for different types of soil in direct proportion to the safe bearing capacity
3. Compact gravel, sand and gravel, resistance to penetration
4. Loose gravel, sand and gravel, resistance to penetration

TABLE I
NO. LOADS TO SIDEWALL FOOTINGS

	FOOTING LOAD - LBS./LIN. FT.	
	*P ₀ = 10 PSI	*P ₀ = 35 PSI
vel and sand, and gravel-sand-crushed rock	10,000 LB/L.F.	30,000 LB/L.F.
avelly clay, sandy of medium to low nd plasticity	10,000	45,000
ery fine sand, t, or soft, plastic,	20,000	60,000

pressure rating of shelter.

TABLE II
NORMAL SAFE BEARING CAPACITY OF VARIOUS SOILS

SOIL TYPE		Normal Safe Bearing Capacity-Lbs/Sq.Ft.
COARSE-GRAINED NON-COHESSIVE SOILS	HARDPAN, cemented gravel ledge rock	20,000 lb/s.f. minim.
	Compact gravel or sand and gravel	8,000 lb/s.f.
	Loose gravel or sand and gravel	6,000
	Compact coarse sand	6,000
	Loose coarse sand	4,000
	Compact fine sand	4,000
	Loose fine sand	2,000
FINE-GRAINED COHESSIVE SOILS	Hard clay	8,000
	Firm or medium clay	4,000
	Soft clay	2,000
	Adobe	1,000
FINEST - MEDIATE TYPE SOILS	Compact inorganic sand and silt	1,500
	Loose inorganic sand and silt	500

The sidewall footing rating for which the shelter and over the shelter, footings.

Table I establishes Enter with the overpressure load in pounds per lineal soil, use that giving the

Next, determine the beneath the footings. The excavated site, or record capacity" is the bearing structures for resistance

The normal safe bear qualified soils engineer, bearing capacities from 1

Bearing capacity is bearing capacities are de size and shape of the foot proportioning footings for adjacent grade. Where be adjustments must be made.

Footings for shelter of the soil under dynamic directly, but is an indic results to be achieved, bearing capacity of the s have a safety factor of 2 conditions.

Bearing values estat factor in this range. An excessive settlement under static bearing capacity s

Normal safe bearing great variation in values may be due to actual vari variation in the actual s in various parts of the t than those in Table II s by a soils engineer, suju

Enter Table III with of soil beneath the footi soils are intermediate in grained, cohesive" groups of the two may be used.

In establishing foot of footing width on beari soils. No further adjust

The detailed design Table IV with the footing thickness of the footing footing details are as st

ILLUSTRATIVE EXAMPLE:

A shelter is to be d will bear on a clay-type will be clean sand and gr the footing load is found a bearing value of 3,000 4,000 pounds per square f since it is the smaller 1 foot and fine-grained col width or 2'-6" is round. or 2'-6", the thickness d spacing. Other footing d

TABLE III
SIDEWALL FOOTING WIDTHS AS REQ'D BY FOOTING LOAD AND NORMAL SAFE BEARING CAPACITY

TYPE OF SOIL BENEATH FOOTING	NORMAL, SAFE BEARING CAPACITY	FOOTING WIDTH REQUIRED IN FEET AND INCHES FOR FOOTING LOAD SHOWN (POUNDS/LIN. FOOT)				
		10,000	20,000	30,000	45,000	60,000
HARDPAN, CEMENTED GRAVEL, OR LEDGE ROCK	20,000 lb/s.f.	1-0	1-0	1-0	1-0	1-0
	12,000 lb/s.f.	1-0	1-0	1-4	2-0	2-6
COARSE-GRAINED NON-COHESSIVE SOILS, SUCH AS GRAVEL, SAND, AND GRAVEL AND SAND	10,000	1-0	1-4	1-8	2-6	3-0
	8,000	1-0	1-8	2-0	2-6	3-0
	6,000	1-0	1-8	2-6	3-0	4-0
	4,000	1-4	2-6	3-0	4-0	5-0
	3,000	1-8	3-0	4-0	5-0	6-0
	2,000	2-6	4-0	5-0	6-0	8-0
	1,500	3-0	5-0	6-0	8-0	-
	1,000	4-0	6-0	8-0	-	-
	12,000 lb/s.f.	1-0	1-0	1-0	1-0	1-4
FINE-GRAINED COHESSIVE SOILS, SUCH AS CLAY AND SANDY, SILTY OR GRAVELLY CLAY	10,000	1-0	1-0	1-0	1-0	1-4
	8,000	1-0	1-0	1-0	1-4	1-8
	6,000	1-0	1-0	1-4	1-8	2-6
	4,000	1-0	1-4	1-8	2-6	4-0
	3,000	1-0	1-8	2-6	4-0	5-0
	2,000	1-4	2-6	4-0	5-0	8-0
	1,500	1-8	3-0	5-0	6-0	-
	1,000	2-6	5-0	8-0	-	-
	12,000 lb/s.f.	1-0	1-0	1-0	1-0	1-4

TABLE IV
FOOTING STEEL REINFORCEMENT SCHEDULE FOR SIDEWALL FOOTINGS *

FOOTING WIDTH "W" (FT/IN.) FROM TABLE I	FOOTING LOAD LBS./LIN. FT. (FROM TABLE I)									
	10,000 LB/L.F.		20,000 LB/L.F.		30,000 LB/L.F.		45,000 LB/L.F.		60,000 LB/L.F.	
	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"
1-0	-	None	-	None	-	None	-	None	-	None
1-4	0-10	None	0-10	None	0-10	None	0-10	None	0-10	None
1-8	0-10	None	0-10	None	0-10	None	1-0	None	1-0	None
2-0	0-10	*3 @ 24 inches	0-10	*3 @ 24 inches	1-0	*3 @ 24 inches	1-2	*3 @ 24 inches	1-3	*3 @ 24 inches
2-6	0-10	*3 @ 6 "	0-10	*3 @ 6 "	0-10	*3 @ 4 "	1-0	*3 @ 3 1/2 "	1-0	*3 @ 2 1/2 "
3-0	0-10	*3 @ 6 "	0-10	*3 @ 5 "	0-10	*3 @ 3 1/2 "	1-0	*3 @ 3 "	1-0	*3 @ 2 1/2 "
4-0	0-10	*3 @ 6 "	0-10	*3 @ 5 "	0-10	*3 @ 3 "	1-0	*3 @ 3 "	1-0	*3 @ 2 "
5-0	0-10	*3 @ 6 "	0-10	*3 @ 4 "	0-10	*3 @ 2 1/2 "	1-0	*4 @ 3 1/2 "	1-2	*4 @ 3 1/2 "
6-0	0-10	*4 @ 10 "	0-10	*4 @ 5 "	0-10	*4 @ 3 1/2 "	1-0	*5 @ 4 1/2 "	1-2	*5 @ 4 "
8-0	0-10	*4 @ 7 "	0-10	*4 @ 3 1/2 "	0-10	*5 @ 3 1/2 "	1-0	*6 @ 4 1/2 "	1-2	*6 @ 4 "

TERMS USED IN TABLES

- Normal safe bearing capacity as shown is for a footing 3'-0" wide at a depth of 1'-6" below grade.
- Bearing values for coarse-grained soils as shown in Table II are for a footing 3'-0" wide, and are to be reduced in direct proportion to footing width for footings less than 3'-0" wide.
- Compact gravel, sand, or sand and gravel are deposits which require picking for removal, and offer high resistance to penetration by excavating tools.

* Reinforcement steel is fabricated in increments of 1/8 inch on the diameter. The designation *3 indicates a rod 3/8 inch in diameter.

TABLE II
Bearing Capacity of Various Soils

TYPE	Normal Safe Bearing Capacity-Lbs/Sq.Ft.
Gravel ledge rock	20,000 lb/s.f. minm.
Sand and gravel	8,000 lb/s.f.
Clay and gravel	6,000
Clay	6,000
Clay	4,000
Clay	4,000
Clay	2,000
Clay	8,000
Clay	4,000
Clay	2,000
Clay	1,000
Sand and silt	1,500
Clay and silt	500

TABLE III
FOOTING WIDTH REQUIRED IN FEET AND INCHES
FOR FOOTING LOAD SHOWN (POUNDS/LIN. FOOT)

10,000	20,000	30,000	45,000	60,000
1-0	1-0	1-0	1-0	1-0
1-0	1-0	1-4	2-0	2-6
1-0	1-4	1-8	2-6	3-0
1-0	1-8	2-0	2-6	3-0
1-0	1-8	2-6	3-0	4-0
1-4	2-6	3-0	4-0	5-0
1-8	3-0	4-0	5-0	6-0
2-6	4-0	5-0	6-0	8-0
3-0	5-0	6-0	8-0	-
4-0	6-0	8-0	-	-
1-0	1-0	1-0	1-0	1-4
1-0	1-0	1-0	1-0	1-4
1-0	1-0	1-0	1-4	1-8
1-0	1-0	1-4	1-8	2-6
1-0	1-4	1-8	2-6	4-0
1-0	1-8	2-6	4-0	5-0
1-4	2-6	4-0	5-0	8-0
1-8	3-0	5-0	8-0	-
2-6	5-0	8-0	-	-

TABLE IV
FOOTING DETAILS FOR SIDEWALL FOOTINGS *

(FROM TABLE I)				
L.F.	45,000 LB./L.F.		60,000 LB./L.F.	
INF. "A"	D	REINF. "A"	D	REINF. "A"
None	-	None	-	None
None	0-10	None	0-10	None
None	1-0	None	1-0	None
@ 2 1/2 inches	1-2	*3 @ 2 1/2 inches	1-3	*3 @ 2 1/2 inches
@ 4 "	1-0	*3 @ 3 1/2 "	1-0	*3 @ 2 1/2 "
@ 3 1/2 "	1-0	*3 @ 3 "	1-0	*3 @ 2 1/2 "
@ 3 "	1-0	*3 @ 3 "	1-0	*3 @ 2 "
@ 2 1/2 "	1-0	*4 @ 3 1/2 "	1-2	*4 @ 3 1/2 "
@ 3 1/4 "	1-0	*5 @ 4 1/2 "	1-2	*5 @ 4 "
@ 3 1/2 "	1-0	*6 @ 4 1/2 "	1-2	*6 @ 4 "

* Reinforcement steel is fabricated in increments of 1/8 inch on the diameter. The designation *3 indicates a rod 3/8 inch in diameter.
wide at a depth of 1'-6" below grade.

footing 3'-0" wide, and are to be reduced to 3'-0" wide.

require picking for removal, and offer high

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

NO.	NAME	NO.	MAT'L.	BACK.	STOCK SIZE	REMARKS
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PROCEDURE FOR DETERMINING THE DESIGN AND CONSTRUCTION DETAILS OF THE SHELTER'S SIDEWALL FOOTINGS

The sidewall footing to be used with a particular shelter is dependent on (a) the overpressure rating for which the shelter is to be designed, (b) the type of soil used for backfill adjacent to and over the shelter, and (c) the type and bearing capacity of the in-place soil beneath the footings.

Table I establishes the bearing load that must be supported by the continuous sidewall footings. Enter with the overpressure rating and the type of soil used for backfill to determine the foundation load in pounds per linear foot of footing. Where doubt exists as to proper classification of backfill soil, use that giving the higher footing load in Table I.

Next, determine the type of soil and the normal safe bearing capacity of the in-place soil beneath the footings. The type of soil is determined by preliminary borings, inspection of the excavated site, or records of previous construction in the immediate area. The "normal safe bearing capacity" is the bearing value that would be used in proportioning footings of building and other structures for resistance to normal service loads exclusive of wind, earthquakes, or impact loads.

The normal safe bearing capacity can be established by (a) a special soils investigation by a qualified soils engineer, (b) use of tabulated "permissible," "allowable," or "presumptive" safe bearing capacities from local building codes, or (c) use of recommended bearing values from Table II.

Bearing capacity is expressed in terms of pounds per square foot of footing area. The actual bearing capacities are dependent not only on the type and properties of the soil, but also on the size and shape of the footing. Values shown in Table II and as used in succeeding steps of proportioning footings for shelters are for a footing 3 feet wide at a depth of 1-1/2 feet below adjacent grade. Where bearing values are stated in terms of other widths or depths, appropriate adjustments must be made by a qualified soils engineer.

Footings for shelters are proportioned on the basis of the expected ultimate bearing capacity of the soil under dynamic conditions of loading. The normal safe bearing capacity is not used directly, but is an indication of the expected ultimate dynamic bearing capacity. For consistent results to be achieved, the normal safe bearing capacity must be reasonably related to the actual bearing capacity of the soil. It is assumed herein that values of normal safe bearing capacity have a safety factor of 2.5 to 3.0 with respect to actual foundation failure under static loading conditions.

Bearing values established by a soils engineer can usually be expected to contain a safety factor in this range. An exception may occur where low bearing values are prescribed to avoid excessive settlement under sustained loads. In this case, higher values based on the actual static bearing capacity should be used.

Normal safe bearing capacities established by building codes of different jurisdictions show great variation in values for soils of apparently similar description. To some extent, this variation may be due to actual variation in properties of local soil formations. It may also be due to variation in the actual safety factors. Values in Table II represent a fair average of building codes in various parts of the United States. Where local building code values are much higher or lower than those in Table II and are not justified by local conditions, as determined by a soils analysis by a soils engineer, adjustment can be made in the local code values.

Enter Table III with the foundation load from Table I and the type and bearing capacity of soil beneath the footings to determine the required width of footing in feet and inches. If soils are intermediate in characteristics between the "coarse-grained, noncohesive" and the "fine-grained, cohesive" groups of soils, an intermediate width of footing may be selected, or the wider of the two may be used.

In establishing footing widths as shown in Table III, allowance has been made for the effect of footing width on bearing capacity, and the difference between static and dynamic resistance of soils. No further adjustment is necessary for these factors.

The detailed design of footings is shown in Types 1, 2, and 3, and in Table IV. Enter Table IV with the footing load from Table I and the footing width from Table III to determine the thickness of the footing base and the size and spacing of transverse reinforcing bars. Other footing details are as shown in the appropriate Type 1, 2, or 3.

ILLUSTRATIVE EXAMPLE:

A shelter is to be designed and constructed for a nominal 35-pai overpressure rating. Footings will bear on a clay-type soil of medium-stiff consistency. Backfill over and around the shelter will be clean sand and gravel. From Table I, with overpressure of 35-pai and sand-gravel backfill, the footing load is found to be 30,000 pounds per linear foot. The local building code establishes a bearing value of 3,000 pounds per square foot for medium-stiff clay, while Table II gives 4,000 pounds per square foot. The building code value of 3,000 pounds per square foot will be used, since it is the smaller value. From Table III, with a footing load of 30,000 pounds per linear foot and fine-grained cohesive soil of 3,000 pounds per square foot bearing value, a required footing width of 2'-6" is found. From Table IV, for a footing load of 30,000 pounds per foot and a footing width of 2'-6", the thickness is found to be 10", and the transverse reinforcement is No. 3 bars at 4-inch spacing. Other footing details are as shown in Type 3.

FINE-GRAINED COHESIVE SOILS	Soft clay	2,000
	Adobe	1,000
INTER-MEDIATE TYPE SOILS	Compact inorganic sand and silt	1,500
	Loose inorganic sand and silt	500

TABLE III
SIDEWALL FOOTING WIDTHS AS REQ'D BY FOOTING LOAD AND NORMAL SAFE BEARING CAPACITY

TYPE OF SOIL BENEATH FOOTING	NORMAL SAFE BEARING CAPACITY	FOOTING WIDTH REQUIRED IN FEET AND INCHES FOR FOOTING LOAD SHOWN (POUNDS/LIN. FOOT)					
		10,000	20,000	30,000	45,000	60,000	
HARDFAN, CEMENTED GRAVEL, OR LEDGE ROCK	20,000 lb/s.f.	1-0	1-0	1-0	1-0	1-0	
COARSE-GRAINED NON-COHESIVE SOILS, SUCH AS GRAVEL, SAND, AND GRAVEL AND SAND	12,000 lb/s.f.	1-0	1-0	1-4	2-0	2-6	
	10,000	1-0	1-4	1-8	2-6	3-0	
	8,000	1-0	1-8	2-0	2-6	3-0	
	6,000	1-0	1-8	2-6	3-0	4-0	
	4,000	1-4	2-6	3-0	4-0	5-0	
	3,000	1-8	3-0	4-0	5-0	6-0	
	2,000	2-6	4-0	5-0	6-0	8-0	
	1,500	3-0	5-0	6-0	8-0	-	
	1,000	4-0	6-0	8-0	-	-	
FINE-GRAINED COHESIVE SOILS, SUCH AS CLAY AND SANDY, SILTY OR GRAVELLY CLAY	12,000 lb/s.f.	1-0	1-0	1-0	1-0	1-4	
	10,000	1-0	1-0	1-0	1-0	1-4	
	8,000	1-0	1-0	1-0	1-4	1-8	
	6,000	1-0	1-0	1-4	1-8	2-6	
	4,000	1-0	1-4	1-8	2-6	4-0	
	3,000	1-0	1-8	2-6	4-0	5-0	
	2,000	1-4	2-6	4-0	5-0	8-0	
	1,500	1-8	3-0	5-0	8-0	-	
	1,000	2-6	5-0	8-0	-	-	

TABLE IV
FOOTING STEEL REINFORCEMENT SCHEDULE FOR SIDEWALL FOOTINGS *

FOOTING WIDTH "W" (FT+IN.) FROM TABLE II	FOOTING LOAD LBS/LIN. FT. (FROM TABLE I)									
	10,000LB/L.F.		20,000LB/L.F.		30,000LB/L.F.		45,000LB/L.F.		60,000LB/L.F.	
	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"	D	REINF. "A"
1-0	-	None	-	None	-	None	-	None	-	None
1-4	0-10	None	0-10	None	0-10	None	0-10	None	0-10	None
1-8	0-10	None	0-10	None	0-10	None	1-0	None	1-0	None
2-0	0-10	*3 @ 24 inches	0-10	*3 @ 24 inches	1-0	*3 @ 24 inches	1-2	*3 @ 24 inches	1-3	*3 @ 24 inches
2-6	0-10	*3 @ 6 "	0-10	*3 @ 6 "	0-10	*3 @ 4 "	1-0	*3 @ 3 1/2 "	1-0	*3 @ 2 1/2 "
3-0	0-10	*3 @ 6 "	0-10	*3 @ 5 "	0-10	*3 @ 3 1/2 "	1-0	*3 @ 3 "	1-0	*3 @ 2 1/2 "
4-0	0-10	*3 @ 6 "	0-10	*3 @ 5 "	0-10	*3 @ 3 "	1-0	*3 @ 3 "	1-0	*3 @ 2 "
5-0	0-10	*3 @ 6 "	0-10	*3 @ 4 "	0-10	*3 @ 2 1/2 "	1-0	*4 @ 3 1/2 "	1-2	*4 @ 3 1/2 "
6-0	0-10	*4 @ 10 "	0-10	*4 @ 5 "	0-10	*4 @ 3 1/2 "	1-0	*5 @ 4 1/2 "	1-2	*5 @ 4 "
8-0	0-10	*4 @ 7 "	0-10	*4 @ 3 1/2 "	0-10	*5 @ 3 1/2 "	1-0	*6 @ 4 1/2 "	1-2	*6 @ 4 "

TERMS USED IN TABLES

- Normal safe bearing capacity as shown is for a footing 3'-0" wide at a depth of 1'-6" below grade.
- Bearing values for coarse-grained soils as shown in Table II are for a footing 3'-0" wide, and are to be reduced in direct proportion to footing width for footings less than 3'-0" wide.
- Compact gravel, sand, or sand and gravel are deposits which require picking for removal, and offer high resistance to penetration by excavating tools.
- Loose gravel, sand, or sand and gravel are deposits which can readily be removed by shoveling only.
- Hard clay requires picking for removal. A fresh sample can be molded in the fingers only with the greatest difficulty.
- Medium or firm clay can be removed by spading. A fresh sample requires substantial pressure to mold in the fingers.
- Soft clay can be molded in the fingers with relatively slight pressure.
- Coarse gravel is particles retained on a No. 10 mesh sieve. Coarse sand passes No. 10 and is retained on a No. 40 mesh sieve. Fine sand passes a No. 40 mesh sieve and is retained on a No. 270 mesh sieve. Gravel, sand, and mixtures of gravel and sand possess little or no cohesion when dry.
- Clay is an extremely fine-grained soil which has sufficient cohesion when dry to form hard lumps which cannot readily be broken in the fingers.
- Silt is particles smaller than fine sand but coarser than clay. Its cohesive strength when dry is slight, and lumps can easily be broken in the fingers.

* Reinforcement steel is fabricated in increments of 1/8 inch on the diameter. The designation *3 indicates a rod 3/8 inch in diameter.

5

ENGINEERING & DESIGN
IS APPROVED BY: _____

Lewis W. Pratt

	2,000
	1,000
and silt	1,500
and silt	500

AND NORMAL SAFE BEARING CAPACITY

FOOTING WIDTH REQUIRED IN FEET AND INCHES
FOOTING LOAD SHOWN (POUNDS/LIN. FOOT)

000	20,000	30,000	45,000	60,000
0	1-0	1-0	1-0	1-0
0	1-0	1-4	2-0	2-6
0	1-4	1-8	2-6	3-0
0	1-8	2-0	2-6	3-0
0	1-8	2-6	3-0	4-0
4	2-6	3-0	4-0	5-0
8	3-0	4-0	5-0	6-0
6	4-0	5-0	6-0	8-0
0	5-0	6-0	8-0	-
0	6-0	8-0	-	-
0	1-0	1-0	1-0	1-4
0	1-0	1-0	1-0	1-4
0	1-0	1-0	1-4	1-8
0	1-0	1-4	1-8	2-6
0	1-4	1-8	2-6	4-0
0	1-8	2-6	4-0	5-0
4	2-6	4-0	5-0	8-0
8	3-0	5-0	8-0	-
6	5-0	8-0	-	-

FOR SIDEWALL FOOTINGS *

(FROM TABLE I)

	45,000LB/L.F.	60,000LB/L.F.
"A"	D REINF. "A"	D REINF. "A"
-	None	None
0-10	None	None
1-0	None	None
24 inches	1-2 *3 @ 24 inches	1-3 *3 @ 24 inches
"	1-0 *3 @ 3 1/2 "	1-0 *3 @ 2 1/2 "
3 1/2 "	1-0 *3 @ 3 "	1-0 *3 @ 2 1/2 "
3 "	1-0 *3 @ 3 "	1-0 *3 @ 2 "
2 1/2 "	1-0 *4 @ 3 1/2 "	1-2 *4 @ 3 1/2 "
3 1/2 "	1-0 *5 @ 4 1/2 "	1-2 *5 @ 4 "
3 1/2 "	1-0 *6 @ 4 1/2 "	1-2 *6 @ 4 "

* Reinforcement steel is fabricated in increments of 1/8 inch on the diameter. The designation *3 indicates a rod 3/8 inch in diameter.

ing 3'-0" wide, and are to be reduced 0" wide.

ire picking for removal, and offer high

adily be removed by shoveling only.

olded in the fingers only with the greatest

quires substantial pressure to mold in the

essure.

erse sand passes No. 10 and is retained ned on a No. 270 mesh sieve. Gravel, sand, en dry.

in when dry to form hard lumps which cannot

its cohesive strength when dry is slight,

ENGINEERING & DESIGN

IS APPROVED BY :

soil, use that giving the higher footing load in Table I.

Next, determine the type of soil and the normal safe bearing capacity of the in-place soil beneath the footings. The type of soil is determined by preliminary borings, inspection of the excavated site, or records of previous construction in the immediate area. The "normal safe bearing capacity" is the bearing value that would be used in proportioning footings of building and other structures for resistance to normal service loads exclusive of wind, earthquake, or impact loads.

The normal safe bearing capacity can be established by (a) a special soils investigation by a qualified soils engineer; (b) use of tabulated "permissible," "allowable," or "presumptive" safe bearing capacities from local building codes; or (c) use of recommended bearing values from Table II.

Bearing capacity is expressed in terms of pounds per square foot of footing area. The actual bearing capacities are dependent not only on the type and properties of the soil, but also on the size and shape of the footing. Values shown in Table II and as used in succeeding steps of proportioning footings for shelters are for a footing 3 feet wide at a depth of 1-1/2 feet below adjacent grade. Where bearing values are stated in terms of other widths or depths, appropriate adjustments must be made by a qualified soils engineer.

Footings for shelters are proportioned on the basis of the expected ultimate bearing capacity of the soil under dynamic conditions of loading. The normal safe bearing capacity is not used directly, but is an indication of the expected ultimate dynamic bearing capacity. For consistent results to be achieved, the normal safe bearing capacity must be reasonably related to the actual bearing capacity of the soil. It is assumed herein that values of normal safe bearing capacity have a safety factor of 2.5 to 3.0 with respect to actual foundation failure under static loading conditions.

Bearing values established by a soils engineer can usually be expected to contain a safety factor in this range. An exception may occur where low bearing values are prescribed to avoid excessive settlement under sustained loads. In this case, higher values based on the actual static bearing capacity should be used.

Normal safe bearing capacities established by building codes of different jurisdictions show great variation in values for soils of apparently similar description. To some extent, this variation may be due to actual variation in properties of local soil formations. It may also be due to variation in the actual safety factors. Values in Table II represent a fair average of building codes in various parts of the United States. Where local building code values are much higher or lower than those in Table II and are not justified by local conditions, as determined by a soils analysis by a soils engineer, adjustment can be made in the local code values.

Enter Table III with the foundation load from Table I and the type and bearing capacity of soil beneath the footings to determine the required width of footing in feet and inches. If soils are intermediate in characteristics between the "coarse-grained, noncohesive" and the "fine-grained, cohesive" groups of soils, an intermediate width of footing may be selected, or the wider of the two may be used.

In establishing footing widths as shown in Table III, allowance has been made for the effect of footing width on bearing capacity, and the difference between static and dynamic resistance of soils. No further adjustment is necessary for these factors.

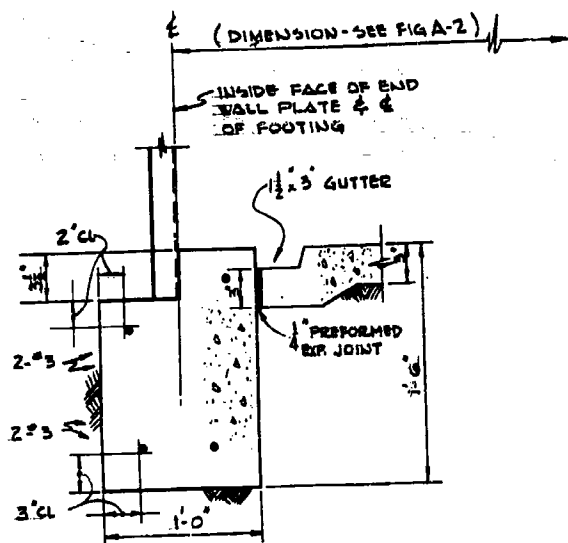
The detailed design of footings is shown in Types 1, 2, and 3, and in Table IV. Enter Table IV with the footing load from Table I and the footing width from Table III to determine the thickness of the footing base and the size and spacing of transverse reinforcing bars. Other footing details are as shown in the appropriate Type 1, 2, or 3.

ILLUSTRATIVE EXAMPLE:

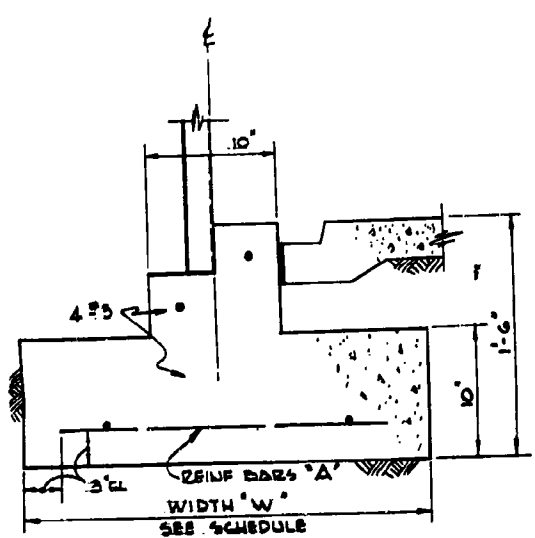
A shelter is to be designed and constructed for a nominal 35-psi overpressure rating. Footings will bear on a clay-type soil of medium-stiff consistency. Backfill over and around the shelter will be clean sand and gravel. From Table I, with overpressure of 35-psi and sand-gravel backfill, the footing load is found to be 30,000 pounds per linear foot. The local building code establishes a bearing value of 3,000 pounds per square foot for medium-stiff clay, while Table II gives 4,000 pounds per square foot. The building code value of 3,000 pounds per square foot will be used, since it is the smaller value. From Table III, with a footing load of 30,000 pounds per linear foot and fine-grained cohesive soil of 3,000 pounds per square foot bearing value, a required footing width of 2'-6" is found. From Table IV, for a footing load of 30,000 pounds per foot and a footing width of 2'-6", the thickness is found to be 10", and the transverse reinforcement is No. 3 bars at 4-inch spacing. Other footing details are as shown in Type 3.

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	FIG. A-2N-1 SHELTER SIDEWALL FOUNDATION DETAILS		
CHECKED	ZLR			
PROJ. ENGR.				
SUPV.				
BRANCH HEAD				
DIVISION HEAD		DATE: 5/23/62		
DATE: 22 MAY 62		DWG. NO. S-62-970 3 19		

6



TYPE 4



TYPE 5

ENDWALL FOOTING DETAILS

SCALE: 1 1/2" = 1'-0"

UN:
BA:
Gravel
Gravel
clay m
Inorga
clay,
compre
Inorga
sand s
compre
*P ₀ = Des

ENDWALL FOOTING WIDTH	
TYPE OF SOIL BENEATH FOOTINGS	NORM BEA
Coarse-grained, non-cohesive soils, such as gravel, sand, or sand and gravel.	
Fine-grained cohesive soils, such as clay and sandy, silty or gravelly clay.	

FOOTING
WIDTH 'W' (ft)

TABLE A
UNIFORM BEARING LOADS TO ENDWALL FOOTINGS

BACKFILL SOIL TYPE	FOOTING LOAD (LB. /LIN. FT.)	
	*P _o = 10 PSI	*P _o = 35 PSI
Gravel, sand, gravel and sand, Gravel-sand-silt and gravel-sand clay mixtures, or crushed rock	2,500 LB./L.F.	7,500 LB./L.F.
Inorganic clay, gravelly clay, sandy clay, or silty clay of medium to low compressibility and plasticity	2,500	7,500
Inorganic silt, very fine sand, fine sand and silt, or soft, plastic, compressible clay	5,000	15,000

*P_o = Design blast overpressure rating of Shelter.

The endwall footing pressure rating for which backfill adjacent to an in-place soil beneath it

Table A establishes footings. Enter with determine the foundation to proper classification

Next, determine the soil beneath the footing of the excavated site, safe bearing capacity of buildings and other structures, earthquake, or impact

The normal safe bearing capacity of soils as safe bearing capacities from Table II, Fig. A-1

For definition of Fig. A-2-1N.

Enter Table B with of soil beneath the footing. If soils are intermediate and the "fine-grained, selected, or the wider

The detailed design reinforcement for the with the footing width

In the event the total footing design (

TABLE B
ENDWALL FOOTING WIDTHS AS REQUIRED BY FOOTING LOAD AND NORMAL SAFE BEARING CAPACITY

TYPE OF SOIL BENEATH FOOTINGS	NORMAL SAFE BEARING CAPACITY	FOOTING LOAD - LB. /LIN. FT.				
		2,500	5,000	7,500	10,000	15,000
Coarse-grained, non-cohesive soils, such as gravel, sand, or sand and gravel.	10,000					1-0
	6,000				1-0	1-4
	4,000			1-0	1-4	2-0
	3,000		1-0	1-4	1-8	2-6
	2,000	1-0	1-4	2-0	2-6	3-0
	1,500	1-0	1-8	2-6	3-0	-
	1,000	1-4	2-0	3-0	-	-
Fine-grained cohesive soils, such as clay and sandy, silty or gravelly clay.	4,000 or more					1-0
	3,000				1-0	1-4
	2,000			1-0	1-4	1-8
	1,500		1-0	1-4	1-8	-
	1,000	1-0	1-4	1-8	-	-

TABLE C
FOOTING STEEL REINFORCEMENT SCHEDULE FOR TYPE 5

FOOTING WIDTH "w" (FT. & IN.)	REINF. BARS "A" (All Loads)
1-4	None
1-8	None
2-0	* 3 @ 24
2-6	* 3 @ 6
3-0	* 3 @ 6

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

NO.	NAME	NO. REQ.	MAT'L	MAT'L SPEC.	STOCK SIZE	REMARKS
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PROCEDURE FOR DETERMINING THE DESIGN AND CONSTRUCTION DETAILS OF THE BREWER'S ENDWALL FOOTINGS

OTINGS

FOOTING LOAD (LB. /LIN. FT.)	
*P ₀ = 10 PSI	*P ₀ = 35 PSI
2,500LB/L.F.	7,500LB/L.F.
2,500	7,500
5,000	15,000

Shelter.

The endwall footing to be used with a particular shelter is dependent on (a) the overpressure rating for which the shelter is to be designed, (b) the type of soil used for backfill adjacent to and over the shelter, and (c) the type and bearing capacity of the in-place soil beneath the footings.

Table A establishes the bearing load that must be supported by the continuous endwall footings. Enter with the overpressure rating and the type of soil used for backfill to determine the foundation load in pounds per lineal foot of footing. Where doubt exists as to proper classification of backfill soil, use that giving the higher footing load in Table A.

Next, determine the type of soil and the "normal safe bearing capacity" of the in-place soil beneath the footings. The type of soil is determined by preliminary borings, inspection of the excavated site, or records of previous construction in the immediate area. The normal safe bearing capacity is the bearing value that would be used in proportioning footings of buildings and other structures for resistance to normal service loads exclusive of wind, earthquake, or impact loads.

The normal safe bearing capacity can be established by (a) a special soils investigation by a qualified soils engineer, (b) use of tabulated "permissible," "allowable," or "presumptive" safe bearing capacities from local building codes, or (c) use of recommended bearing values from Table II, Fig. A-2-1N.

For definition of normal safe bearing capacity (Table B), see notes that appear in Fig. A-2-1N.

Enter Table B with the foundation load from Table A and the type and bearing capacity of soil beneath the footings to determine the required width of footing in feet and inches. If soils are intermediate in characteristics between the "coarse-grained, noncohesive," and the "fine-grained, cohesive" groups of soils, an intermediate width of footing may be selected, or the wider of the two may be used.

The detailed design of the range of footings are shown as Types 4 and 5. Steel reinforcement for the footing design shown as Type 5 is determined by entering Table C with the footing width as is given in Table B.

In the event the endwall footing width as determined in Table B is 1 foot, the total footing design (including steel) is that shown as Type 4.

NORMAL SAFE BEARING CAPACITY

LB. /LIN. FT.		
7,500	10,000	15,000
		1-0
	1-0	1-4
1-0	1-4	2-0
1-4	1-8	2-6
2-0	2-6	3-0
2-6	3-0	-
3-0	-	-
		1-0
	1-0	1-4
1-0	1-4	1-8
1-4	1-8	-
1-8	-	-

3

5,000	15,000
-------	--------

Shelter.

determine the foundation load in pounds per lineal foot of footing. Where doubt exists as to proper classification of backfill soil, use that giving the higher footing load in Table A.

Next, determine the type of soil and the "normal safe bearing capacity" of the in-place soil beneath the footings. The type of soil is determined by preliminary borings, inspection of the excavated site, or records of previous construction in the immediate area. The normal safe bearing capacity is the bearing value that would be used in proportioning footings of buildings and other structures for resistance to normal service loads exclusive of wind, earthquake, or impact loads.

The normal safe bearing capacity can be established by (a) a special soils investigation by a qualified soils engineer; (b) use of tabulated "permissible," "allowable," or "presumptive" safe bearing capacities from local building codes; or (c) use of recommended bearing values from Table II, Fig. A-2-1N.

For definition of normal safe bearing capacity (Table B), see notes that appear in Fig. A-2-1N.

Enter Table B with the foundation load from Table A and the type and bearing capacity of soil beneath the footings to determine the required width of footing in feet and inches. If soils are intermediate in characteristics between the "coarse-grained, nonschhesive," and the "fine-grained, cohesive" groups of soils, an intermediate width of footing may be selected, or the wider of the two may be used.

The detailed design of the range of footings are shown as Types 4 and 5. Steel reinforcement for the footing design shown as Type 5 is determined by entering Table C with the footing width as is given in Table B.

In the event the endwall footing width as determined in Table B is 1 foot, the total footing design (including steel) is that shown as Type 4.

D NORMAL SAFE BEARING CAPACITY

LOAD - LB. /LIN. FT.			
	7,500	10,000	15,000
			1-0
		1-0	1-4
1-0	1-4	2-0	
1-4	1-8	2-6	
2-0	2-6	3-0	
2-6	3-0	-	
3-0	-	-	
			1-0
		1-0	1-4
1-0	1-4	1-8	
1-4	1-8	-	
1-8	-	-	

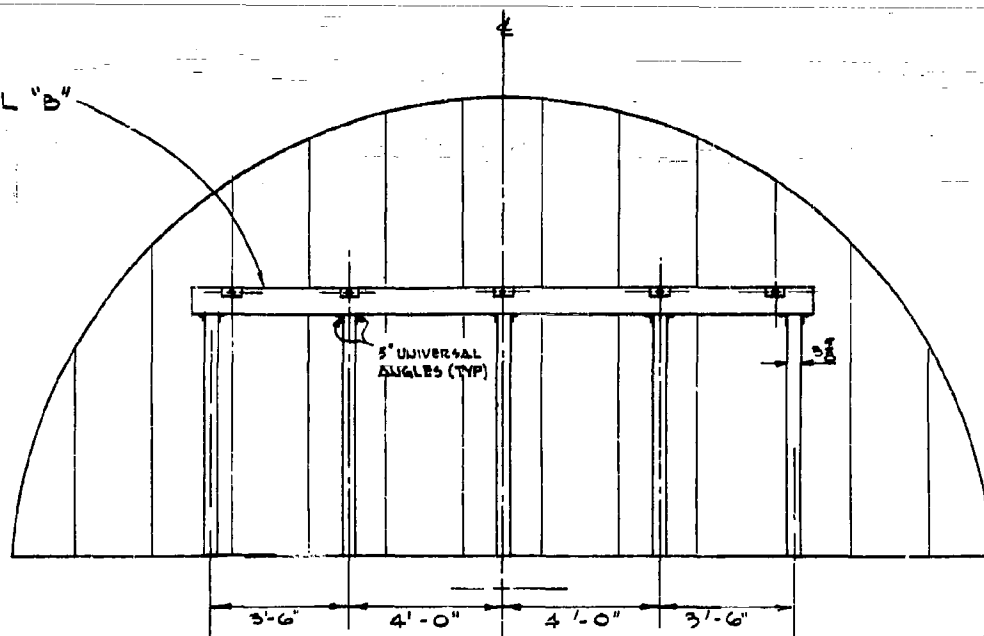
4

ENGINEERING & DESIGN
14 APPROVED BY: Lewis B. Potemkin DATE: 22 MAY 62

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	FIG. A-2N-2 SHELTER ENDWALL FOUNDATION DETAILS		
CHECKED	<i>RL</i>			
PROJ. ENGR.				
SUPV.				
BRANCH HEAD		DATE SCALE PROJECT TECH MEMO		
DIVISION HEAD				
ENG. DESIGN APPROVAL SCOP. APPROVED: <i>2-60</i>		DATE: 5-22-62	DWG NO. S-62-970 4 19 SHT. OF	

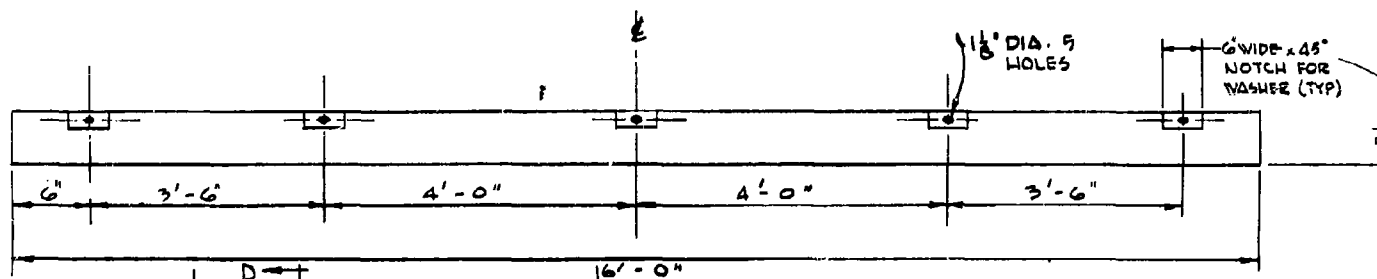
SEE DETAIL "B"

SEE DETAIL "



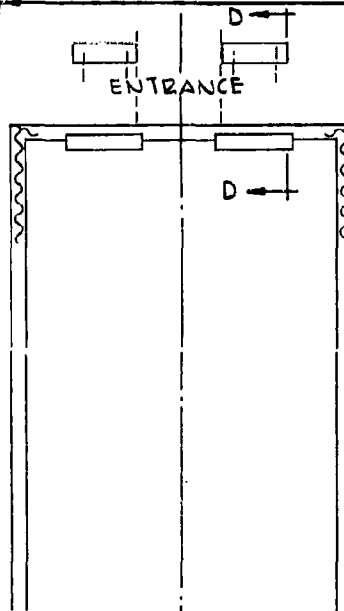
ELEVATION "B"

ENDWALL - LOOKING OUT
SCALE: $\frac{3}{8}" = 1'-0"$

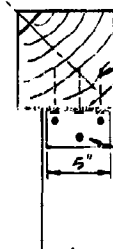


DETAIL "B"

MAT'L - STRUCTURAL GRADE TIMBER
SCALE: $\frac{3}{4}" = 1'-0"$



HOT PITCH CAULKING
POURED BOTH SIDES
OF ARCH TO SEAL
UNIONED BOLT NAILS



1" IR MALLEABLE IRON WASHER W/NUT (TYP EA ROD)

8"x8" WOOD STRINGER

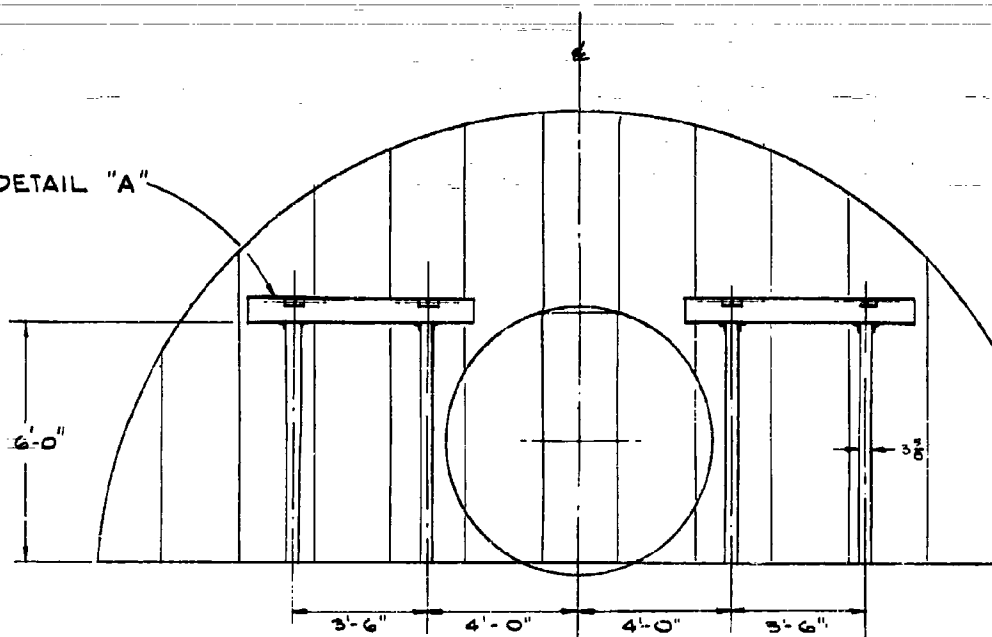
4"x6" WOOD POST

FASTEN WOOD POST TO ENDWALL W/ONE 3/8"

QUANTITIES SHOWN ARE FOR

REVISION NAME

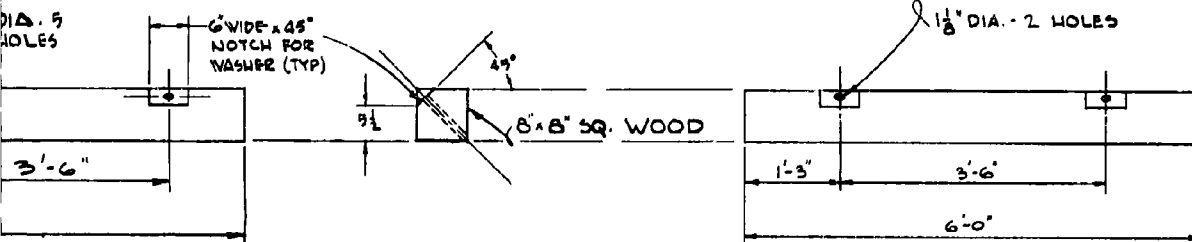
SEE DETAIL "A"



ELEVATION "A"

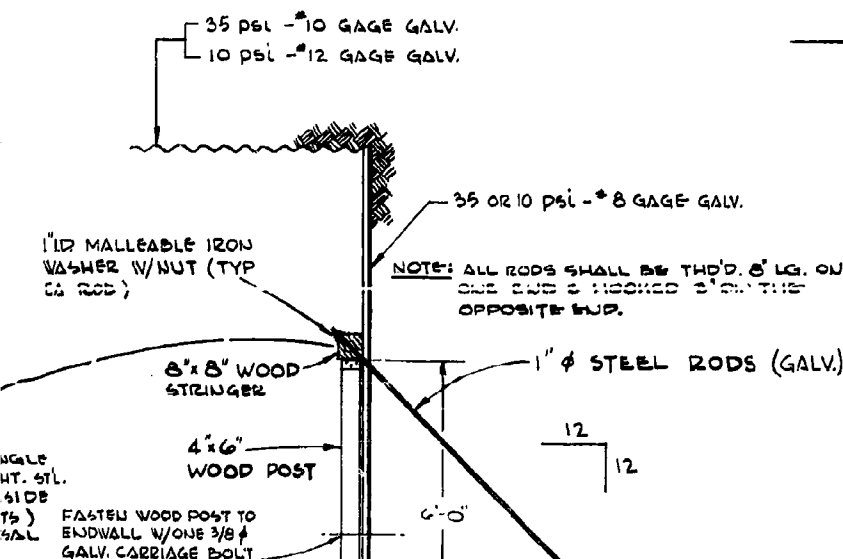
ENTRANCE - LOOKING OUT

SCALE: $\frac{3}{8}" = 1'-0"$



DETAIL "A"

2 PCS. REQ'D.
SCALE: $\frac{3}{4}" = 1'-0"$



1. THE METAL ARCH SHALL BE FIRMLY SECURED TO THE FOUNDATION OR OTHERWISE SPECIFIED HEREIN SPECIFICATION M 36-57.
- (a) PLATES SHALL BE FABRICATED FROM METAL FOR WHICH IS MADE ABOVE REFERENCED SPECIFICATION PROCESS BEFORE FORMING. A RATE OF NOT LESS THAN 2.0% SHALL BE FABRICATED OF THE SAME.
- (b) DIMENSIONS, WEIGHTS & GAUGES SHALL BE AS FOLLOWS:
 - (1) CORRUGATIONS SHALL HAVE A DEPTH OF 2 INCHES WITH A CORRUGATION SHALL BE A MINIMUM OF 1/2 INCH.
 - (2) PLATES SHALL BE EITHER 4.531 OR 5.781 LB./SQ. FT. MINIMUM ENTIRE LOT-PLUS 5% MINIMUM.
- (c) FORMING & PUNCHING PLATES SHALL BE DONE IN SUCH A MANNER AS TO PROPER RADIUS & THE BOLTS SHALL BE PLACED AT THE LONGITUDINAL JOINTS 2 INCHES APART, WITH ONE CORRUPTION. THE CENTER OF THE BOLT FROM THE END OF THE FORMING CIRCUMFERENTIAL CENTER TO CENTER. ALL BOLTS SHALL BE SO CLOSELY FORMED IN ACCORDANCE WITH THE REQUIREMENTS OF SUBSECTION 3.
- (d) BOLTS & NUTS SHALL BE HEAVY DUTY AND SHALL BE FIT THE CORRUGATED METAL ARCH. THE BOLT HEADS SHALL BE OBTAINED, WITHOUT THE HEAD IS USED ON THE CORRUPTION. THE BOLT SHALL BE ROUNDED ON ONE FACE TO THE VALLEY OF THE CORRUGATION.
- (2) CHANNELS - UNBALANCED COLD-FORMED METAL OF NO. 10 OR LARGER FOR ANCHORING TO THE FOUNDATION HOLES TO MATCH THE HOLES IN THE FOUNDATION.
2. SHELTER ENDWALLS SHALL BE CONSTRUCTED AS INDICATED.
- (a) STRUCTURAL PLATES & CHANNELS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF ASTM A 36-57, COLD-FORMED METAL OF NO. 10 OR LARGER FOR ANCHORING TO THE FOUNDATION HOLES TO MATCH THE HOLES IN THE FOUNDATION.
- (b) BOLTS & NUTS - CONNECTIONS SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF SUBSECTION 3.
3. ENTRANCE TUNNEL SHALL BE CONSTRUCTED AS INDICATED, CONFORMING TO SPECIFICATION M 36-57, COLD-FORMED METAL OF NO. 10 OR LARGER FOR ANCHORING TO THE FOUNDATION HOLES TO MATCH THE HOLES IN THE FOUNDATION.
4. ARCH & PIPE ERECTION - THE ARCH SHALL BE ERECTED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS. ALL SEAMS & JOINTS SHALL BE SEALED WITH 1 1/2 INCH x 1/8 INCH PERMACON ONE STRIP SHALL BE PLACED OVER EACH JOINT. PLATES COMPRISING A JOINT SHALL BE SEALED IN THE STRUCTURE, INCLUDING THE ARCH, SHALL BE SEALED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.
5. REPAIR AFTER ERECTION - THE ARCH SHALL BE REPAIRED & CONFORMING TO SPECIFICATION M 36-57.

2

REVISION DATE

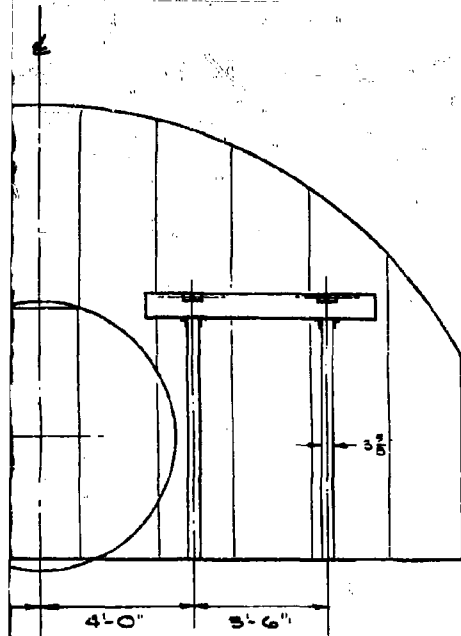
LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

QTY.	NAME	REQ.	MATL.	MATL. SPEC.	STOCK SIZE	REMARKS
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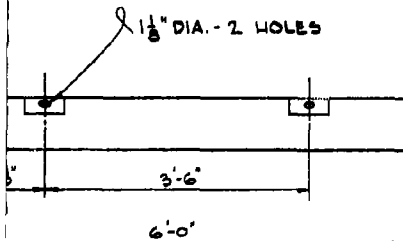
GENERAL NOTES

1. THE METAL ARCH SHALL BE FIELD ASSEMBLED OF CORRUGATED METAL PLATES & EXCEPT AS OTHERWISE SPECIFIED HEREIN, SHALL COMPLY WITH THE APPLICABLE REQUIREMENTS OF ASSHO SPECIFICATION M 36-57.
- (a) PLATES SHALL BE FABRICATED FROM GALV. COPPER BEARING ST'L. PLATES, THE BASE METAL FOR WHICH IS MADE BY THE OPEN HEARTH PROCESS & WHICH COMPLIES WITH THE ABOVE REFERENCED SPECIFICATION. THE BASE METAL SHEETS SHALL BE GALV. BY THE HOT-DIP PROCESS BEFORE FORMING. A COATING OF PRIME WESTERN SPECTER SHALL BE APPLIED AT THE RATE OF NOT LESS THAN 2 OZ. PER SQ. FT. OF DOUBLE EXPOSED SURFACE. ALL PLATES SHALL BE FABRICATED OF THE SAME BASE METAL.
- (b) DIMENSIONS, WEIGHTS & GAGE.
 - (1) CORRUGATIONS SHALL HAVE A PITCH OF 6 INCHES WITH A TOLERANCE OF 1/4 INCH, & A DEPTH OF 2 INCHES WITH A TOLERANCE OF 1/8 INCH. THE RADIUS ON THE INSIDE OF THE CORRUGATION SHALL BE AT LEAST 1 1/16 INCHES.
 - (2) PLATES SHALL BE EITHER #12 OR #10 GAGE, AS SPECIFIED, & SHALL WEIGH AFTER GALV. 4.531 OR 3.781 LB./SQ. FT. RESPECTIVELY. WEIGHT TOLERANCES THAT ARE PERMISSIBLE: ENTIRE LOT - PLUS 5%, MINUS 5%; INDIVIDUAL PLATES - PLUS 5%, MINUS 10%.
- (c) FORMING & PUNCHING PLATES AFTER CORRUGATING, EACH PLATE SHALL BE CURVED TO THE PROPER RADIUS & THE BOLT HOLES SHALL BE SO PUNCHED THAT ALL PLATES HAVING LIKE DIMENSIONS & CURVATURE ARE INTERCHANGEABLE IN THE ERECTION PROCESS. ON THE LONGITUDINAL JOINTS OF THE ARCH, BOLT HOLES SHALL BE IN STAGGERED ROWS 2 INCHES APART, WITH ONE HOLE PUNCHED IN THE VALLEY & ONE IN THE CREST OF EACH CORRUGATION. THE CENTER OF NO HOLE SHALL BE CLOSER THAN 1 3/4 TIMES THE DIAMETER OF THE BOLT FROM THE EDGE OF THE PLATE. BOLT HOLES IN THOSE EDGES OF THE PLATES FORMING CIRCUMFERENTIAL SEAMS SHALL BE SPACED NOT MORE THAN 12 INCHES CENTER TO CENTER. ALL BOLT HOLES SHALL BE 1/8 INCH LARGER THAN THE BOLTS. PLATES SHALL BE SO CURVED THAT, WHEN BOLTED TOGETHER, THE ARCH SHALL BE FORMED IN ACCORDANCE WITH THE PLAN DIMENSIONS.
- (d) BOLTS & NUTS SHALL BE HOT-DIP GALV. & SHALL BE PROVIDED BY THE MANUFACTURER OF THE CORRUGATED METAL ARCH. THREADS SHALL BE AMERICAN STANDARD COARSE, CLASS 2 FREE FIT. MATERIAL SHALL CONFORM TO THE REQUIREMENTS OF ASTM SPECIFICATIONS A 325. THE BOLT HEADS SHALL BE SO SHAPED THAT ADEQUATE BEARING OF THE BOLT HEAD WILL BE OBTAINED, WITHOUT THE USE OF WAGUERS REGARDLESS OF WHETHER THE BOLT HEAD IS USED ON THE CREST OR VALLEY OF THE CORRUGATIONS. THE NUTS SHALL BE ROUNDED ON ONE FACE TO SECURE PROPER BEARING & NOT TO CUT THE GALVANIZING IN THE VALLEY OF THE CORRUGATIONS.
- (e) CHANNELS - UNBALANCED CHANNELS, WHERE REQ'D. ON THE PLANS SHALL BE HOT-DIP GALV. COLD-FORMED METAL OF NOT LESS THAN 3/16 INCH IN THICKNESS, WITH SLOTTED TONGUES FOR ANCHORING TO THE FOOTINGS. ONE VERTICAL LEG SHALL BE PUNCHED WITH SLOTTED HOLES TO MATCH THE HOLES IN THE PLATE.
2. SHELTER ENDWALLS SHALL BE ASSEMBLED AT THE SITE OF STRUCTURAL PLATES AS INDICATED.
 - (a) STRUCTURAL PLATES & CHANNELS SHALL BE FABRICATED OF STEEL CONFORMING TO THE REQUIREMENTS OF ASTM SPECIFICATION A 245-58T, GRADE C, & SHALL BE #8 GA. PRIOR TO FORMING, THE STEEL SHALL BE HOT-DIP GALVANIZED WITH PRIME WESTERN SPECTER AT NOT LESS THAN 2 OUNCES PER SQ. FT. OF DOUBLE EXPOSED SURFACE.
 - (b) BOLTS & NUTS - CONNECTIONS SHALL BE MADE WITH BOLTS & NUTS CONFORMING TO THE REQUIREMENTS OF SUBPARAGRAPH 1(d).
3. ENTRANCE TUNNEL SHALL BE FABRICATED OF GALVANIZED, CORRUGATED METAL PIPE, GAGE AS INDICATED, CONFORMING TO THE REQUIREMENTS OF ASSHO SPECIFICATION M 36-57, COPPER BEARING STEEL. EXCEPT AS INDICATED OTHERWISE, THE JOINTS SHALL BE MANUFACTURER'S STANDARD FOR SIMILAR SERVICE.
4. ARCH & PIPE SECTION - THE METAL ARCH & ENTRANCE PIPE SHALL BE ERECTED IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS & TO THE LINES & GRADES INDICATED. ALL SEAMS OR JOINTS BETWEEN OVERLAPPING PLATES SHALL BE SEALED WITH 1 1/2 INCH x 1/8 INCH "PERMAGUM" STRIPS. ONE STRIP SHALL BE PRESSED OVER EACH ROW OF BOLT HOLES ON ONE OF THE PLATES COMPRISING A JOINT, PRIOR TO BOLTING UP. ALL JOINTS OF THE CORRUGATED STRUCTURE, INCLUDING THE JUNCTION BETWEEN THE TUNNEL & THE ENDWALL OF THE ARCH, SHALL BE SEALED IN A SIMILAR MANNER.
5. REPAIR AFTER ERECTION - GALVANIZED SURFACES DAMAGED DURING CONSTRUCTION SHALL BE WIRE BRUSHED & GIVEN 2 COATS OF ZINC-DUST ZINC-OXIDE PAINT CONFORMING TO SPECIFICATION MIL-P-15145A.



SECTION "A"

LOOKING OUT
SCALE: 3/8" = 1'-0"



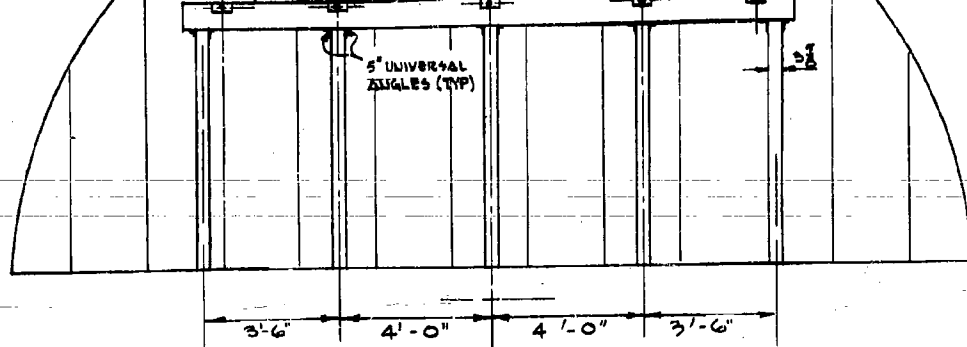
DETAIL "A"

2 PCS. REQ'D.
SCALE: 3/4" = 1'-0"

3

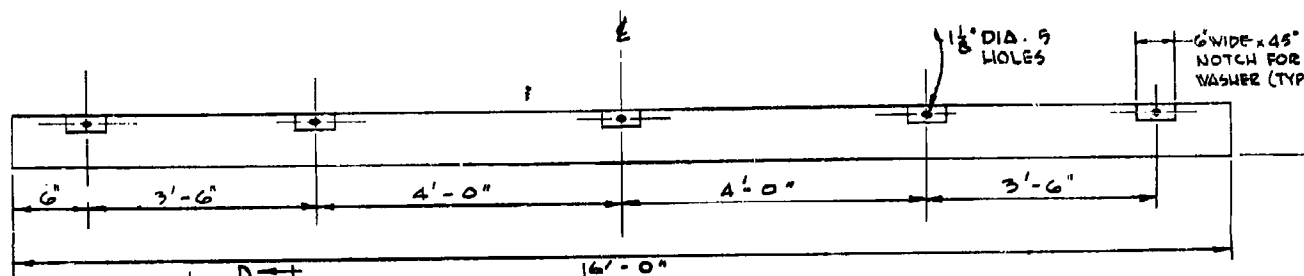
REVISION	DATE	DESCRIPTION	BY	APP.
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UNITED STATES



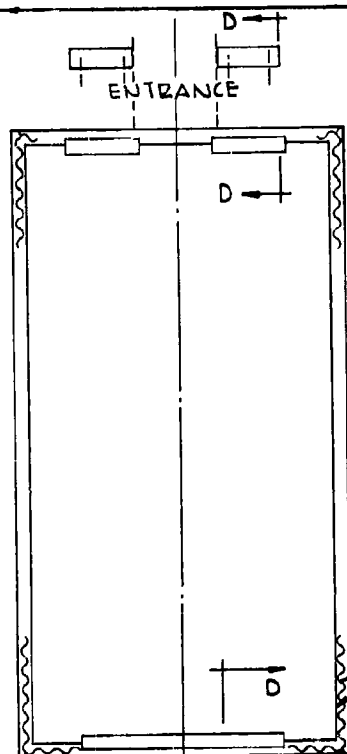
ELEVATION "B"

ENDWALL - LOOKING OUT
SCALE: $\frac{3}{8}" = 1'-0"$

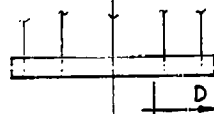


DETAIL "B"

MAT'L - STRUCTURAL GRADE TIMBER
SCALE: $\frac{3}{4}" = 1'-0"$



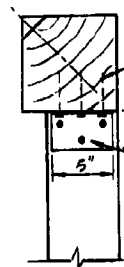
HOT PITCH CAULKING
POURED BOTH SIDES
OF ARCH TO SEAL
UNUSED BOLT HOLES
AND SEAM BETWEEN
ARCH AND CHANNEL



PLOT PLAN

SCALE: $\frac{1}{8}" = 1'-0"$

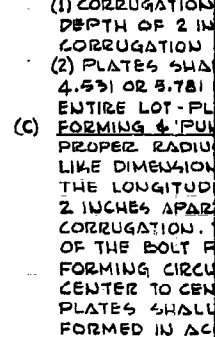
FOR DETAILS SEE FIG. A-2M



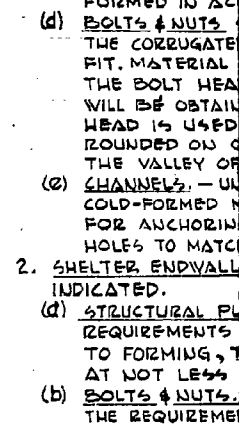
SCALE: $1\frac{1}{2}" = 1'-0"$

4

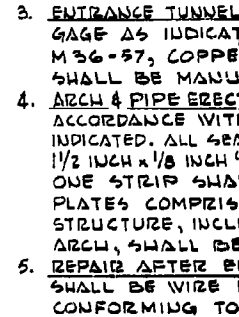
TYPICAL REIN



ENTRANCE - LOOKING OUT
SCALE: $\frac{3}{8}" = 1'-0"$



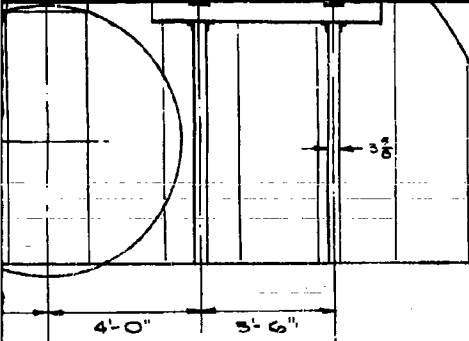
2 PLS. REQ'D.
SCALE: $\frac{3}{4}" = 1'-0"$



SCALE: $\frac{3}{8}" = 1' - 0"$

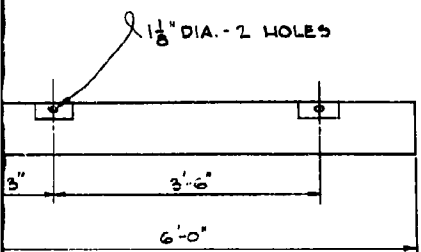
TYPICAL REINFORCING POST DETAIL

IS APPROVED BY: Lauri V. Potters DATE: 22 MAY 68



SECTION "A"

- LOOKING OUT
E: 3/8" - 1'-0"



DETAIL "A"

2 PCS. REQ'D.
SCALE: 3/4" = 1'-0"

- (1) CORRUGATIONS SHALL HAVE A PITCH OF 2 INCHES WITH A TOLERANCE OF 1/8 INCH. THE RADIUS ON THE INSIDE OF THE CORRUGATION SHALL BE AT LEAST 1 1/4 INCHES.
- (2) PLATES SHALL BE EITHER #12 OR #10 GAGE, AS SPECIFIED, & SHALL WEIGH AFTER GALV. 4.5% OR 5.78 LBS/SQ. FT. RESPECTIVELY. WEIGHT TOLERANCES THAT ARE PERMISSIBLE: ENTIRE LOT - PLUS 5%, MINUS 5%; INDIVIDUAL PLATES - PLUS 5%, MINUS 10%.
- (C) FORMING & PUNCHING PLATES, AFTER CORRUGATING, EACH PLATE SHALL BE CURVED TO THE PROPER RADIUS & THE BOLT HOLES SHALL BE SO PUNCHED THAT ALL PLATES HAVING LIKE DIMENSIONS & CURVATURE ARE INTERCHANGEABLE IN THE ERECTION PROCESS. ON THE LONGITUDINAL JOINTS OF THE ARCH, BOLT HOLES SHALL BE IN STAGGERED ROWS 2 INCHES APART, WITH ONE HOLE PUNCHED IN THE VALLEY & ONE IN THE CREST OF EACH CORRUGATION. THE CENTER OF NO HOLE SHALL BE CLOSER THAN 1 3/4 TIMES THE DIAMETER OF THE BOLT FROM THE EDGE OF THE PLATE. BOLT HOLES IN THOSE EDGES OF THE PLATES FORMING CIRCUMFERENTIAL SEAMS SHALL BE SPACED NOT MORE THAN 12 INCHES CENTER TO CENTER. ALL BOLT HOLES SHALL BE 1/8 INCH LARGER THAN THE BOLTS. PLATES SHALL BE SO CURVED THAT, WHEN BOLTED TOGETHER, THE ARCH SHALL BE FORMED IN ACCORDANCE WITH THE PLAN DIMENSIONS.
- (d) BOLTS & NUTS SHALL BE HOT-DIP GALV. & SHALL BE PROVIDED BY THE MANUFACTURER OF THE CORRUGATED METAL ARCH. THREADS SHALL BE AMERICAN STANDARD COARSE, CLASS 2 FREE FIT. MATERIAL SHALL CONFORM TO THE REQUIREMENTS OF ASTM SPECIFICATIONS A 325. THE BOLT HEADS SHALL BE SO SHAPED THAT ADEQUATE BEARING OF THE BOLT HEAD WILL BE OBTAINED, WITHOUT THE USE OF WASHERS REGARDLESS OF WHETHER THE BOLT HEAD IS USED ON THE CREST OR VALLEY OF THE CORRUGATIONS. THE NUTS SHALL BE ROUNDED ON ONE FACE TO SECURE PROPER BEARING & NOT TO CUT THE GALVANIZING IN THE VALLEY OF THE CORRUGATIONS.
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2. SHELTER ENDWALLS SHALL BE ASSEMBLED AT THE SITE OF STRUCTURAL PLATES AS INDICATED.
 - (a) STRUCTURAL PLATES & CHANNELS SHALL BE FABRICATED OF STEEL CONFORMING TO THE REQUIREMENTS OF ASTM SPECIFICATION A 245-58T, GRADE C, & SHALL BE #8 GA. PRIOR TO FORMING, THE STEEL SHALL BE HOT-DIP GALVANIZED WITH PRIME WESTERN SPECTER AT NOT LESS THAN 2 OUNCES PER SQ. FT. OF DOUBLE EXPOSED SURFACE.
 - (b) BOLTS & NUTS. - CONNECTIONS SHALL BE MADE WITH BOLTS & NUTS CONFORMING TO THE REQUIREMENTS OF SUBPARAGRAPH 1(d).
3. ENTRANCE TUNNEL SHALL BE FABRICATED OF GALVANIZED, CORRUGATED METAL PIPE, GAGE AS INDICATED, CONFORMING TO THE REQUIREMENTS OF ASSHO SPECIFICATION M 36-57, COPPER BEARING STEEL. EXCEPT AS INDICATED OTHERWISE, THE JOINTS SHALL BE MANUFACTURER'S STANDARD FOR SIMILAR SERVICE.
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5. REPAIR AFTER ERECTION. - GALVANIZED SURFACES DAMAGED DURING CONSTRUCTION SHALL BE WIRE BRUSHED & GIVEN 2 COATS OF ZINC-DUST ZINC-OXIDE PAINT CONFORMING TO SPECIFICATION MIL-P-15145A.

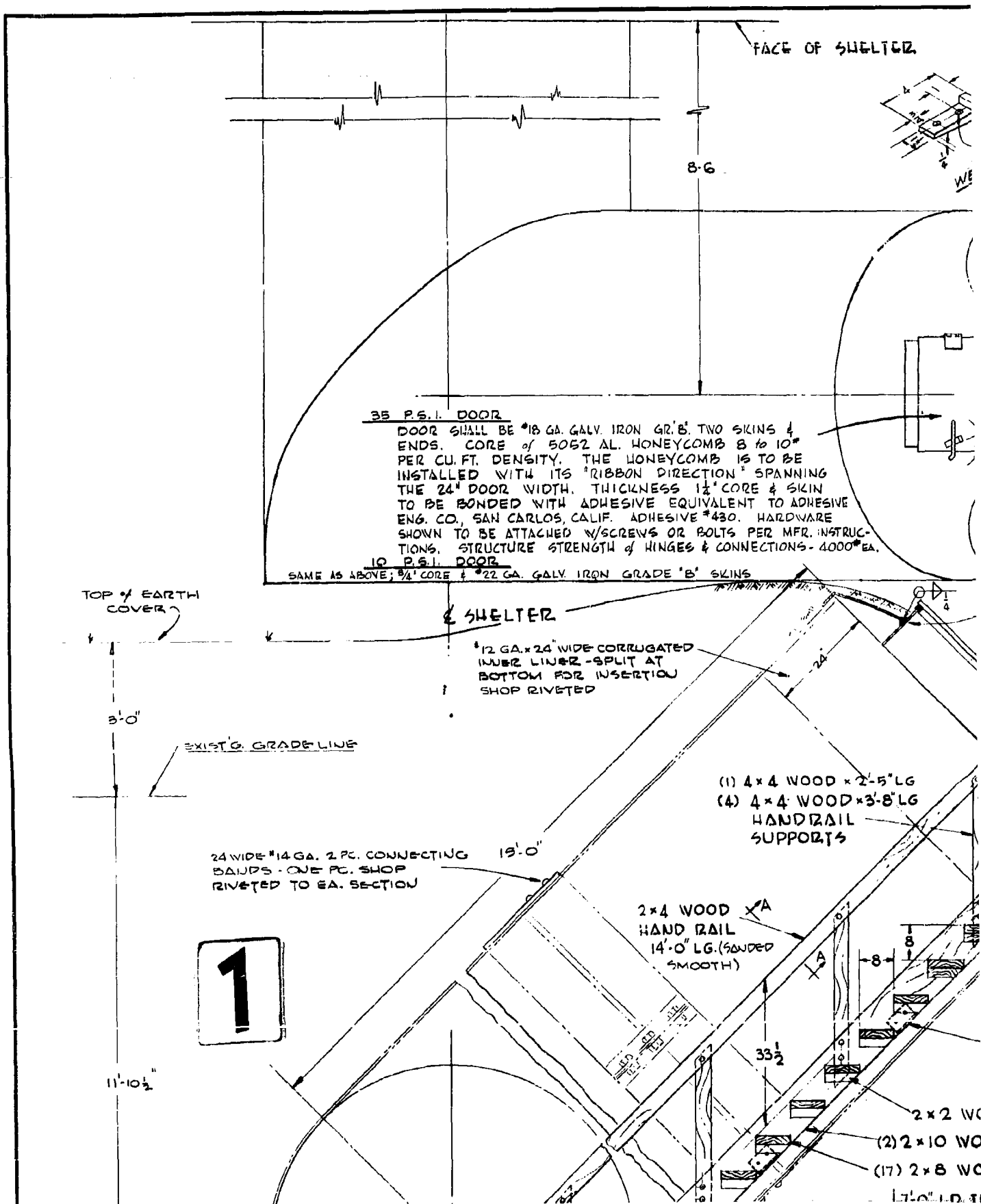
ON
GALV.)

CONCRETE
MAN
(Y.P.)
SEE FIG A-2
OR DETAILS

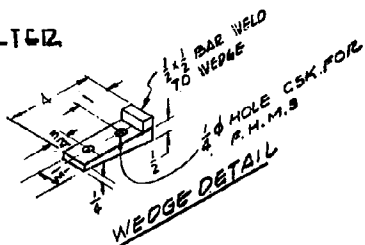


REVISION	DATE	DESCRIPTION	BY	APP.	
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA					
DRAWN	FJA	FIG. A-3M ENTRANCE & END WALLS SUPPORT DETAILS			
CHECKED	FJO				
SECTION HEAD					
BRANCH HEAD					
DIVISION HEAD					
DATE		SCALE	PROJECT	FINISH	HEAT TREAT
26 FEB 62		NOTED			
SATISFACTORY TO: <i>[Signature]</i>			DRAWING NUMBER S-62-970		ALT.
DATE 5-22-62			SHEET 5 OF 19		

ENGINEERING & DESIGN
IS APPROVED BY: *Lewis H. Podeszwa* DATE: 22 MAY 62



FACE OF SHELTER



QUANTITIES SHOWN ARE FOR

RC: NAME

PADEYE BOLTED TO WEDGE

WEDGE

1 SCR

2 x 1

U-SHAPED ASBESTOS GASKET

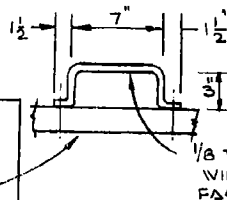
20" O.D. SEMI-ELLIPTICAL TY
20" DISH RADIUS, 3/16 THK STL, 4" S.F.

14" O.D. STD 3/8" WALL

2

REVISION

INTAKE VENT



10 PSI OR 35 PSI. HATCH
24" x 66" CLEAR OPENING

10 PSI. BULKHEAD - 1/4 THK. 90" DISH RAD. 1" V.R. 3" S.F.
35 PSI. BULKHEAD - 5/16 THK. 90" DISH RAD. 1" V.R. 3" S.F.

NO SKINS 4 MB 8 to 10" B IS TO BE TION" SPANNING CORE & SKIN VALENT TO ADHESIVE 430. HARDWARE BOLTS PER MFR. INSTRUCTIONS - 4000" EA.

SKINS
INTAKE VENT
COAMING 1/2 THK x 12" W. WELD TO DISHED BULKHEAD

2 x 2 1/2 STL ANGLE (WELDED) TREAD SUPPORT

2 x 8 WOOD TREAD - 24 LG.

EXIST'G. GRADE

(1) 4 x 4 WOOD x 2'-5" LG
(4) 4 x 4 WOOD x 3'-8" LG HANDRAIL SUPPORTS

INNER LINER CORR. PIPE TUNNEL

1/2" BOLTS W/ WASHERS

1-1/2" BOLTS - 22 REQ'D EVENLY SPACED

4 x 4 1/4 STL BENT ANGLE, 6" LG., 8 REQ'D.
(2) 1/2 BOLTS EA. LEG
LOCATE STRINGER SO IT RESTS ON TUNNEL WALL - FULL LENGTH

2 x 2 WOOD TREAD SUPPORTS

(2) 2 x 10 WOOD STRINGERS x 16'-5"

(17) 2 x 8 WOOD TREADS - 30" LG., NAIL ENDS WITH 3-20d NAILS.

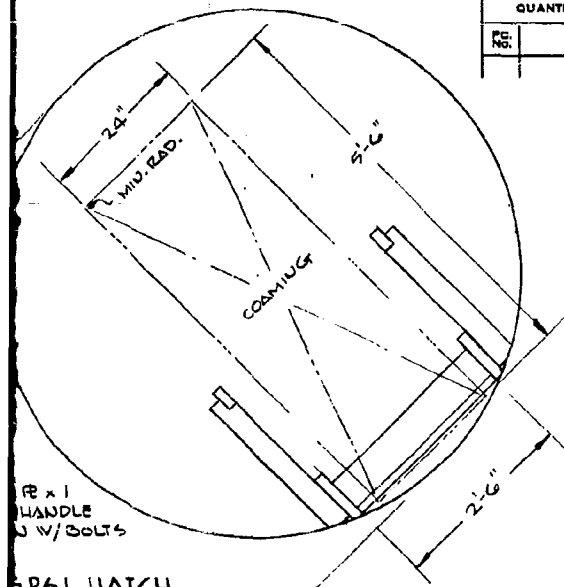
17'-0" ID TUNNEL

0" 12" 24"

LIST OF MATERIAL

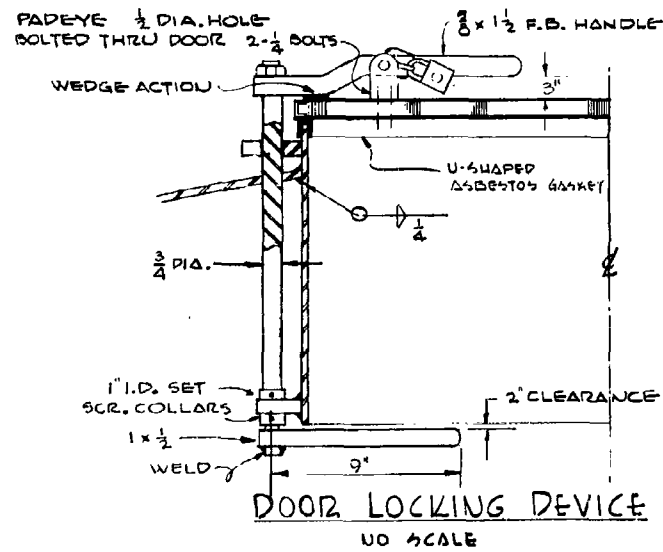
QUANTITIES SHOWN ARE FOR

FIG. NO.	NAME	QTY. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS
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PR. S.I. HATCH
AND OPENING

1/4 THK. 90° DISH RAD. 1" K.D. 3" S.F.
3/16 THK. 90° DISH RAD. 1" K.D. 3" S.F.



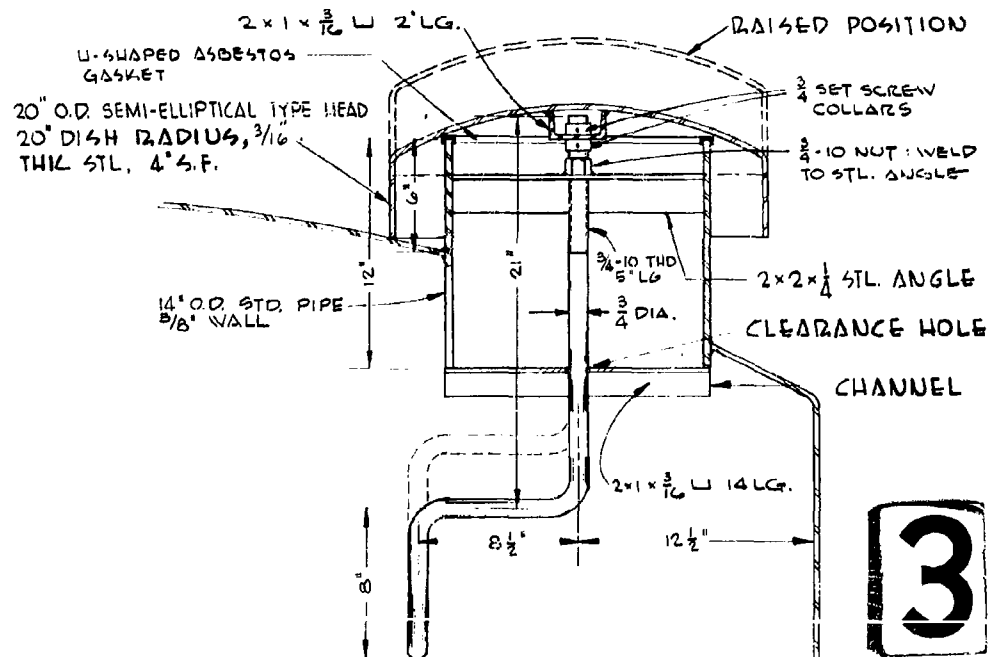
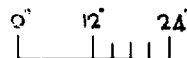
LODED)
D TREAD - 24 LG.
G. GRADE

DISHED
BULKHEAD
1/2-13 BOLTS - 22 REQ'D
EVENLY SPACED

5" LG., 8 REQ'D.

ITS
TH

3 WITH 3-20d NAILS.
2 2/3 PITCH



SECTION THRU INTAKE VENT
NO SCALE

REVISION	DATE	DESCRIPTION	BY	APP.
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UNITED STATES

35 P.S.I. DOOR

DOOR SHALL BE #18 GA. GALV. IRON GR. 'B' TWO SKINS & ENDS. CORE of 5052 AL. HONEYCOMB 8 to 10" PER CU. FT. DENSITY. THE HONEYCOMB IS TO BE INSTALLED WITH ITS 'RIBBON DIRECTION' SPANNING THE 24" DOOR WIDTH. THICKNESS 1 1/2" CORE & SKIN TO BE BONDED WITH ADHESIVE EQUIVALENT TO ADHESIVE ENG. CO., SAN CARLOS, CALIF. ADHESIVE #430. HARDWARE SHOWN TO BE ATTACHED W/SCREWS OR BOLTS PER MFR. INSTRUCTIONS. STRUCTURE STRENGTH of HINGES & CONNECTIONS - 4000# EA.

10 P.S.I. DOOR

SAME AS ABOVE; 3/4" CORE & #22 GA. GALV. IRON GRADE 'B' SKINS

TOP of EARTH COVER

SHELTER

*12 GA. x 24" WIDE CORRUGATED INNER LINER - SPLIT AT BOTTOM FOR INSERTION SHOP RIVETED

3'-0"

EXIST'G. GRADE LINE

24 WIDE #14 GA. 2 PC. CONNECTING BANDS - ONE PC. SHOP RIVETED TO EA. SECTION

19'-0"

(1) 4x4 WOOD x 2'-5" LG
(4) 4x4 WOOD x 3'-8" LG
HANDRAIL SUPPORTS

2x4 WOOD x A
HAND RAIL
14'-0" LG. (SANDED SMOOTH)

11'-10 1/2"

4

FLOOR LINE

12

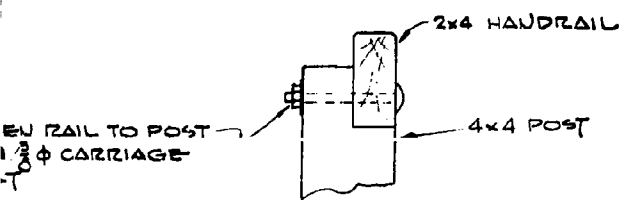
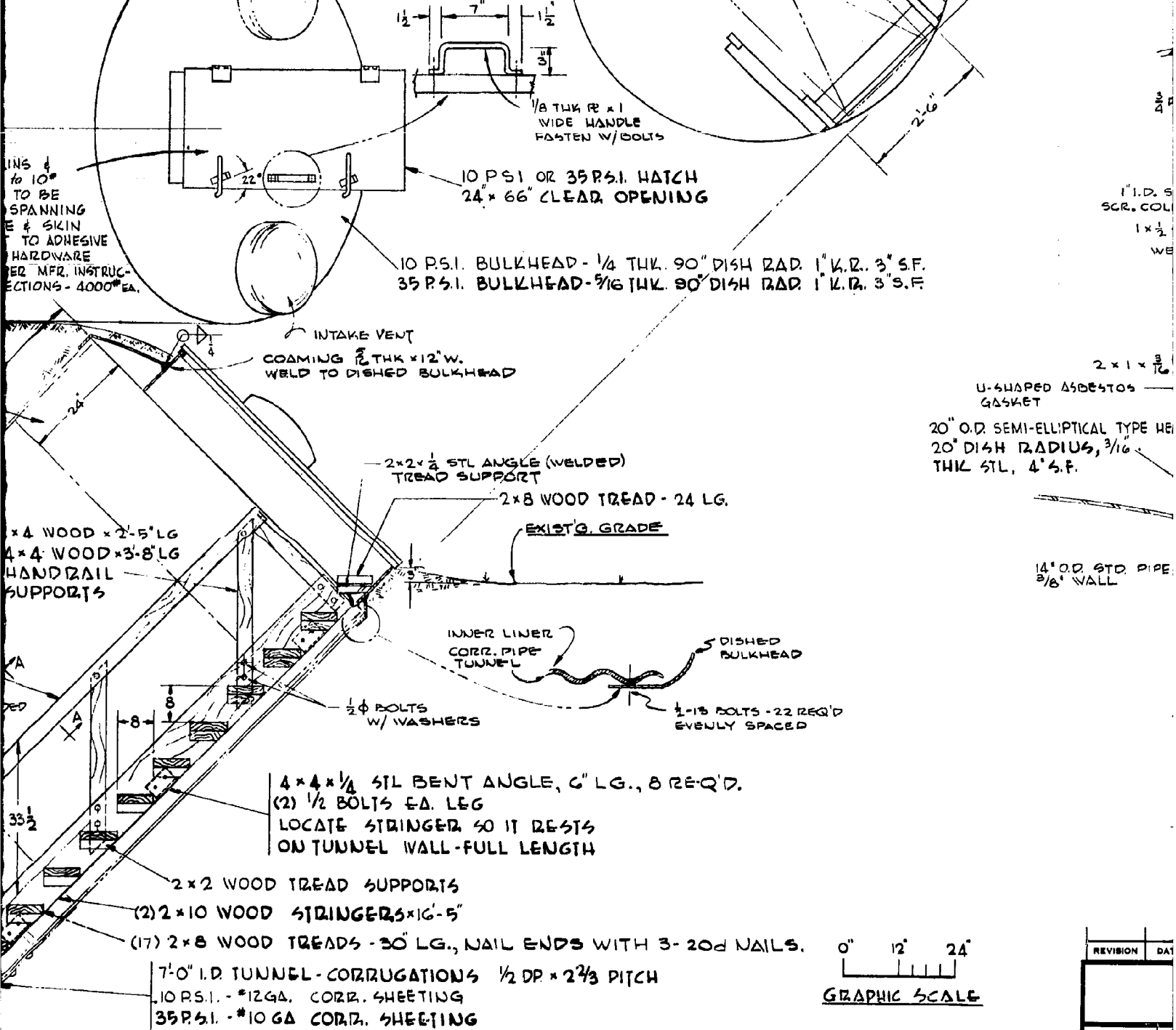
2x2 WOOD
(2) 2x10 WOOD
(17) 2x8 WOOD
7'-0" I.D. TUN
10 P.S.I. - #12
35 P.S.I. - #10

FASTEN RAIL TO POST WITH 3/8" φ CARRIAGE BOLT

STAIR NOSE

13 1/2"

HANDRAIL & SCALE



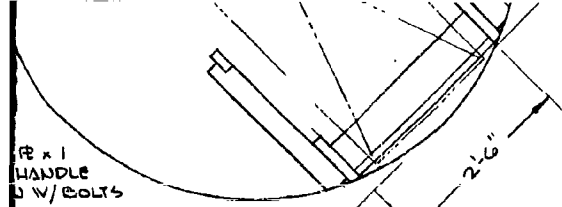
NOTES:

1. FOR TREATMENT REQUIREMENTS - STEEL
& WOOD - SEE NOTES ON FIGS. A-5M & A-15M.

ENGINEERING & DESIGN

IS APPROVED BY: *James H. Portman* DATE: 22 MAY 62

REVISION	DATE
DRAWN	
CHECKED	
SECTION HEAD	
BRANCH HEAD	
DIVISION HEAD	
DATE	
26 FEB 62	
SATISFACTORY	
DATE	5-



PS.1. HATCH
AND OPENING

1/4 THK. 90° DISH RAD. 1\"/>

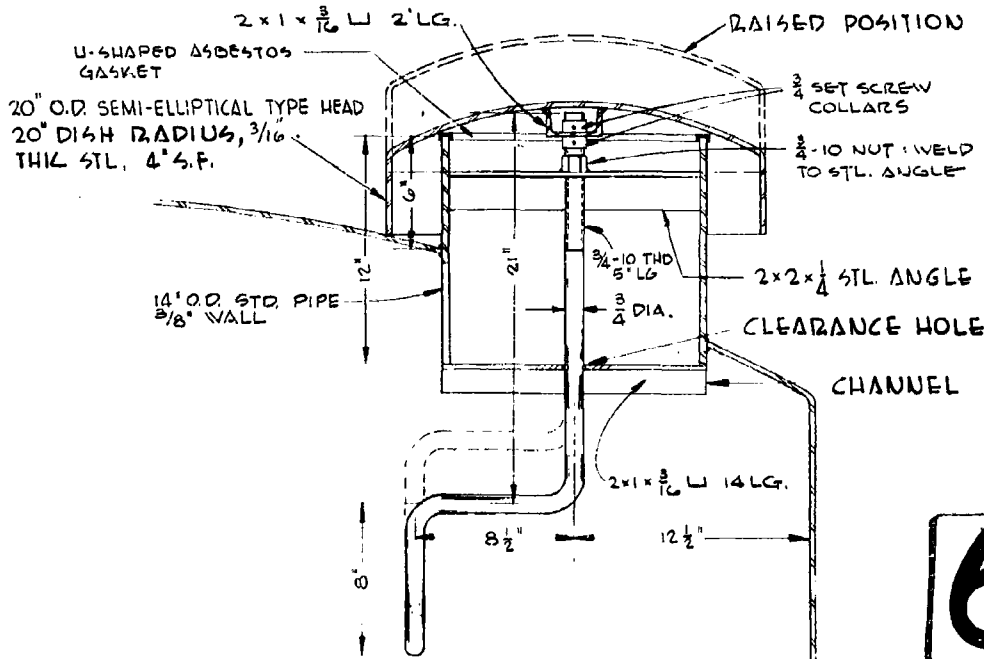
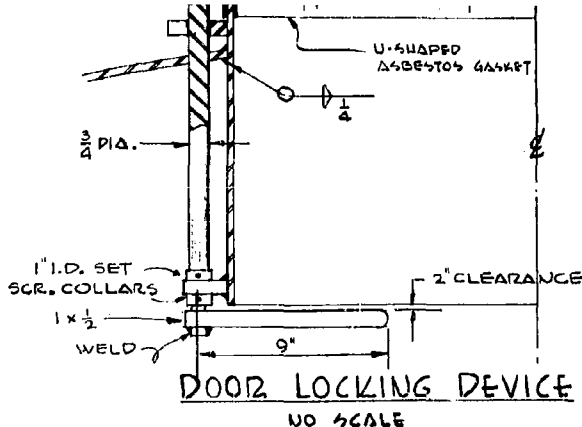
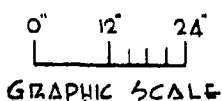
DED)
D TREAD - 24 LG.
GRADE

DISHED
BULKHEAD
1/2-18 BOLTS - 22 REQ'D
EVENLY SPACED

LG., 8 REQ'D.

WITH 3-20d NAILS.
2/3 PITCH

TREATMENT REQUIREMENTS - STEEL
DOD - SEE NOTES ON FIGS. A-5M & A-15M.



SECTION THRU INTAKE VENT
NO SCALE

6

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	POND			
CHECKED	782			
SECTION HEAD	FIG. A-4M ENTRANCE DETAILS I			
BRANCH HEAD				
DIVISION HEAD				
DEVELOPMENT				
DATE	SCALE	PROJECT	FINISH	HEAT TREAT
26 FEB 62	3/4" = 1'-0"			
SATISFACTORY TO:		DRAWING NUMBER		ALT.
DATE 5-22-62		S-62-970		
		SHEET 6 OF 19		

ENGINEERING & DESIGN
IS APPROVED BY: James H. Portman DATE: 22 MAY 62

*10GA. MULTI-PLATE ARCH

*8 GA. CURVED CHANNEL

HOOK BOLT W/NUT & WASHER

ENDWALL PLATE

2x4 & 1x4 WOOD DOOR
HEADER ASSEMBLY TO
BE BOLTED TO ENDWALL

MASTIC

SEE NOTE #8

SEE SECT B-B FOR
DETAILS OF THIS
CONNECTION

$\frac{1}{2} \times 1\frac{1}{2}$ DR. STOP

2-2x4 DOOR FRAME
ASSEMBLY BOLTED
TO ENDWALL

$\frac{1}{2} \times 1\frac{1}{2}$ WOOD DOOR
STOP. SECURE
W/ #10 P.W. WD. SCREWS
(DR. CL. HOLES THRU ENDWALL PLATE)

FIN. FLR.

USE 2" x 6" x 10" DOOR
6'-6"

ENTRANCE END
WALL FOUNDATION

SECTION A-A

SCALE: 5" = 1'-0"

$\frac{1}{2}$ "-13 HEX HD M.S.
W/WASHERS, SPACED
TO SUIT (24 MIN.)

SEE NOTE 4

2x2x $\frac{3}{8}$ CURVED
ANGLE RING, SHOP
RIVETED TO CORR.
PIPE

ENDWALL

84" DIA
CORR.

SECTION B-B

SCALE: 5" = 1'-0"

SHELTER INTERIOR

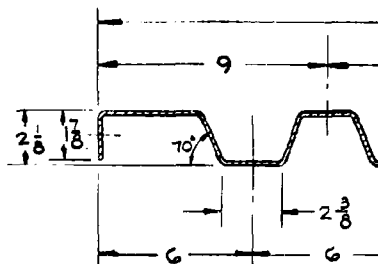
2-2x4 DOOR FRAME
BOLTED TO END WALL

DOOR
(SEE A)

ENDWALL
PLATE

SECTION C-C

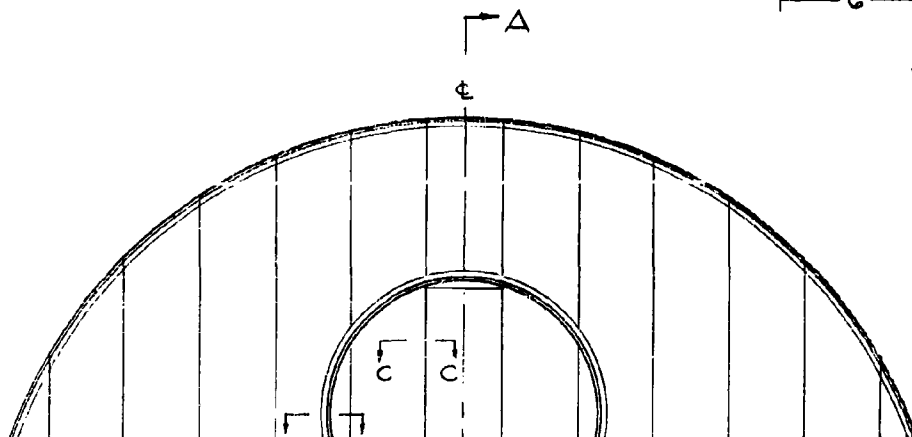
SCALE: 5" = 1'-0"



TYP. END

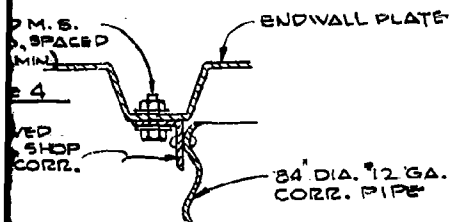
SE

SCALE

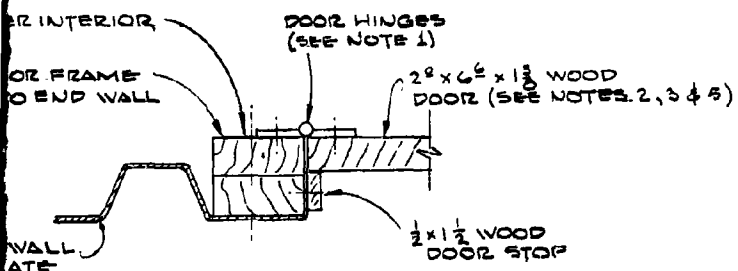


1

QUANTITIES SHC

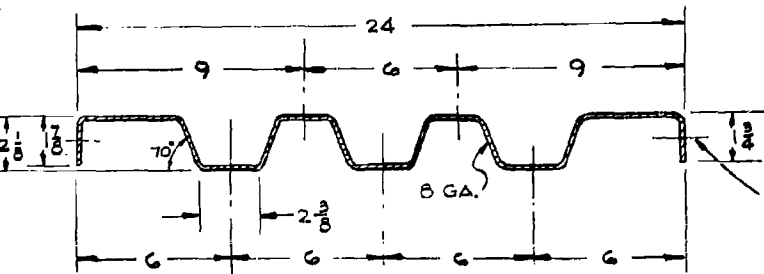


SECTION B-B
SCALE: 3"=1'-0"



SECTION C-C
SCALE: 3"=1'-0"

1. ONE P. PAINT
2. DOOR 1 HAMIL
3. SCREE FINISH 12 FRC
4. CONTR JUNCT
5. THE WC DOOR.
6. ALL LL DOOR 1 ZINC C TO ST. ASSOC
7. ALL E LUMBI DOUGL OTHER
8. THE J PIPE AIR LE WHEN TWO EQUIV WEATI A PR



DRILL 3/16" @ 12" CTES BOTH SIDES FOR 1/2" BOLTS, WASHERS & NUTS (GALV.)

TYP. ENDWALL PLATE SECTION
SCALE: 3"=1'-0"

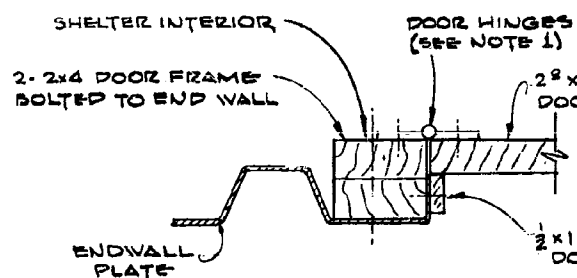
LIST OF MATERIAL						
QUANTITIES SHOWN ARE FOR						
PC. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPECS.	STOCK SIZE	REMARKS

GENERAL NOTES

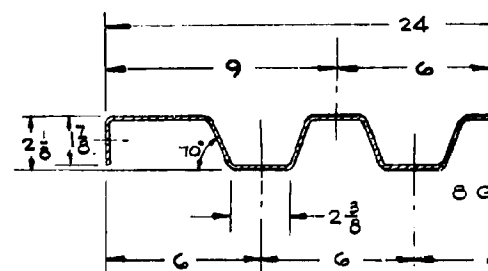
1. ONE PAIR 4x4 BUTT HINGES, WROUGHT STL., PRIMED /¹¹/₁₆ PAINTING, LOOSE PIN - STANLEY N242P OR EQUAL.
2. DOOR PULL, STL., JAPANNE FIN., STANLEY 1¹/₂ x 5³/₄, BAKER-HAMILTON-PAC. CO. C7782 OR EQUAL. (2 REQ'D.)
3. SCREEN DOOR CATCHES, "SNAPPY", WRT. STL. JAPANNE FINISH, BAKER-HAMILTON-PAC. CO., 2 REQ'D. ONE MOUNTED 12" FROM TOP & ONE MTD. 12" FROM BOTTOM.
4. CONTRACTOR TO PROVIDE SUITABLE FLASHING AT JUNCTION OF CORR. PIPE & ENDWALL.
5. THE WOOD DOOR SHALL BE A PLAIN CORE, 1³/₈ INCH FLUSH DOOR.
6. ALL LUMBER & TIMBERS USED IN STAIRWAY, ENDWALL SUPPORTS, DOOR ETC. SHALL BE GIVEN 2 BRUSH COATS OF CHROMATED ZINC CHLORIDE OR TANALITH. THE PRESERVATIVE SHALL CONFORM TO STANDARD P5-57 OF THE AMERICAN WOOD PRESERVER'S ASSOCIATION MANUAL.
7. ALL BOLTS, SCREWS & NAILS SHALL BE GALVANIZED. ALL LUMBER & TIMBERS SHALL BE EQUIVALENT TO PACIFIC COAST DOUGLAS FIR, S4S, & OF GRADES INDICATED. WOOD NOT OTHERWISE INDICATED SHALL BE CONSTRUCTION GRADE.
8. THE JOINT BETWEEN THE ENDWALL PLATE & 84" DIA. ENTRY PIPE SHALL BE SUITABLY FLASHED IN ORDER TO PREVENT AIR LEAKAGE FROM THE SHELTER TO THE ENTRY TUBE WHEN A DIFFERENCE IN AIR PRESSURE EXISTS BETWEEN THE TWO SPACES EQUAL TO 0.3 INCH STATIC HEAD (WATER EQUIVALENT). THE WOOD DOOR SHALL BE ADEQUATELY WEATHER STRIPPED TO PREVENT AN AIR EXCHANGE WITH A PRESSURE DIFFERENTIAL AS SPECIFIED ABOVE.

DRILL ¹/₂ " Ø @ 12" CTRS BOTH SIDES FOR
¹/₂ " BOLTS, WASHERS & NUTS (GALV.)

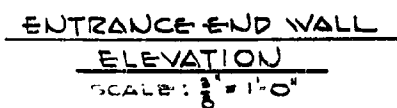
3

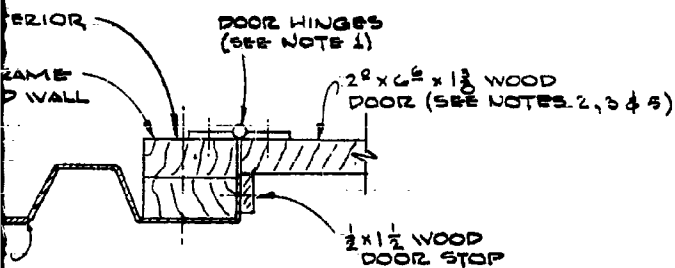


SCALE: 3" = 1'-0"



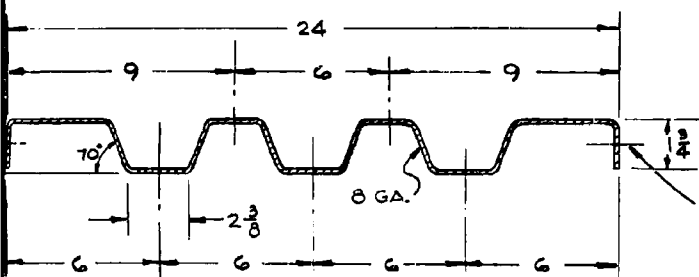
SECTION
SCALE: 3" = 1'





SECTION C-C

SCALE: 3" = 1'-0"



TYP. ENDWALL PLATE

SECTION

SCALE: 3" = 1'-0"

1. ONE PAIR 4
- PAINTING,
2. DOOR PULL
- HAMILTON.
3. SCREEN DOOR
- FINISH, BAK
- 12 FROM TO
4. CONTRACTOR
- JUNCTION
5. THE WOOD DOOR.
6. ALL LUMBER
- DOOR ETC. S
- ZINC CHLOR
- TO STANDAR
- ASSOCIATION
7. ALL BOLTS
- LUMBER & "
- DOUGLAS F
- OTHERWISE
8. THE JOINT
- PIPE SHALL
- AIR LEAKAG
- WHEN A DIP
- TWO SPACE
- EQUIVALENT
- WEATHER &
- A PRESSUR

5

ENGINEERING & DESIGN
IS APPROVED BY: James H. Portman DATE: 12 MAY 62

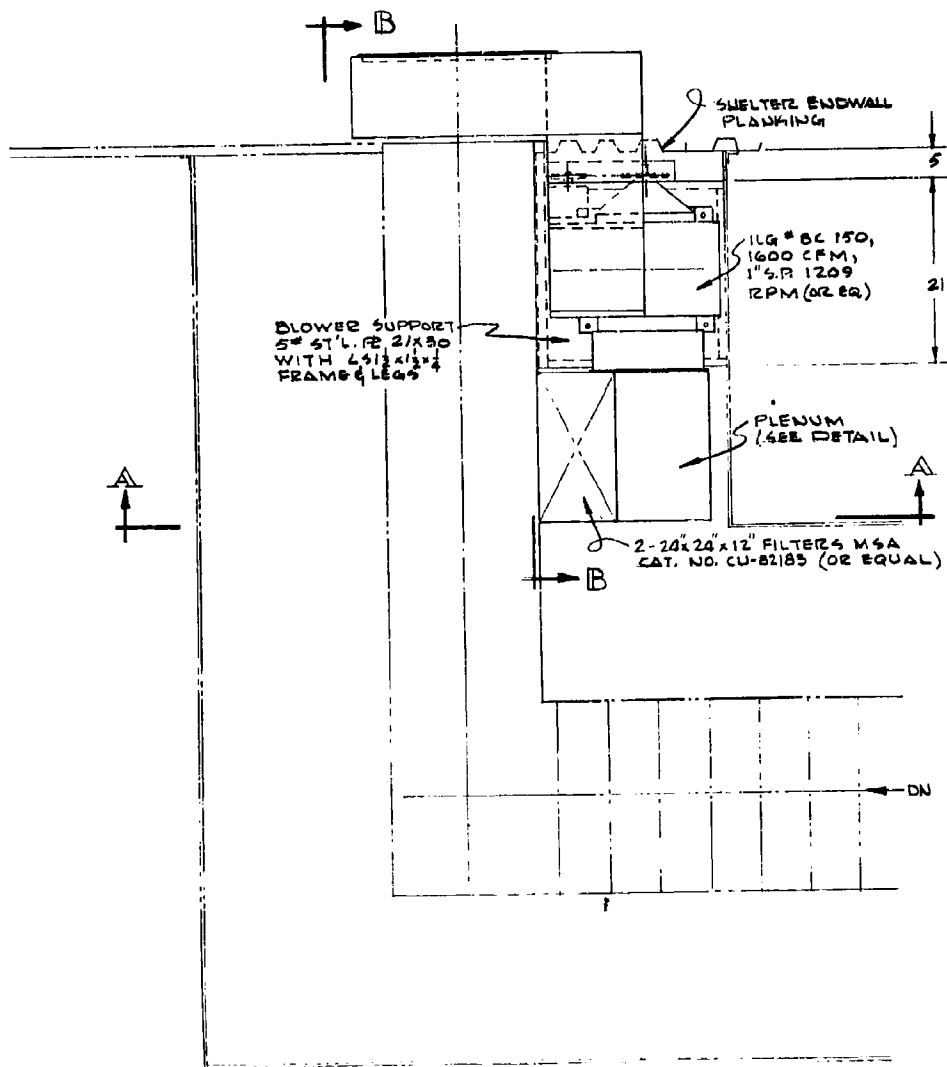
1. ONE PAIR 4x4 BUTT HINGES, WROUGHT STL., PRIMED & PAINTING, LOOSE PIN - STANLEY N242P OR EQUAL.
2. DOOR PULL, STL., JAPANNE FIN., STANLEY 1 1/2 x 5 3/4, BAKER-HAMILTON-PAC. CO. C7782 OR EQUAL. (2 REQ'D.)
3. SCREEN DOOR CATCHES, "SNAPPY", WRT. STL. JAPANNE FINISH, BAKER-HAMILTON-PAC. CO., 2 REQ'D. ONE MOUNTED 12" FROM TOP & ONE MTD. 12" FROM BOTTOM.
4. CONTRACTOR TO PROVIDE SUITABLE FLASHING AT JUNCTION OF CORR. PIPE & ENDWALL.
5. THE WOOD DOOR SHALL BE A PLAIN CORE, 1 3/8 INCH FLUSH DOOR.
6. ALL LUMBER & TIMBERS USED IN STAIRWAY, ENDWALL SUPPORTS, DOOR ETC. SHALL BE GIVEN 2 BRUSH COATS OF CHROMATED ZINC CHLORIDE OR TANALITH. THE PRESERVATIVE SHALL CONFORM TO STANDARD PS-57 OF THE AMERICAN WOOD PRESERVER'S ASSOCIATION MANUAL.
7. ALL BOLTS, SCREWS & NAILS SHALL BE GALVANIZED. ALL LUMBER & TIMBERS SHALL BE EQUIVALENT TO PACIFIC COAST DOUGLAS FIR, S4S, & OF GRADES INDICATED. WOOD NOT OTHERWISE INDICATED SHALL BE CONSTRUCTION GRADE.
8. THE JOINT BETWEEN THE ENDWALL PLATE & 84" DIA. ENTRY PIPE SHALL BE SUITABLY FLASHED IN ORDER TO PREVENT AIR LEAKAGE FROM THE SHELTER TO THE ENTRY TUBE WHEN A DIFFERENCE IN AIR PRESSURE EXISTS BETWEEN THE TWO SPACES EQUAL TO 0.3 INCH STATIC HEAD (WATER EQUIVALENT). THE WOOD DOOR SHALL BE ADEQUATELY WEATHER STRIPPED TO PREVENT AN AIR EXCHANGE WITH A PRESSURE DIFFERENTIAL AS SPECIFIED ABOVE.

DRILL 1/2" @ 12" CTES BOTH SIDES FOR
1/2" BOLTS, WASHERS & NUTS (GALV.)

6

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	POND	DATE	FIG. A-5M ENTRANCE DETAILS II	
CHKD	JHA	5/16		
SCOPE APPROVED	JHA	5/16		
ENGR.				
SUPVR.				
BRANCH HEAD				
DIVISION HEAD				
SCALE AS NOTED			PROJECT	TECH MEMO.
DRAWING NUMBER S 62 7 970 19			ALT.	

ENGINEERING & DESIGN
 IS APPROVED BY: Louis G. Portner DATE: 12 May 62



1

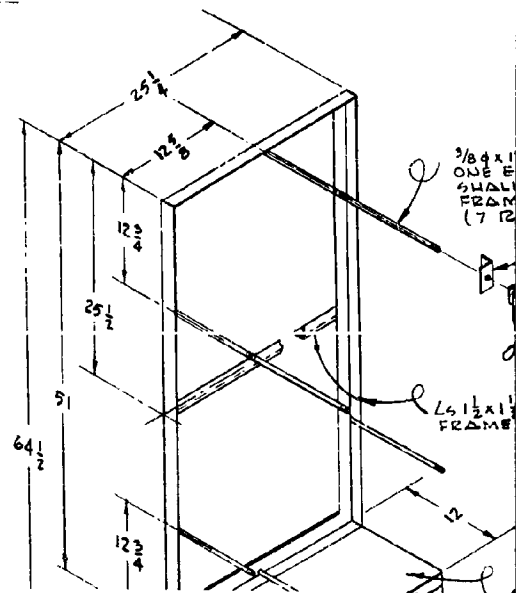
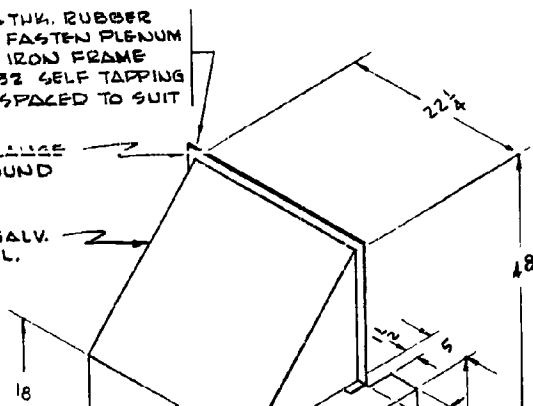
PLAN VIEW SHOWING VENTILATION INSTALL'N SYSTEM

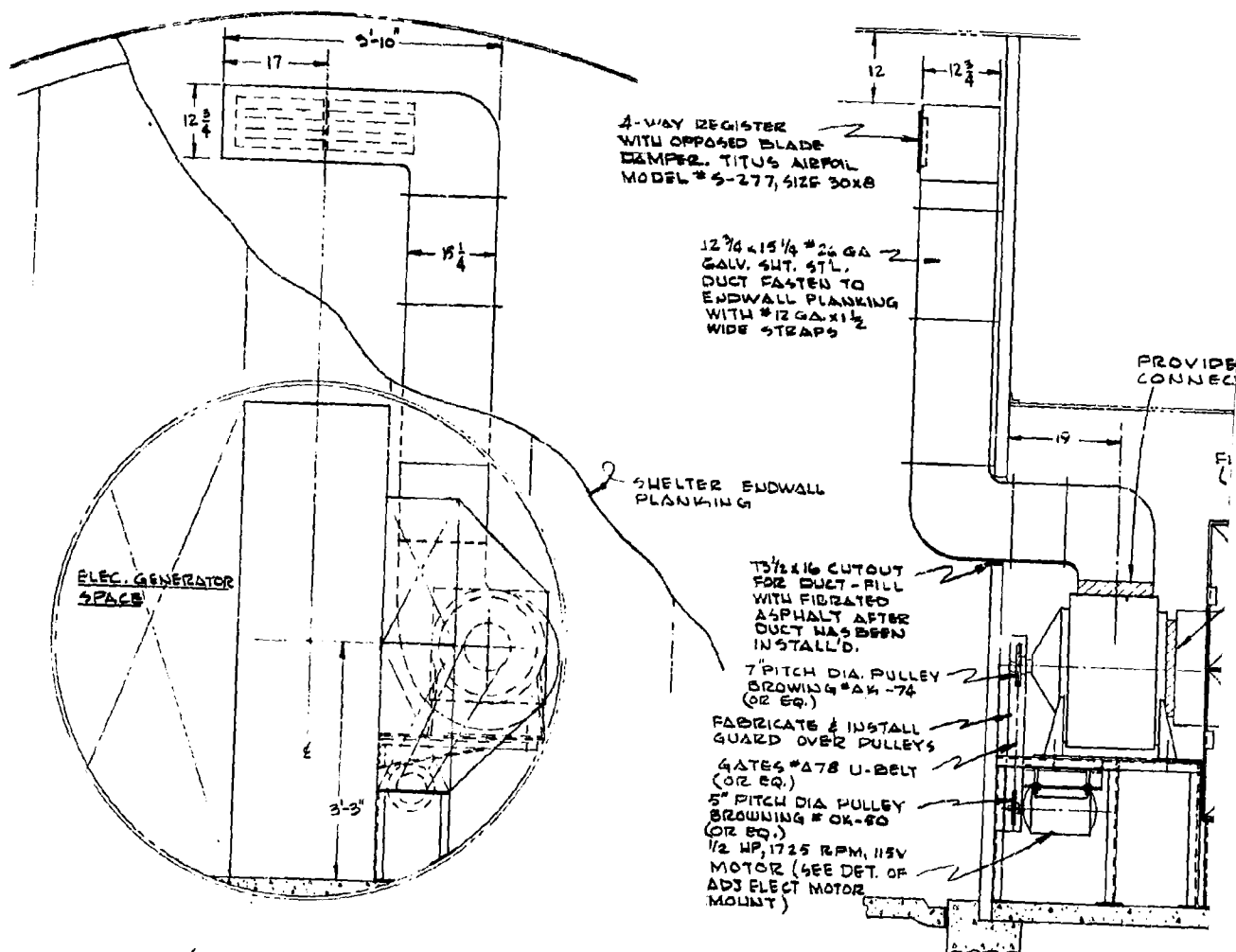
SCALE: 3/4" = 1'-0"

PROVIDE 1/16 THK. RUBBER GASKET & FASTEN PLENUM TO ANGLE IRON FRAME WITH #6-32 SELF TAPPING SCREWS, SPACED TO SUIT

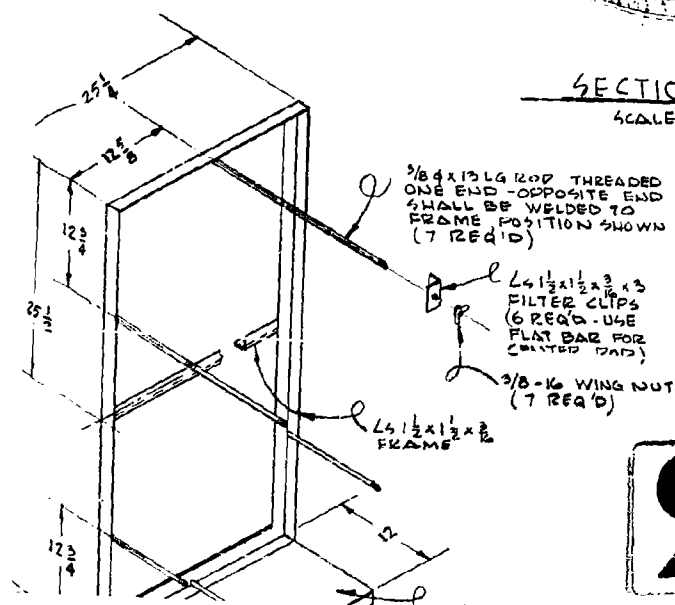
1" WIDE FLANGE ALL AROUND

*18 GA. GALV. SUT. ST'L.



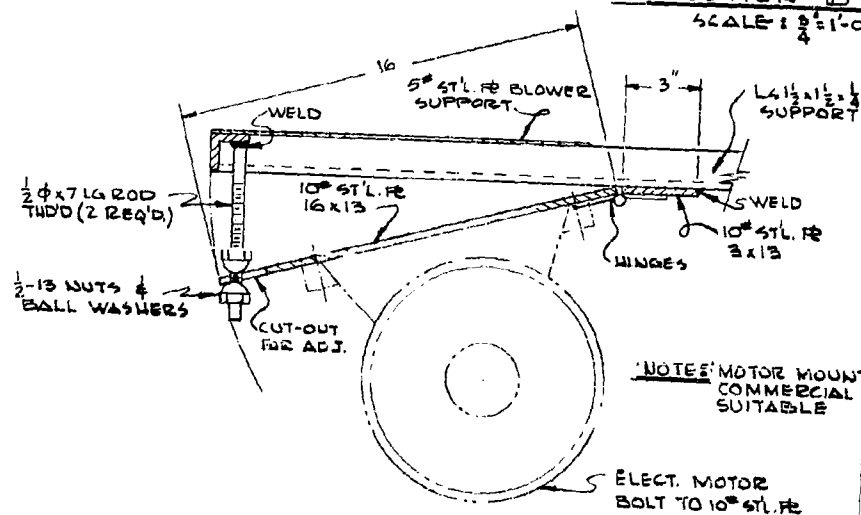


SCALE: $\frac{3}{4}" = 1'-0"$



2

SCALE: $\frac{1}{8}'' = 1'-0''$



NOTES: MOTOR MOUNT
COMMERCIAL
SUITABLE

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

QTY.	NAME	NO.	MATL.	MATL. SPEC.	STOCK SIZE	REMARKS
------	------	-----	-------	-------------	------------	---------

VENTILATION SCHEDULE

VENTILATION PKG. NO.		BLOWER TYPE (ILG ELEC. VENT. CO. OR EQ.)	
10 PSI	35 PSI	RATING	CAPACITY
V-1A	V-2A	1/2 HP	675 CFM @ 0.2 S.P.
V-1B	V-2B	1/3 H.P.	675 CFM @ 0.7 S.P.
V-1C	V-2C	1/3 H.P.	1600 CFM @ 0.2 S.P.
V-1D	V-2D	1/2 H.P.	1600 CFM @ 1.0 S.P.

4-WAY REGISTER WITH OPPOSED BLADE DAMPER, TITUS AIRFOIL MODEL #S-277, SIZE 30x8

12 3/4 x 15 1/4 x 26 GA 2 GALV. SH. STL. DUCT FASTEN TO ENDWALL PLANKING WITH #12 GALV. 1/2" WIDE STRAPS

PROVIDE CANVAS CONNECTION

FILTER FRAME (SEE DETAIL)

PROVIDE CANVAS CONNECTION BETWEEN PLENUM CHAMBER & VENT FAN.

SHELTER ENDWALL PLANKING

15" x 16" CUTOUT FOR DUCT - FILL WITH FIBERGLASS ASPHALT AFTER DUCT HAS BEEN INSTALLED.

7" PITCH DIA. PULLEY BROWNING #AK-74 (OR EQ.)

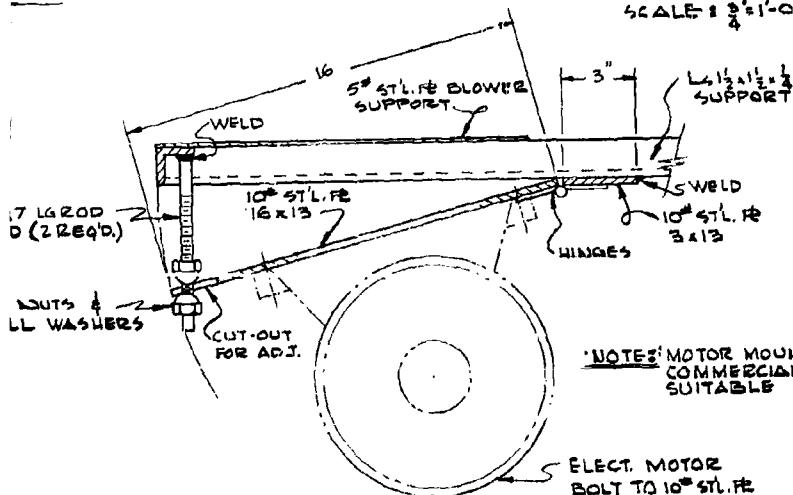
FABRICATE & INSTALL GUARD OVER PULLEYS GATES #A78 U-BELT (OR EQ.)

5" PITCH DIA PULLEY BROWNING #OK-50 (OR EQ.)

1/2 HP, 1725 RPM, 115V MOTOR (SEE DET. OF ADJ ELECT MOTOR MOUNT)

SECTION B-B

SCALE: 1 3/4" = 1'-0"



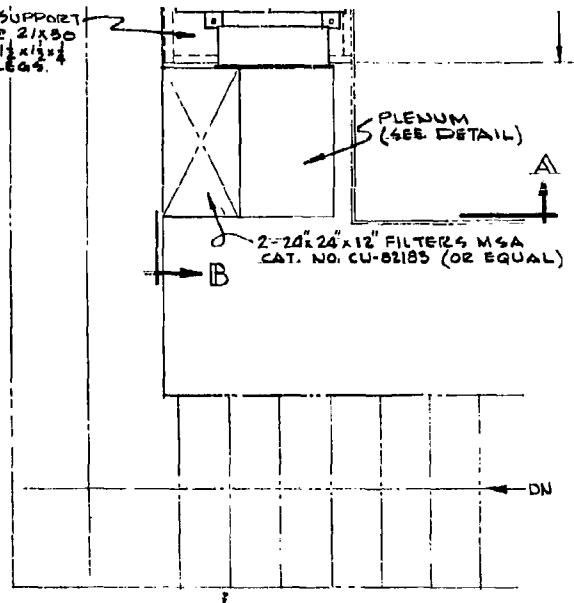
NOTES: MOTOR MOUNT MAY BE OF COMMERCIAL DESIGN IF SUITABLE

ELECT. MOTOR BOLT TO 10\"/>

3



BLOWER SUPPORT
5" ST'L. FE 2 1/2 X 30
WITH L 5 1/2 X 1 1/2
FRAME & LEGS.



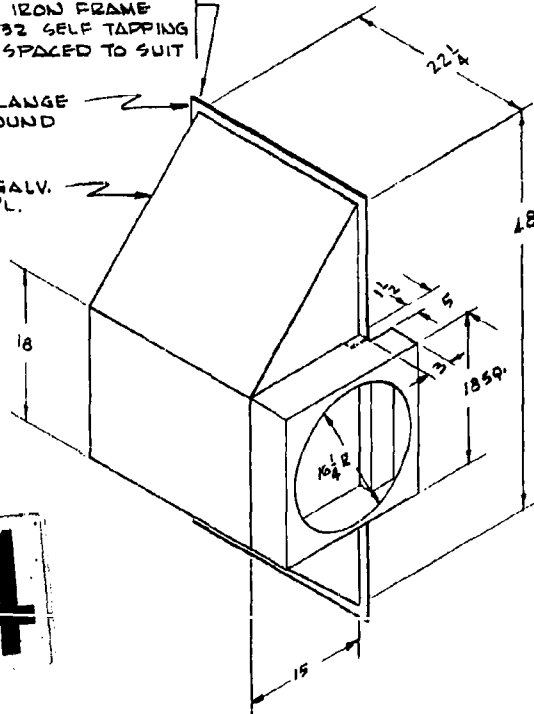
PLAN VIEW SHOWING VENTILATION INSTALLATION SYSTEM

SCALE: 3/4" = 1'-0"

PROVIDE 1/16 THK. RUBBER
GASKET & FASTEN PLENUM
TO ANGLE IRON FRAME
WITH #6-32 SELF TAPPING
SCREWS, SPACED TO SUIT

1" WIDE FLANGE
ALL AROUND

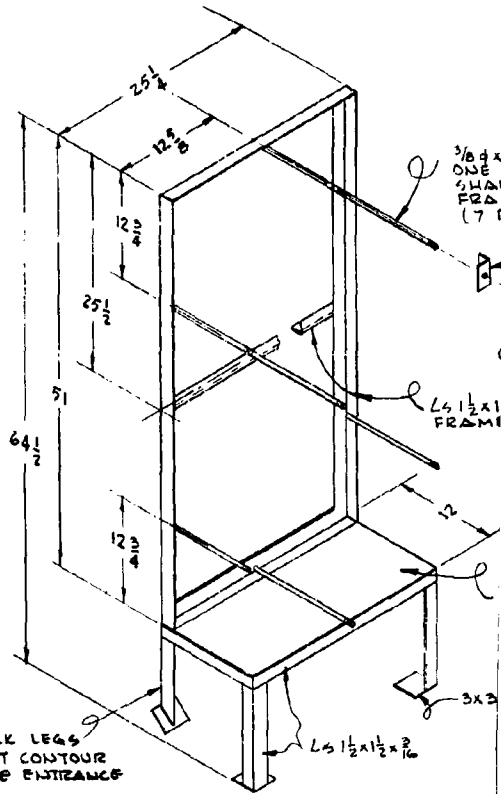
#18 GA. GALV.
SHT. ST'L.



4

DETAIL OF PLENUM (SEE NOTE # 2)

SCALE: 1" = 1'-0"



FILTER FRAME & PLENUM SUPPORT (SEE NO

WELD AS SHOWN

SCALE: 1" = 1'-0"

12 7/8 x 1 1/4 #26 GA 2
GALV. SHT. STL.
DUCT FASTEN TO
ENDWALL PLANKING
WITH #12 GA 1 1/2
WIDE STRAPS

PROVIDE CANVAS
CONNECTION

SHELTER ENDWALL
PLANKING

FILTER FRAME
(SEE DETAIL)

PROVIDE CANVAS
CONNECTION BETWEEN
PLENUM CHAMBER
& VENT FAN.

13 1/2 x 16 CUTOUT
FOR DUCT - FILL
WITH FIBRATED
ASPHALT AFTER
DUCT HAS BEEN
INSTALL'D.

7" PITCH DIA. PULLEY
BROWNING #AK-74
(OR EQ.)

FABRICATE & INSTALL
GUARD OVER PULLEYS

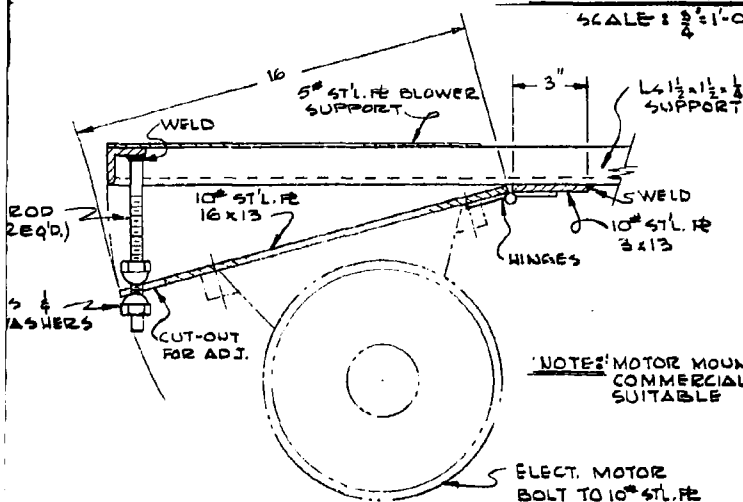
GATES #A78 U-BELT
(OR EQ.)

5" PITCH DIA. PULLEY
BROWNING #OK-60
(OR EQ.)

1/2 HP, 1725 RPM, 115V
MOTOR (SEE DET. OF
ADJ ELECT MOTOR
MOUNT)

SECTION B-B

SCALE: 3/4" = 1'-0"



NOTES: MOTOR MOUNT MAY BE OF
COMMERCIAL DESIGN IF
SUITABLE

DETAIL OF ADJ. ELECT. MOTOR MOUNT

SCALE: 5/8" = 1'-0"

NOTES

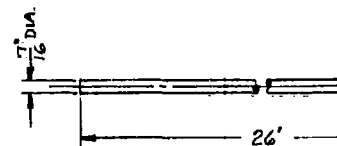
1. MOTOR MOUNT MAY BE OF COMMERCIAL DESIGN IF SUITABLE.
2. FILTER FRAME & PLENUM NOT REQ'D. FOR NON-FILTERED PACKAGE, (V-1A, V-1C, V-2A, V-2C)
3. THE VENT SYSTEM SHOWN ON THIS DRAWING IS IN ACCORDANCE WITH THAT SYSTEM SPECIFIED IN REFERENCE 1 AS 'VENT PACKAGE V-2D.'

ENGINEERING & DESIGN

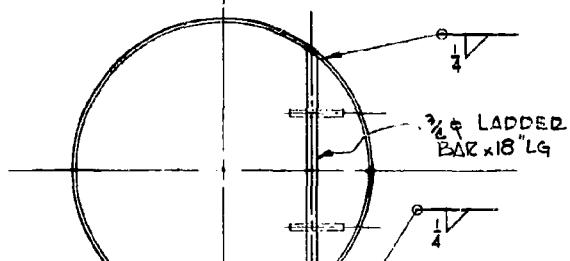
16 APPROVED BY: *Kevin M. Potany* DATE: 22 MAY 62

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	DATE		
CHKD	AKA			
SCOPE APPROVED	LOP	5/16/62		
PROJ. ENGR.				
SUPVR.				
BRANCH HEAD				
DIVISION HEAD				
SCALE		PROJECT	TECH. MEMO.	
AS SHOWN				
DRAWING NUMBER		SHEET		ALT.
S-62-970		8 OF 19		

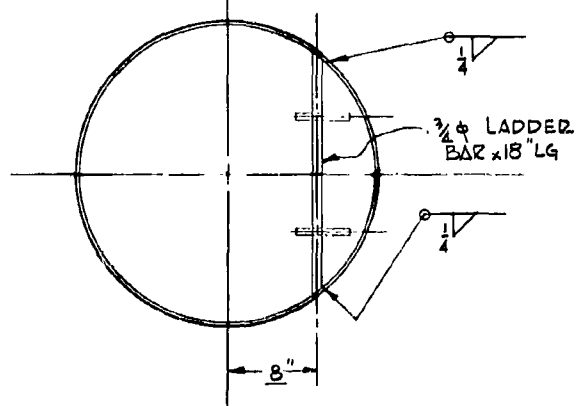
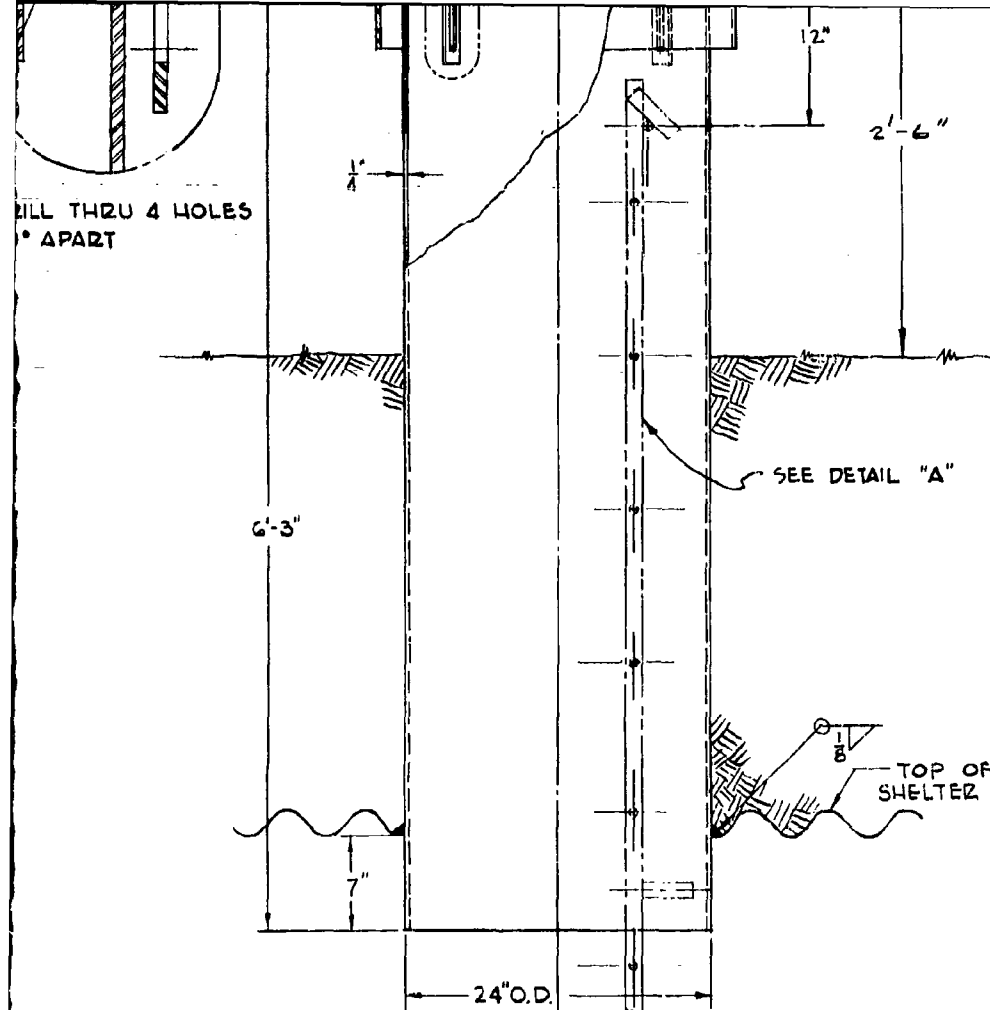
6



DETAIL: C
VENT LOCKING
SCALE: 3" = 1'-0"

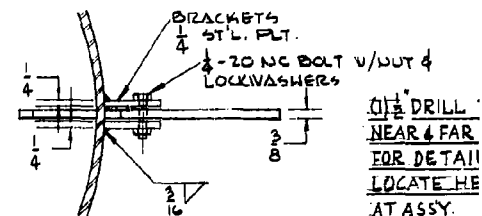
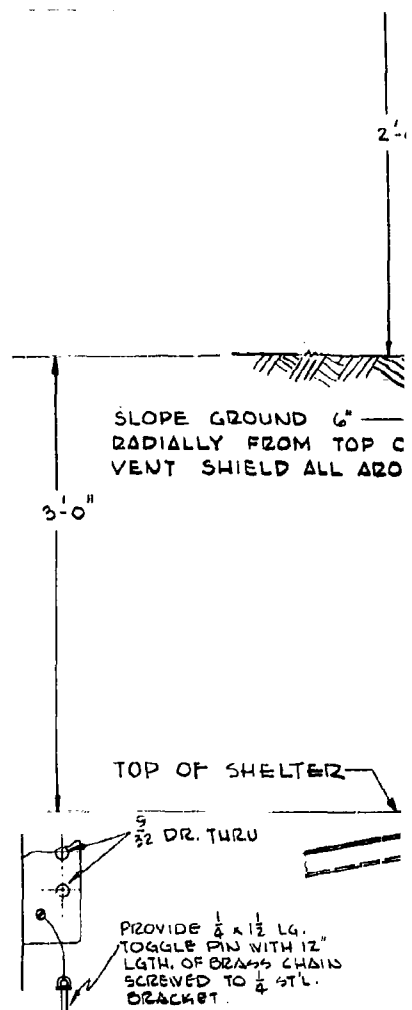






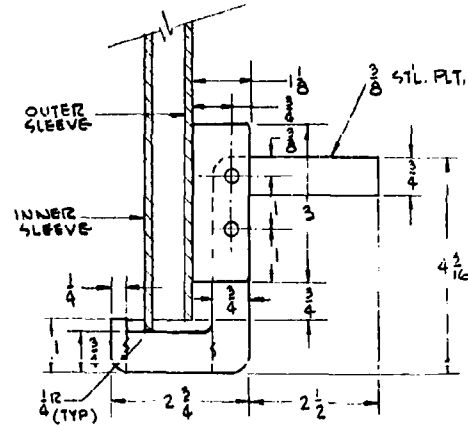
FIXED VENT

4



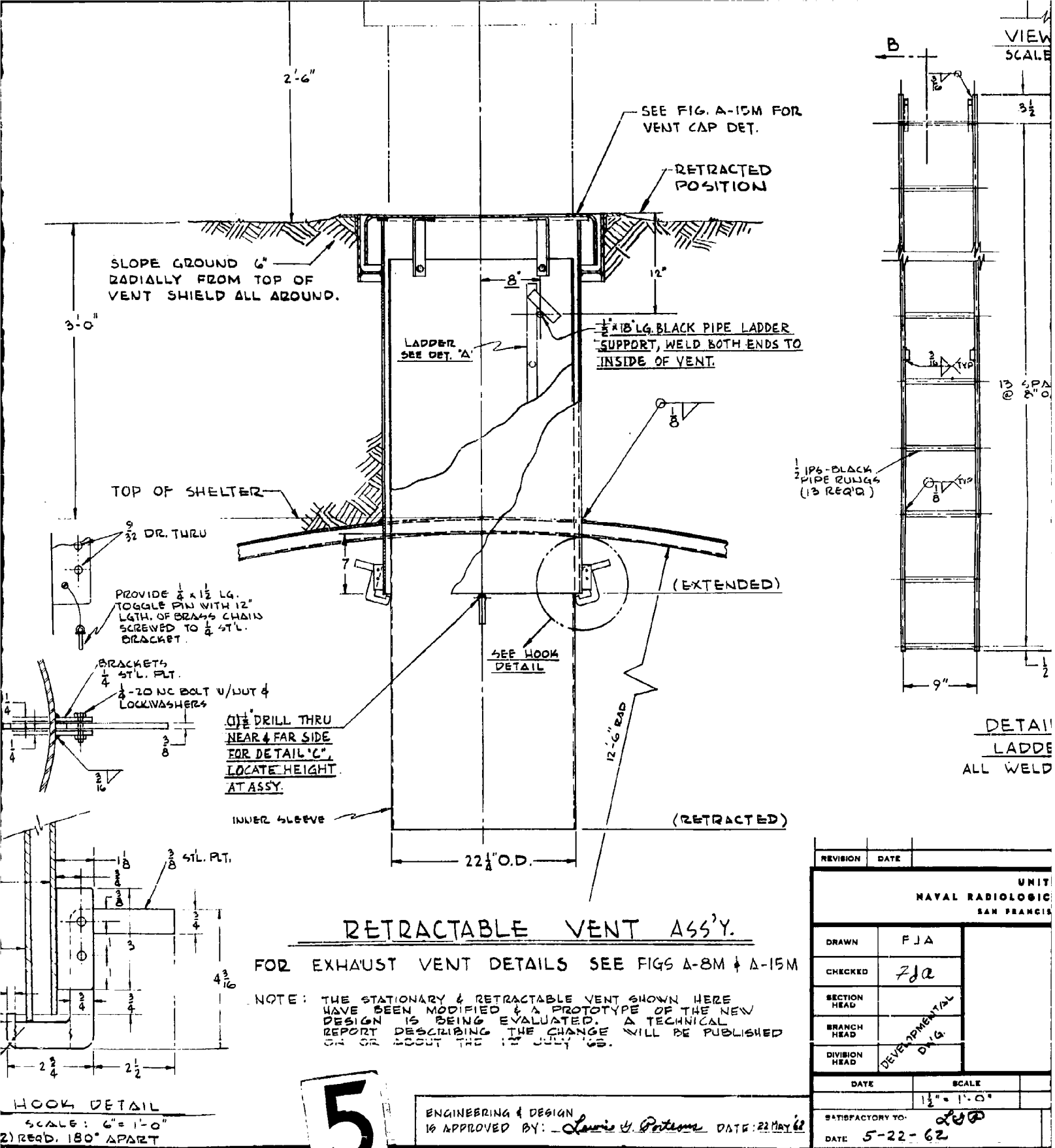
0.125" DRILL
NEAR & FAR
FOR DETAIL
LOCATE HERE
AT ASSY.

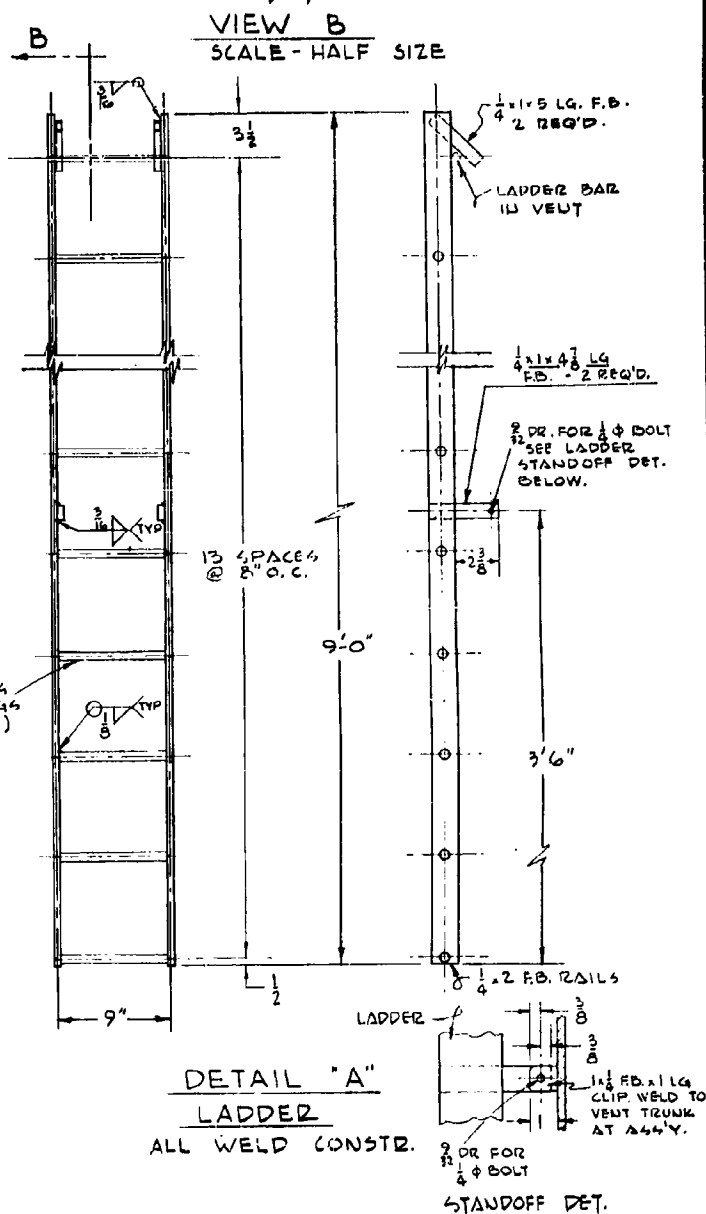
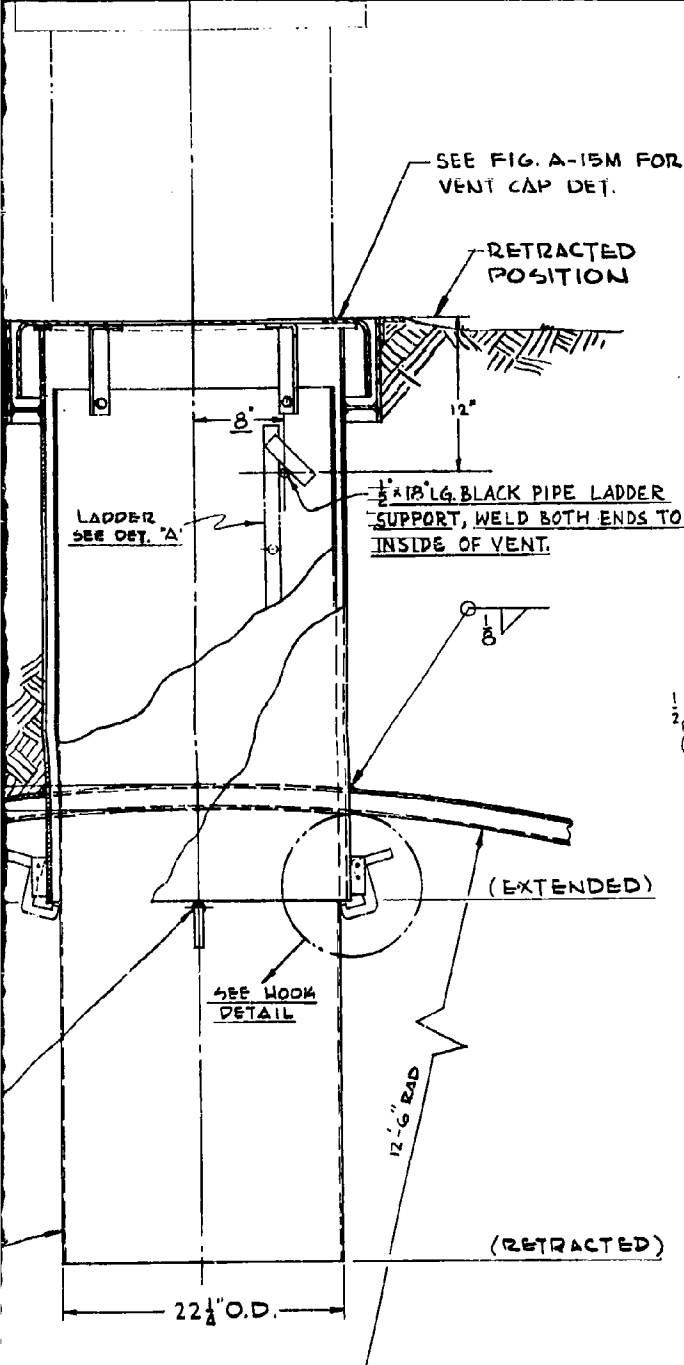
INNER SLEEVE



FOR
NOTE

HOOK DETAIL
SCALE: 6" = 1'-0"
(2) READ. 180° APART





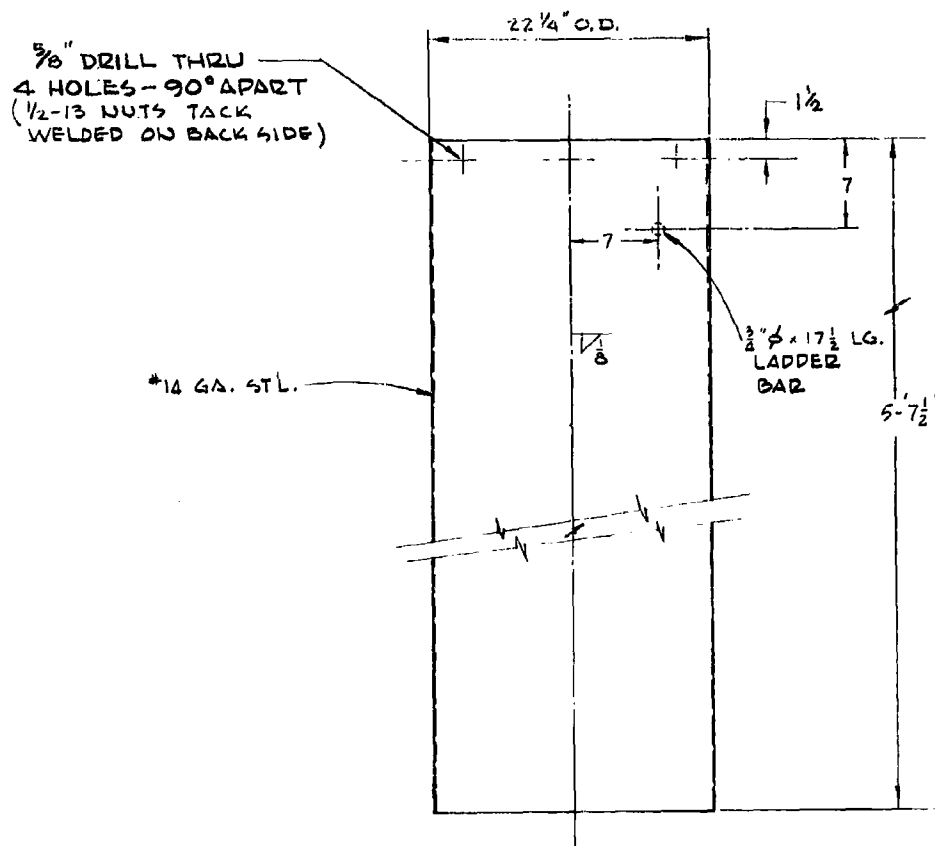
RETRACTABLE VENT ASS'Y.

EXHAUST VENT DETAILS SEE FIGS A-8M & A-15M

STATIONARY & RETRACTABLE VENT SHOWN HERE HAVE BEEN MODIFIED & A PROTOTYPE OF THE NEW DESIGN IS BEING EVALUATED. A TECHNICAL REPORT DESCRIBING THE CHANGE WILL BE PUBLISHED OR ABOUT THE 15 JULY 62.

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	FIG. A-7M. EXHAUST VENT ARRANGEMENTS 6		
CHECKED	Zja			
SECTION HEAD				
BRANCH HEAD				
DIVISION HEAD	DEVELOPMENTAL DWG.			
DATE	SCALE	PROJECT	FINISH	HEAT TREAT
	1/2" = 1'-0"			
SATISFACTORY TO:		DRAWING NUMBER		ALT.
DATE: 5-22-62		S-62-970		
		SHEET 9 OF 19		

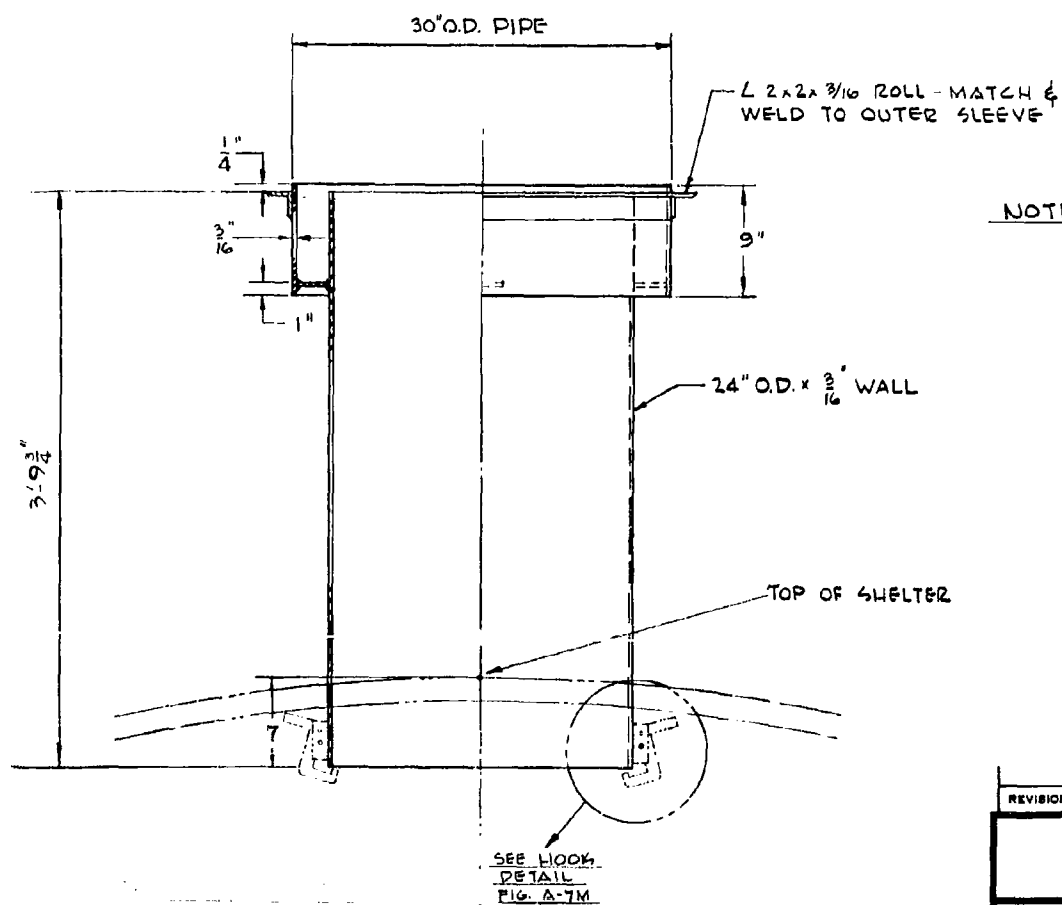
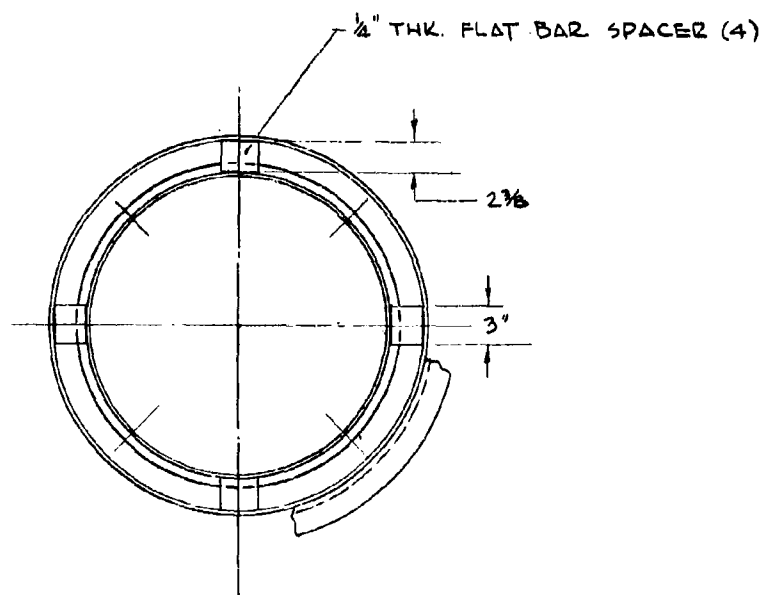
ENGINEERING & DESIGN
IS APPROVED BY: Lewis H. Portman DATE: 22 MAY 62



INNER SLEEVE
RETRACTABLE VENT

SCALE: 1 1/2" = 1'-0"

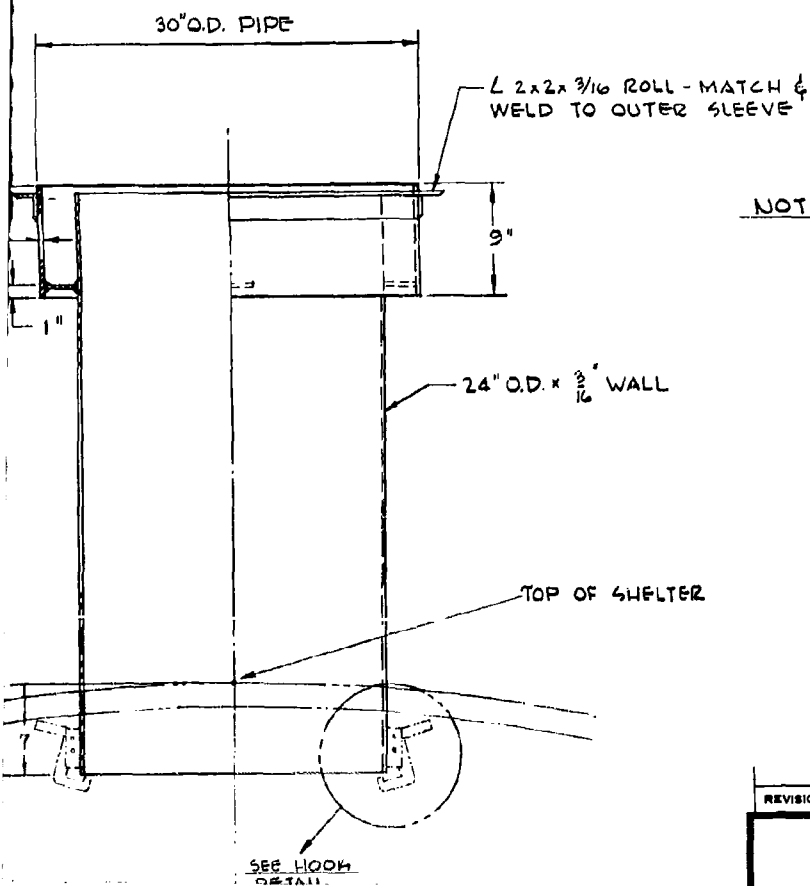
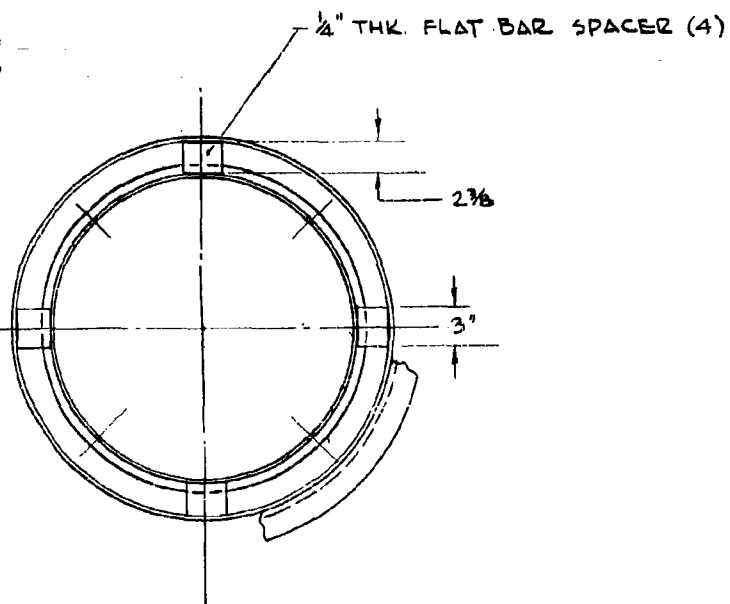
3'-9 3/4"



NOTE:
SEE FIG. A-7M FOR

2

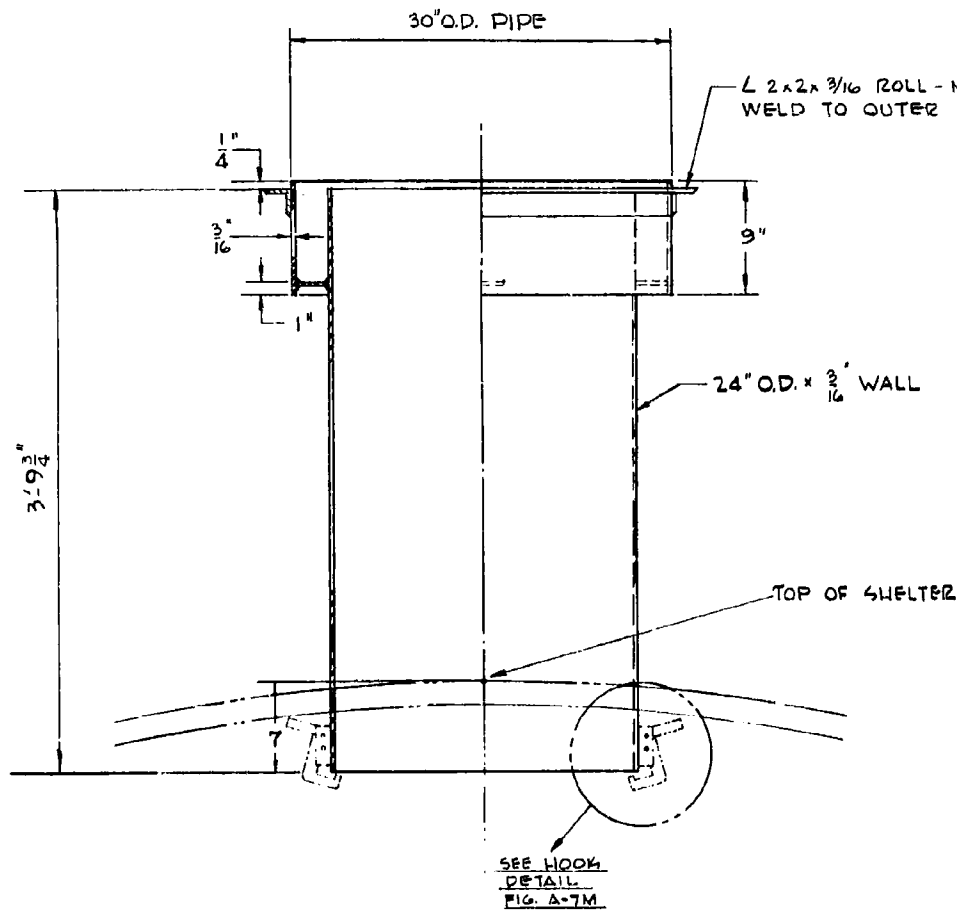
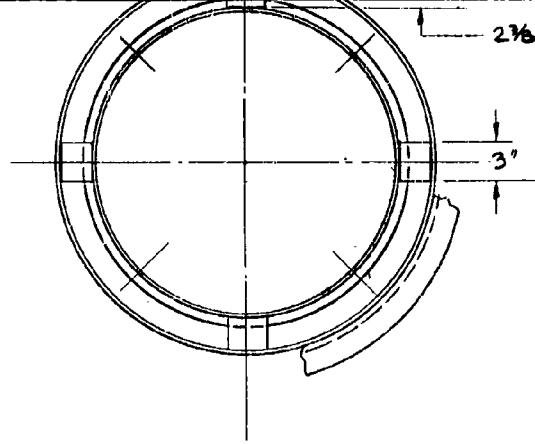
REVISION	DATE	
NAVAL RADI SAN		



NOTE:
SEE FIG. A-7M FOR VENT ASSEMBLY

3

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				



NOTE:
SEE FIG. A-7M FOR VENT

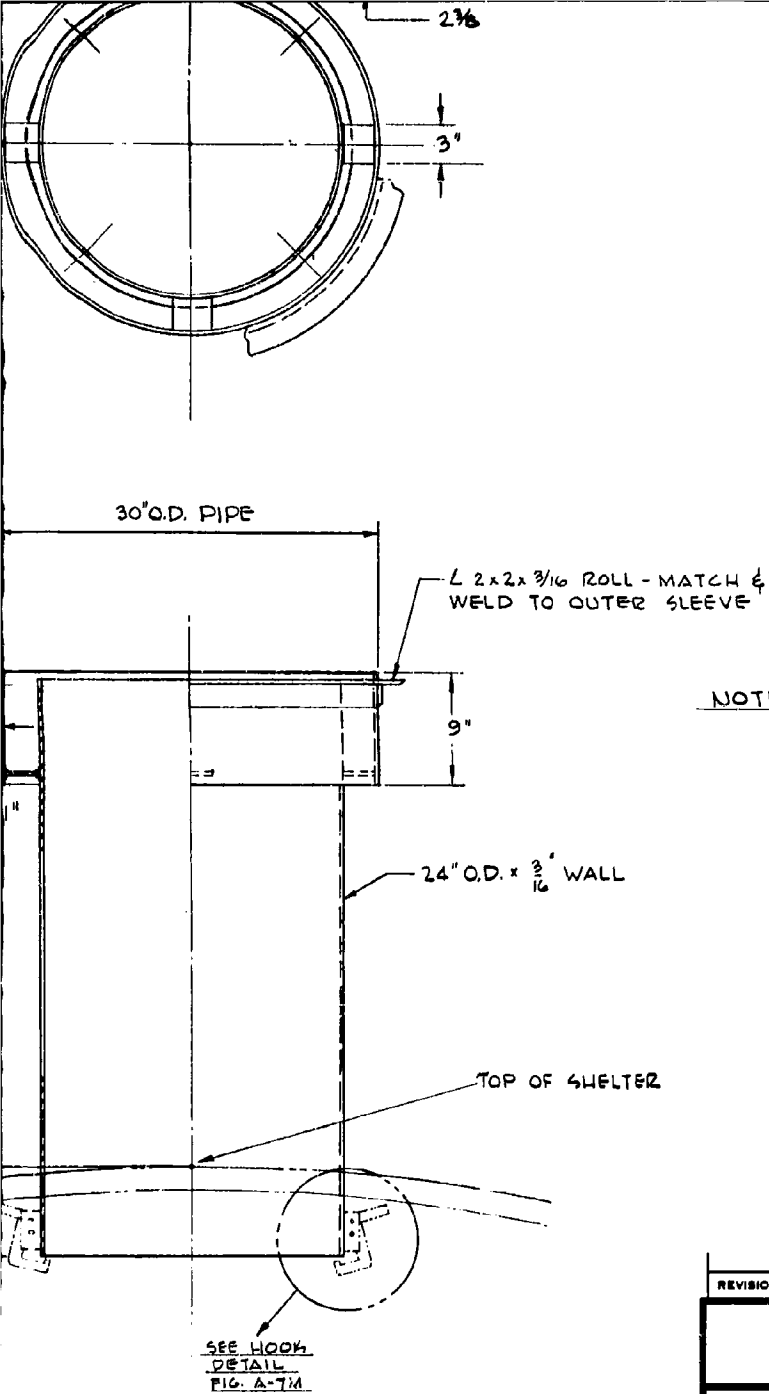
OUTER SLEEVE RETRACTABLE VENT

SCALE: $\frac{1}{8}'' = 1'$

4

REVISION	DATE
NAVAL RADIOLOGICAL DEVELOPMENT CENTER SAN FRANCISCO	
DRAWN	FJA
CHECKED	7ja
SECTION HEAD	DEVELOPMENTAL 7ja
BRANCH HEAD	
DIVISION HEAD	
DATE	SCALE
26 FEB 62	NOTED
SATISFACTORY TO: <i>200</i>	
DATE 5-22-62	

ENGINEERING & DESIGN
APPROVED BY: *Louis B. Portman* DATE: 22 MAY 62



OUTER SLEEVE
RETRACTABLE VENT

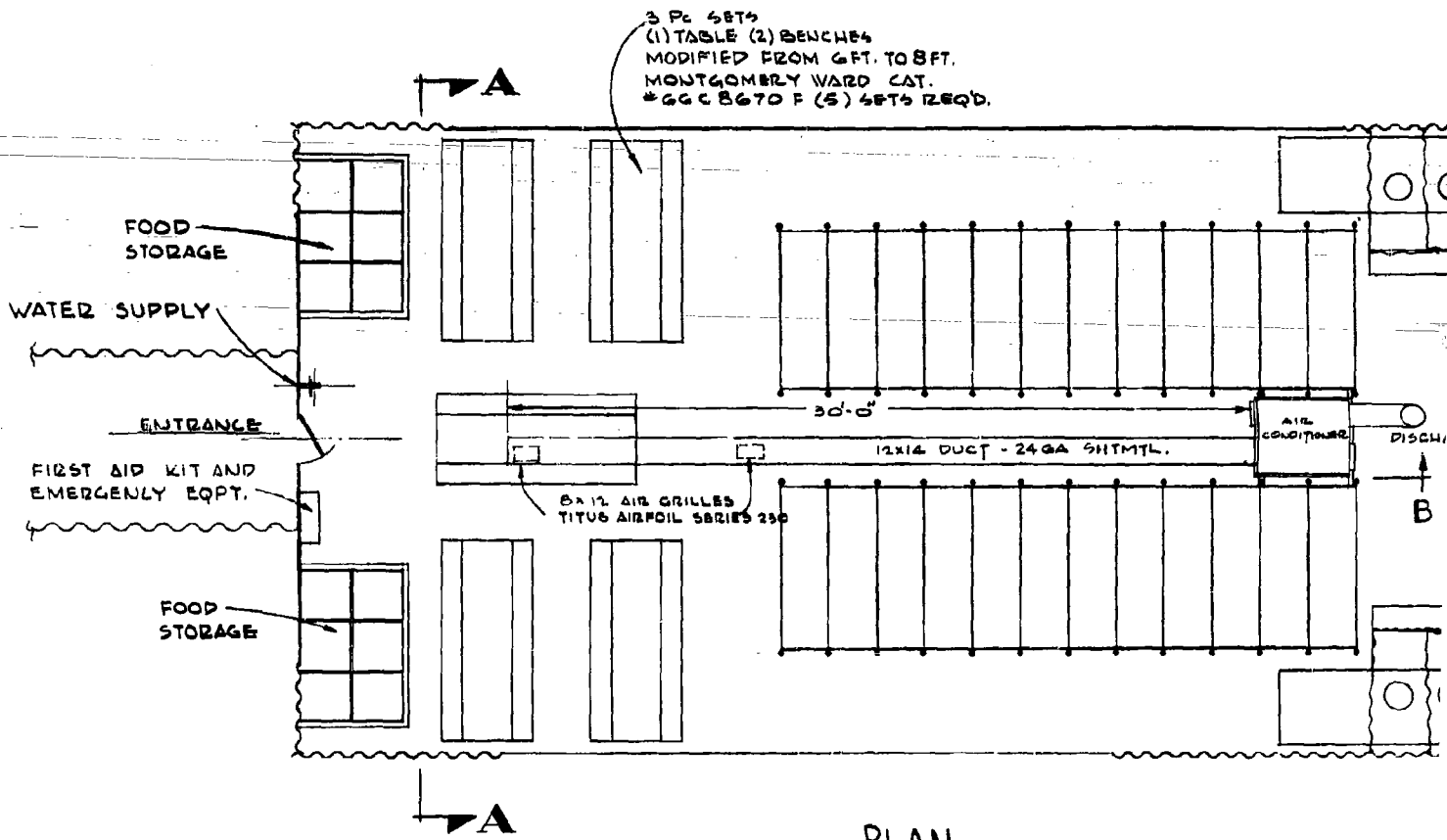
SCALE: $\frac{1}{8}" = 1"$

NOTE:
SEE FIG. A-7M FOR VENT ASSEMBLY

5

REVISION	DATE	DESCRIPTION	BY	APP.	
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA					
DRAWN	FJA	FIG. A-8M EXHAUST VENT DETAILS			
CHECKED	7da				
SECTION HEAD					
BRANCH HEAD					
DIVISION HEAD					
DATE		SCALE	PROJECT	FINISH	HEAT TREAT
24 FEB 62		NOTED			
Satisfactory to:			DRAWING NUMBER		ALT.
DATE 5-22-62			S-62-970		
			SHEET 10 OF 19		

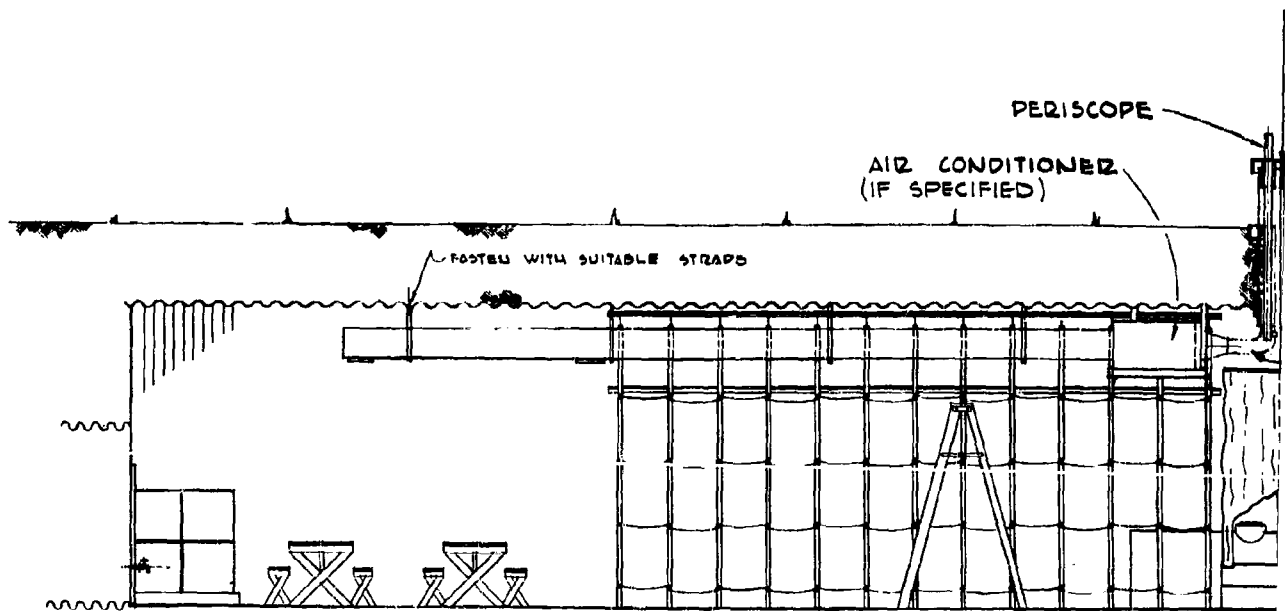
ENGINEERING & DESIGN
IS APPROVED BY: Lewis G. Portman DATE: 22 MAY 62



PLAN

HOTEL PKG. H-1C SHOWN ONLY
SEE FIGS. A-10N & A-11M FOR OTHER ARRANGEMENTS

1

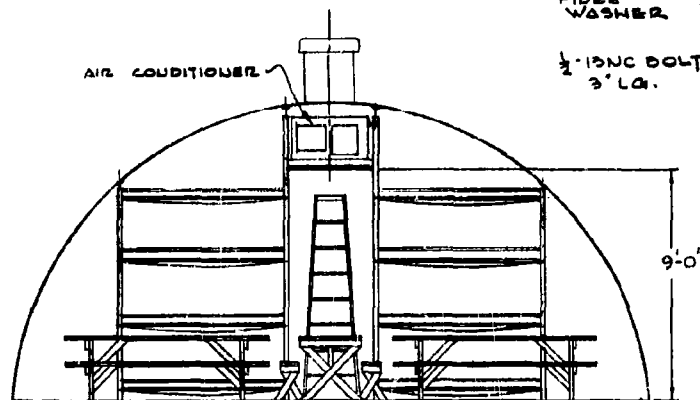
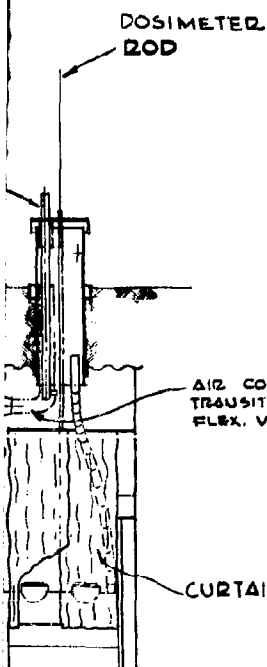
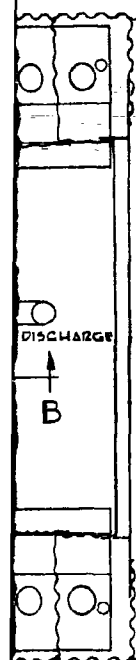


LONGITUDINAL SECTION

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

QTY.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE



AIR CONDITIONER DISCHARGE
TRANSITION PIECE TO 4" DIA.
FLEX. VINYL VENT DUCT

SECTION A-A

2

40 x 39 - 16 GA. DRIP
PAU (GALV.)

1/2 - 13NC BOLTS
4" LG.

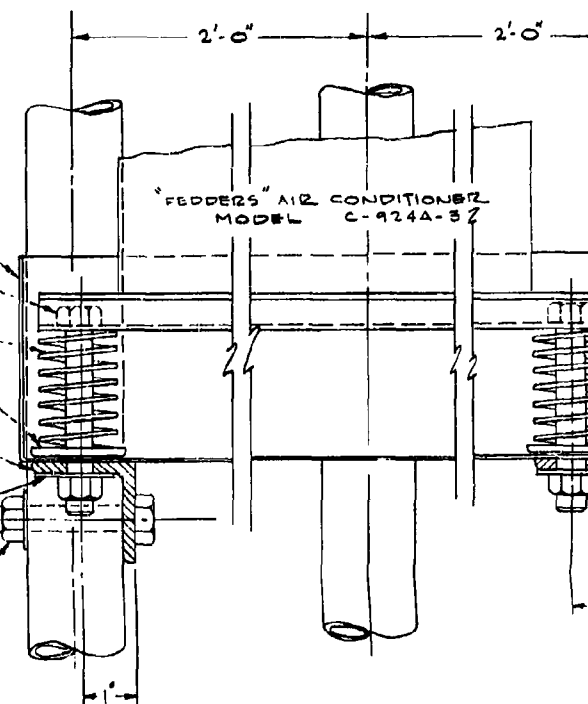
MOUNTING
SPRINGS

SPRING CUP

2 x 2 x 1/4 L 44" LG
COPE FLANGE TO
CLEAR PIPE

FIBRE
WASHER

1/2 - 13NC BOLT
3" LG.



INSTALLATION DETAIL OF AIR CO

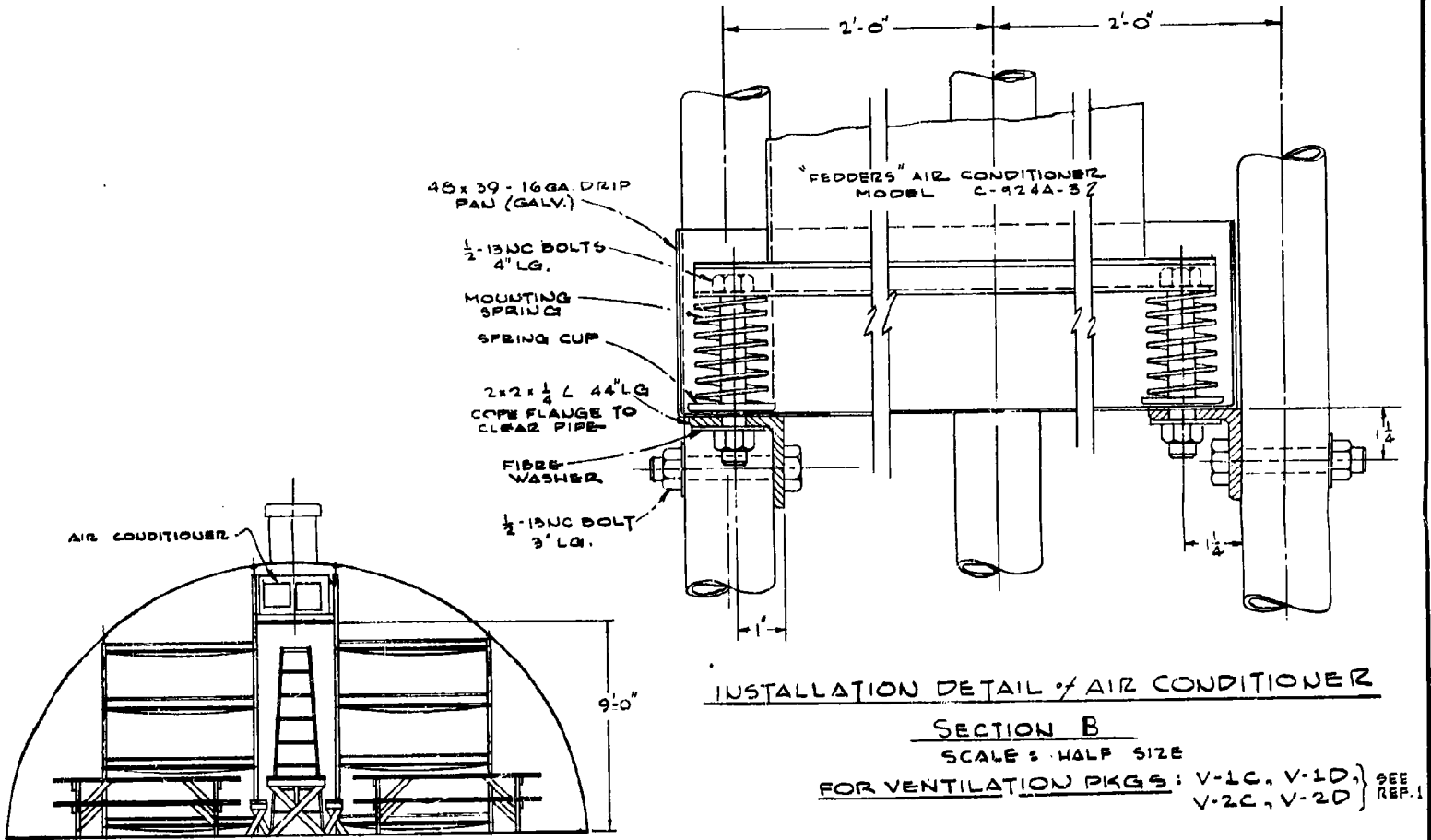
SECTION B

SCALE: HALF SIZE
FOR VENTILATION PKGS:

REVISION	DATE	DESCRIPTION

UNITED STATES
NAVAL RADIOLOGICAL DEFENSE LAB
SAN FRANCISCO 24, CALIFORNIA

LIST OF MATERIAL						
QUANTITIES SHOWN ARE FOR						
QTY.	NAME	REQ.	MATL.	MATL.	STOCK SIZE	REMARKS

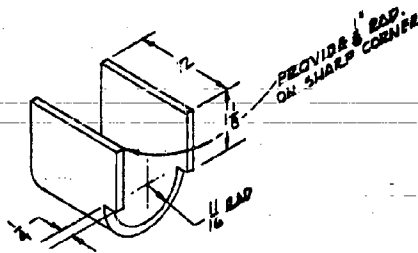


AIR CONDITIONER DISCHARGE
ON PIECE TO 4" DIA.
NYL VENT DUCT

SECTION A-A

3

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 34, CALIFORNIA				
DRAWN	FJA			



**BUNK RAIL
CLIP DETAIL**
SCALE: HALF
MATERIAL: 5# ST'L R
(SEE SCHEDULE)

CONTINUOUS BUNK SHEET SCHEDULE			
HOTEL PKG.	N° OF BUNKS PER SUT.	N° OF SHEETS	DIM. A
H-1	12	8	23'-0"
H-2	6	8	11'-0"
H-3	4	8	7'-8"

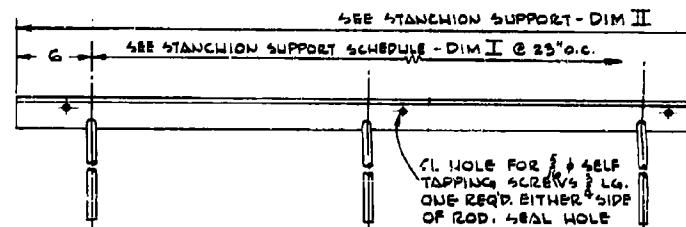
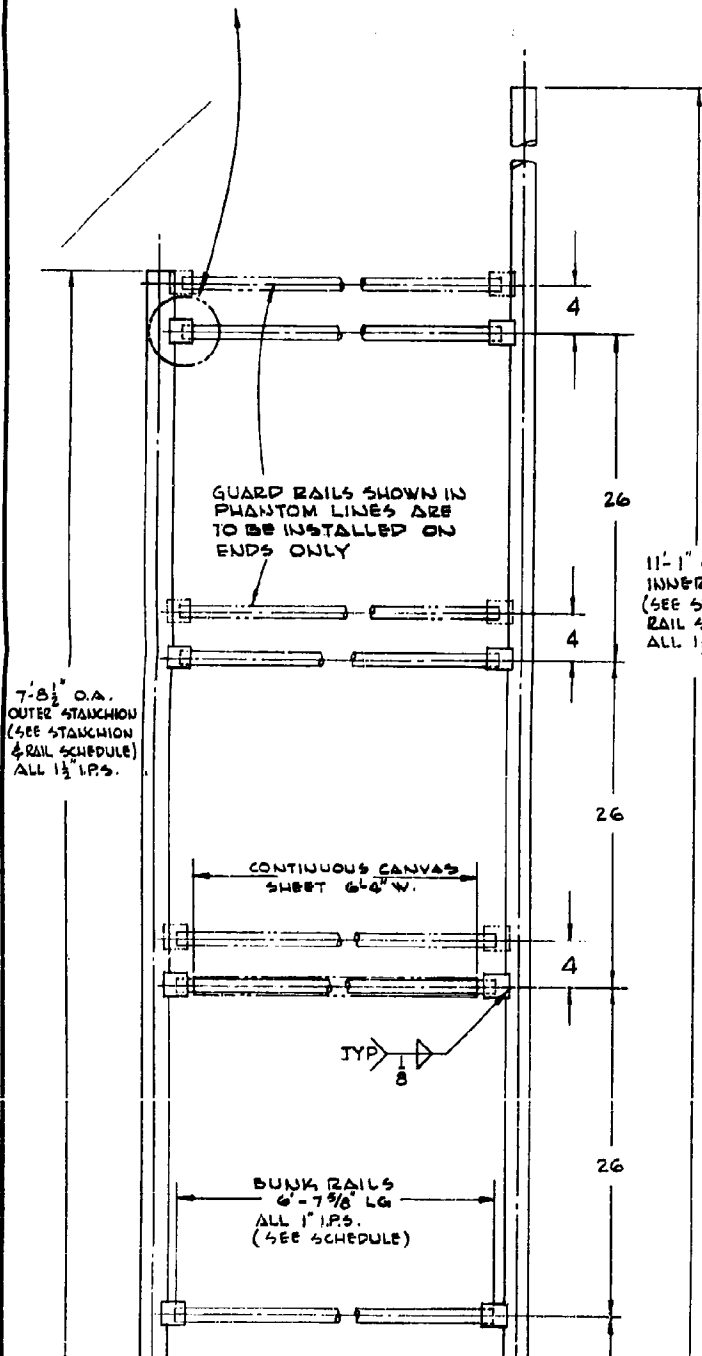
POL STITCH

1" STD I.P.S.

1/2" MANILA ROPE IN
HEM-SEWED ALL
AROUND

STANCHION & RAIL SCHEDULE						
HOTEL PKG.	INNER STANCHION	INNER STANCHION END	OUTER STANCHION	OUTER STANCHION END	BUNK RAIL	BUNK RAIL CLIPS
H-1	22	4	22	4	116	232
H-2	10	4	10	4	68	136
H-3	6	4	6	4	52	104

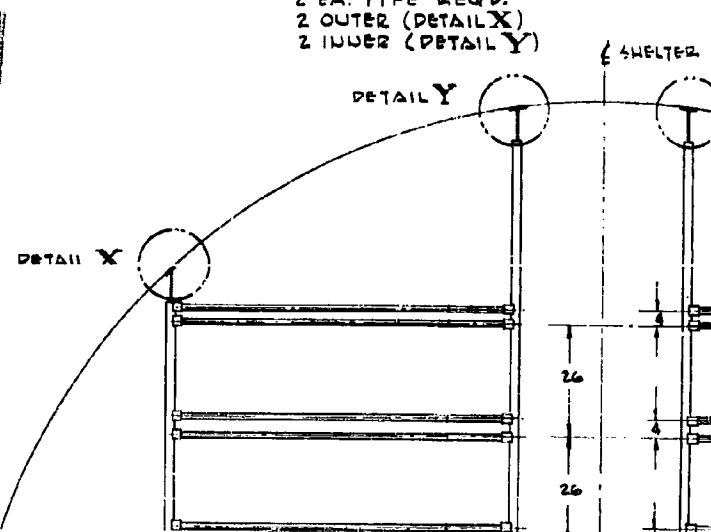
OUTER & INNER STANCHION SUPPORT SCHEDULE				
HOTEL PKG.	N° OF SPACES	DIM. I	DIM. II	
H-1	12	23'-0"	24'-0"	
H-2	6	11'-6"	12'-6"	
H-3	4	6'-0"	7'-0"	



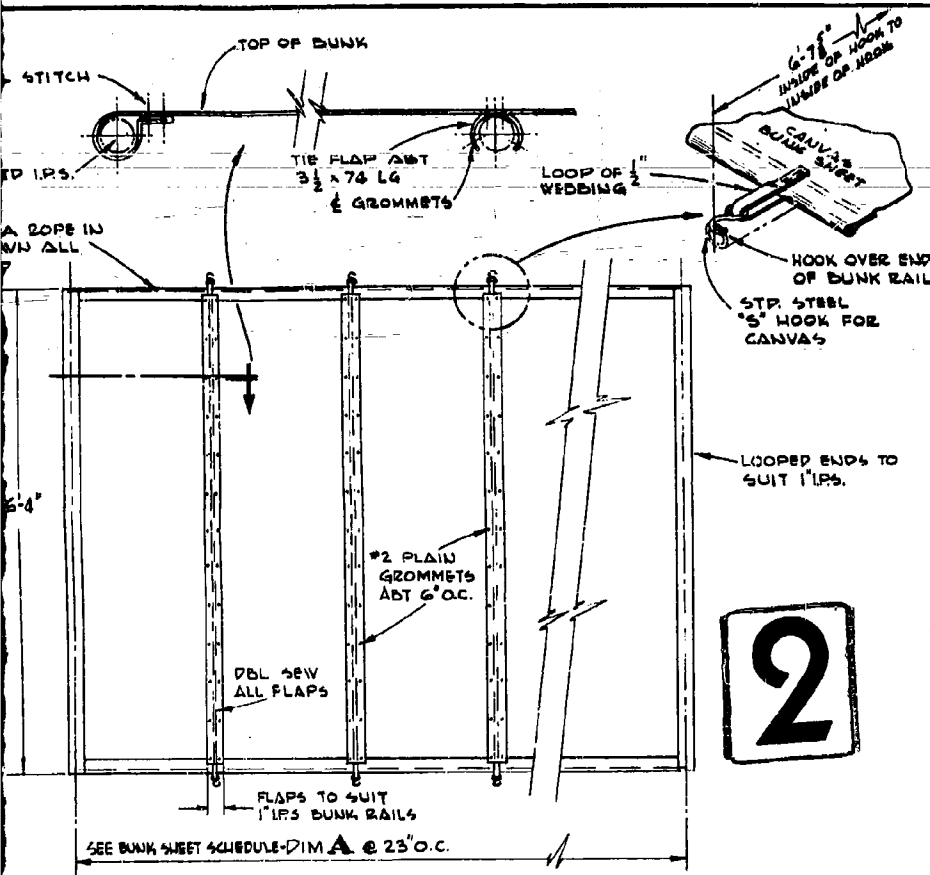
OUTER & INNER STANCHION SUPPORT

SCALE: 1 1/2" = 1'-0"

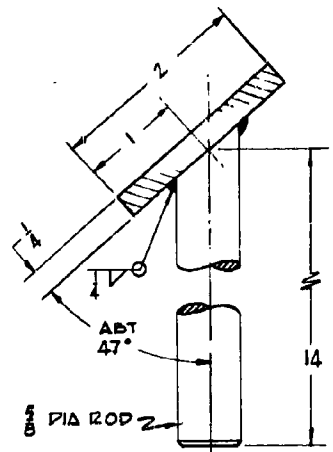
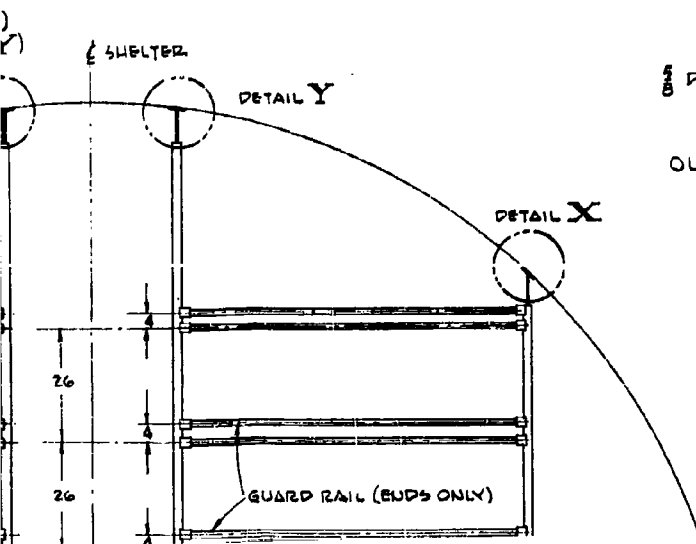
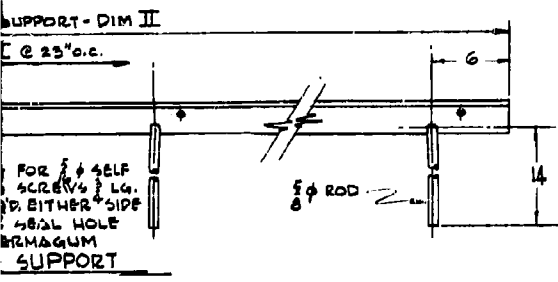
2 EA. TYPE REQ'D.
2 OUTER (DETAIL X)
2 INNER (DETAIL Y)



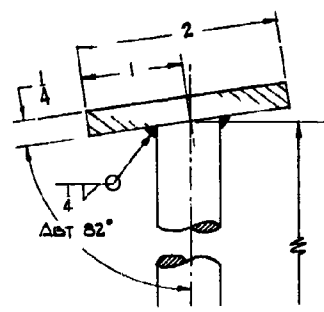
1



CONTINUOUS BUNK SHEET
BOTTOM VIEW SHOWN
SCALE: 3/4" = 1'-0"
MAT'L. #12 NUMBER DUCT



DETAIL X
OUTER STANCHION SUPPORT
SCALE: FULL

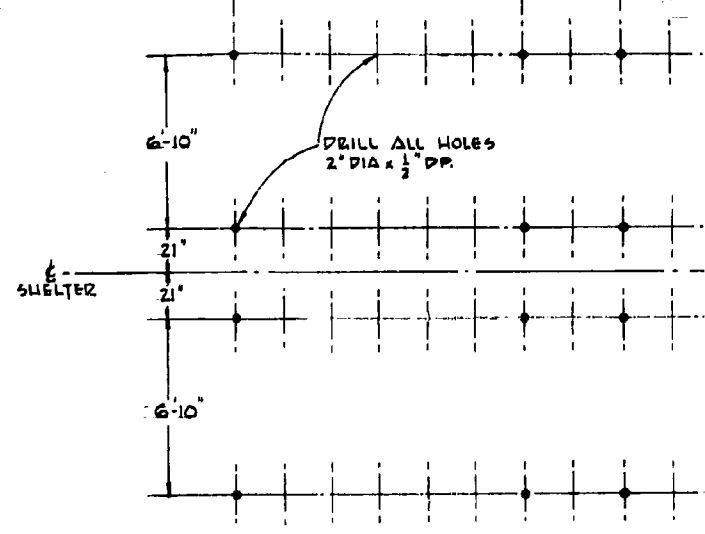


LIST OF MATERIALS			
QUANTITIES SHOWN ARE FOR			
NO.	NAME	NO.	MAT'L.

HOTEL PKG H-1 12 SPACES @ 23" O.C. = 23'

HOTEL PKG H-2 6 @ 23" O.C. = 11'

HOTEL 4 51 @ 23" O.C.

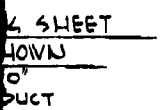


FLOOR PLAN SHOWING LAYOUT OF HOLES FOR BUNK STANCHIONS
SCALE: 1/4" = 1'-0"

REVISION	DATE
----------	------

LIST OF MATERIAL						
QUANTITIES SHOWN ARE FOR						
PG. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS

PT. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. QTY.	STOCK QTY.	REMARKS



FLOOR PLAN SHOWING LAYOUT
OF HOLES FOR BUNK STANCHIONS
SCALE: $\frac{1}{4}'' = 1'-0''$

SCALE: $\frac{1}{4}'' = 1'-0''$



DETAIL X
OUTER STANCHION SUPPORT
SCALE: FULL



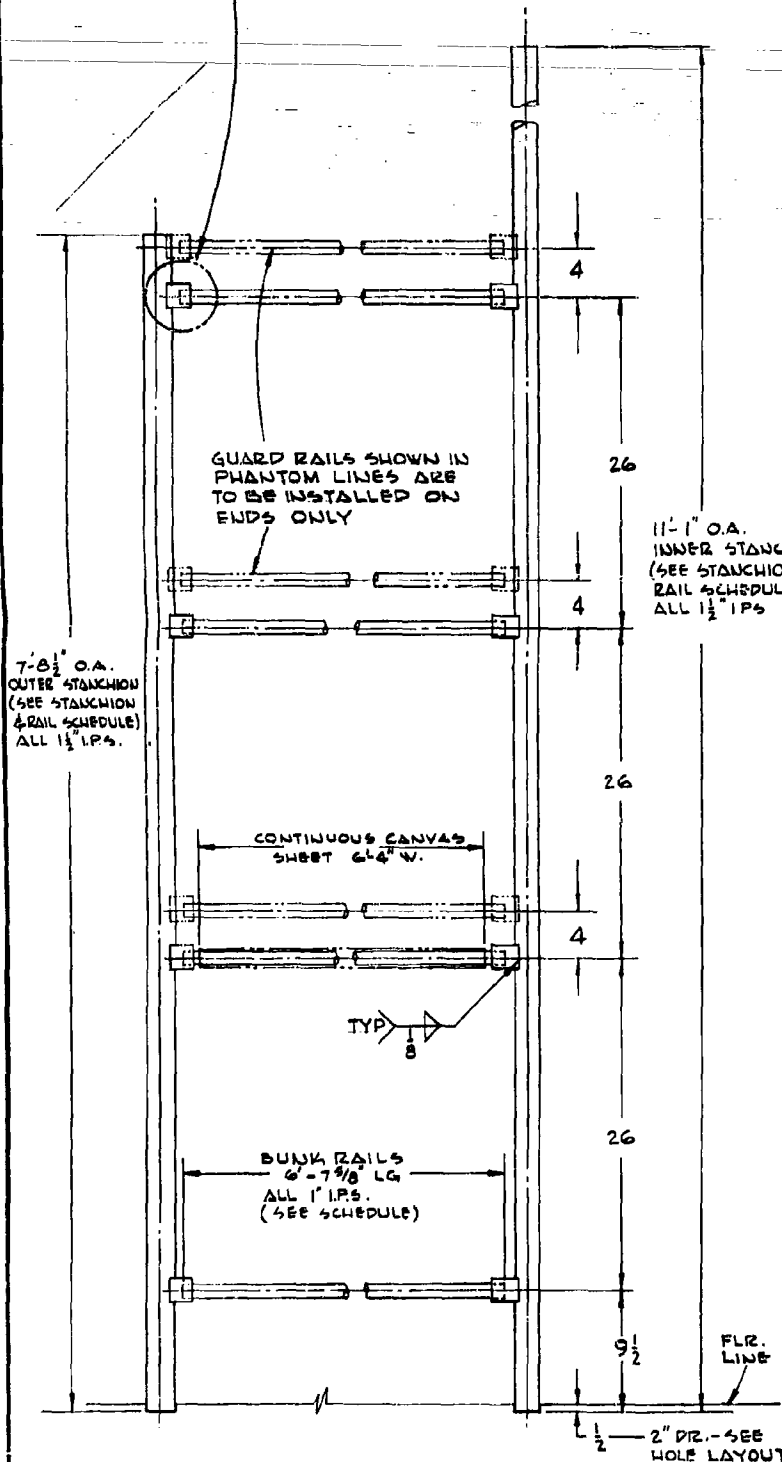
3

REVISION	DATE	DESCRIPTION	BY	APP.
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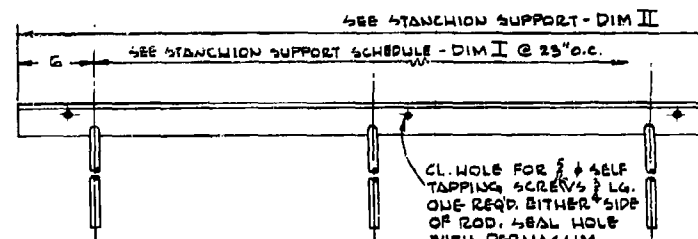
**BUNK RAIL
CLIP DETAIL**
SCALE: 1/2" = 1'-0"
MATERIAL: 5/16" STL PL
(SEE SCHEDULE)

STANCHION & RAIL SCHEDULE						
HOTEL PKG.	INNER STANCHION	INNER STANCHION END	OUTER STANCHION	OUTER STANCHION END	BUNK RAIL	BUNK RAIL CLIPS
H-1	22	4	22	4	116	232
H-2	10	4	10	4	68	136
H-3	6	4	6	4	52	104

OUTER & INNER STANCHION SUPPORT SCHEDULE			
HOTEL PKG.	Nº OF SPACES	DIM I	DIM II
H-1	12	23'-0"	24'-0"
H-2	6	11'-6"	12'-6"
H-3	4	6'-0"	7'-0"

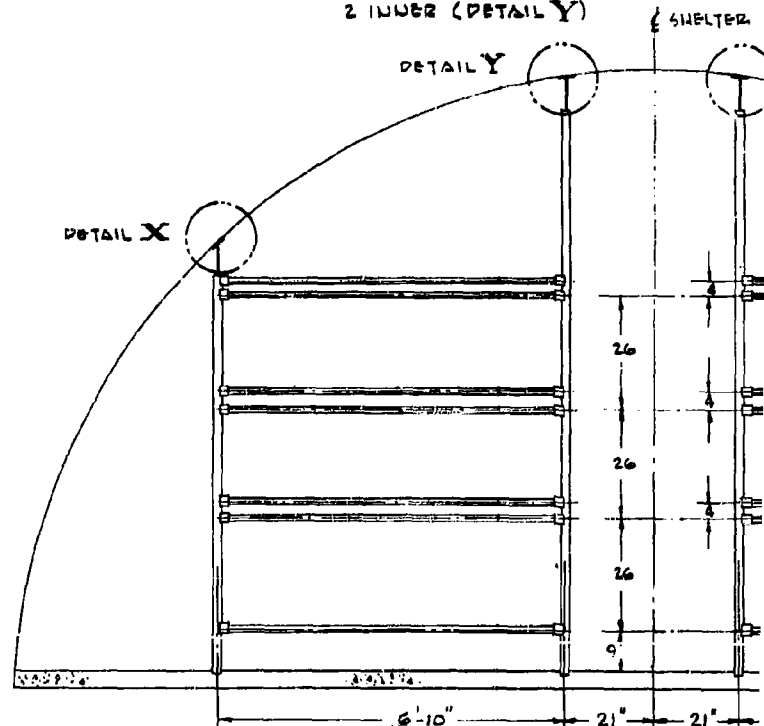


STANCHION & RAIL DETAILS
SCALE: 1/2" = 1'-0"
ALL MATERIAL TO BE GALVANIZED

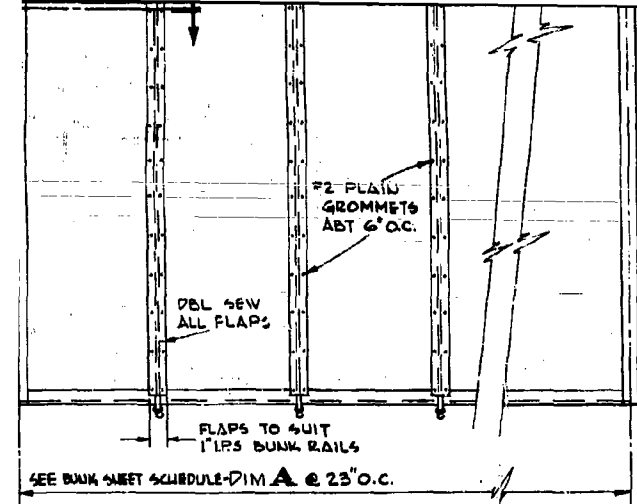


OUTER & INNER STANCHION SUPPORT

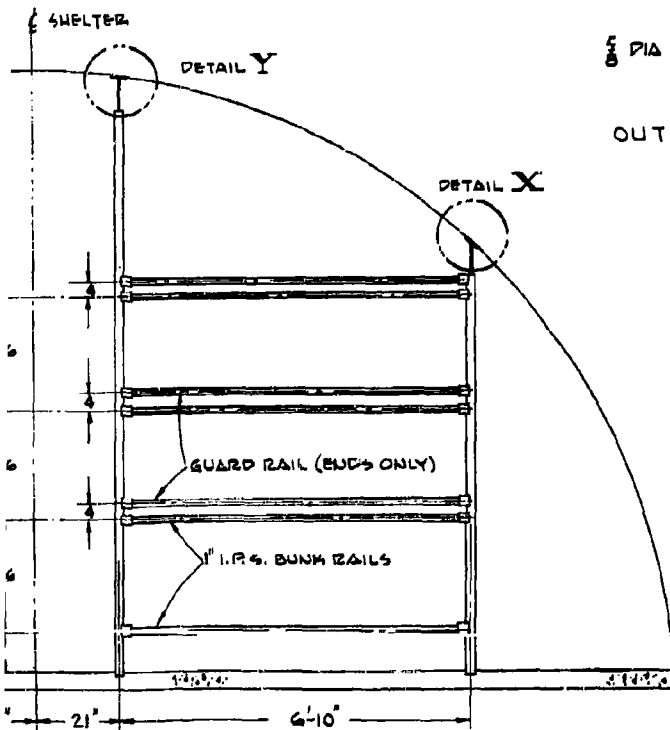
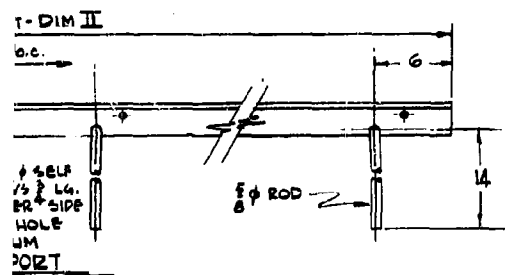
- SCALE: 1/2" = 1'-0"
2 EA. TYPE REQ'D.
2 OUTER (DETAIL X)
2 INNER (DETAIL Y)



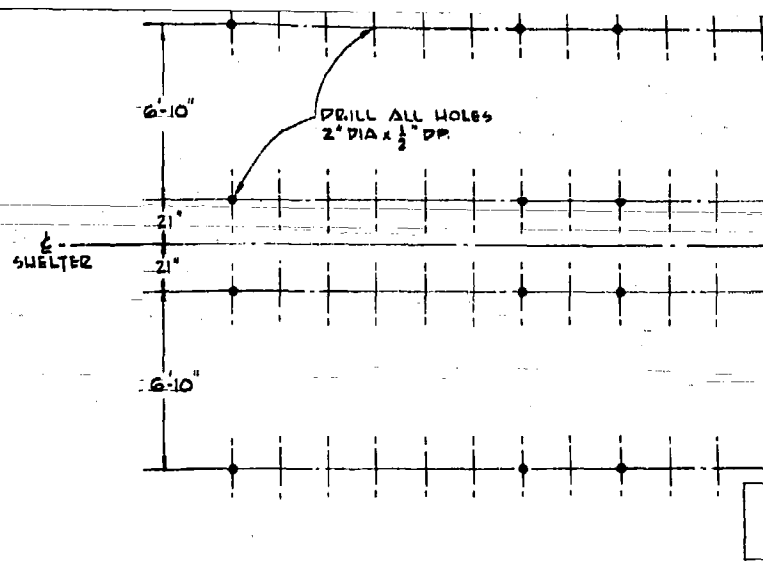
ELEVATION - LOOKING TOWARD RE
SCALE: 1/2" = 1'-0"



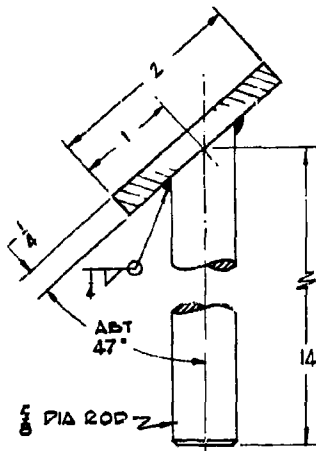
CONTINUOUS BUNK SHEET
BOTTOM VIEW SHOWN
SCALE: $\frac{3}{4}$ " = 1'-0"
MAT'L. #12 NUMBER DUCT



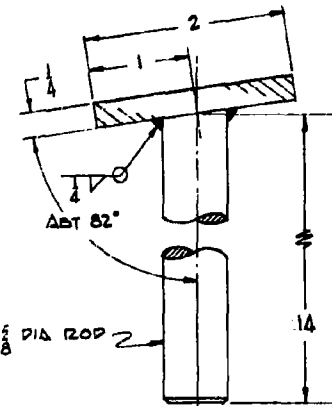
TOWARD REAR OF SHELTER
LE: $\frac{1}{2}$ " = 1'-0"



FLOOR PLAN SHOWING LAYOUT
OF HOLES FOR BUNK STANCHIONS
SCALE: $\frac{1}{4}$ " = 1'-0"



DETAIL X
OUTER STANCHION SUPPORT
SCALE: FULL



DETAIL Y
INNER STANCHION SUPPORT
SCALE: FULL

5

ENGINEERING & DESIGN
IS APPROVED BY: *David S. Portman* DATE: 22 MAY 62

REVISION	DATE
UNITED STATES NAVAL RADIOLOGICAL CENTER SAN FRANCISCO	
DRAWN	FJA
CHECKED	
APPROVED	
PROJ. ENGINEER	
SUPV.	
BRANCH HEAD	
DIVISION HEAD	
SCOPE APPROVED	DATE: 5/22/62
DWG. NO.	

BIARRA

LOOPED ENDS TO
SUIT 1" IPS.

SHELTER

6'-10"

DRILL ALL HOLES
2" DIA x $\frac{1}{2}$ " DP.

21"

21"

6'-10"

REAR
OF
SHELTER

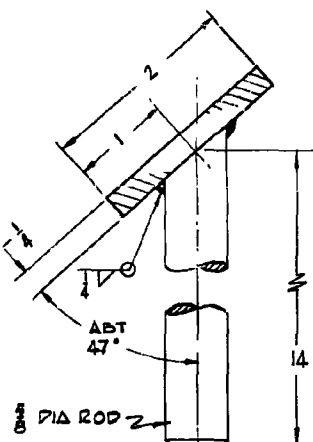
SHEET

OWN

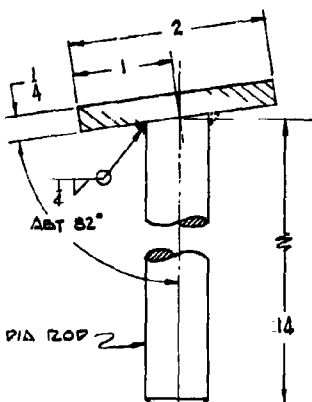
UCT

FLOOR PLAN SHOWING LAYOUT
OF HOLES FOR BUNK STANCHIONS

SCALE: $\frac{1}{4}$ " = 1'-0"



DETAIL X
OUTER STANCHION SUPPORT
SCALE: FULL



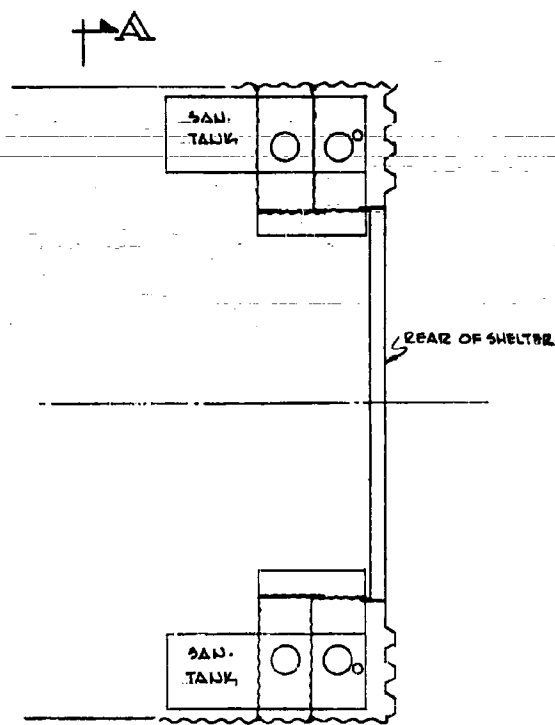
DETAIL Y
INNER STANCHION SUPPORT
SCALE: FULL

6

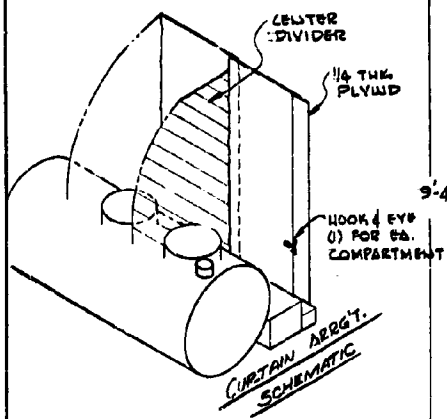
REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN		FJA		
CHECKED				
ENGR. REVIEW APPROVAL PROJ. ENGR. SUPV. BRANCH HEAD DIVISION HEAD	FIG. A-ION BERTHING FACILITY ARRANGEMENT & DETAILS			
	DATE: 5/22/62			
	SCALE: 1/4" = 1'-0"			
	PROJECT: S-62-970			
DATE		SCALE	PROJECT	TECH MEMO
DATE: 5/22/62		SCALE: 1/4" = 1'-0"	PROJECT: S-62-970	TECH MEMO: 12, 19
SCOPE APPROVED: 200		DWG. NO. S-62-970		

ENGINEERING & DESIGN

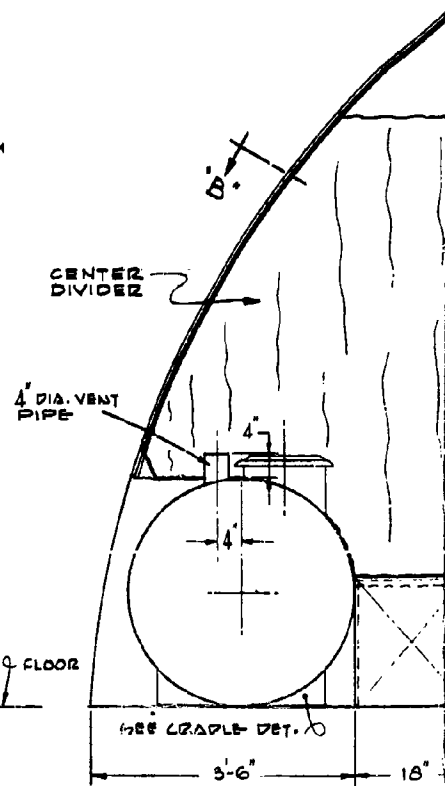
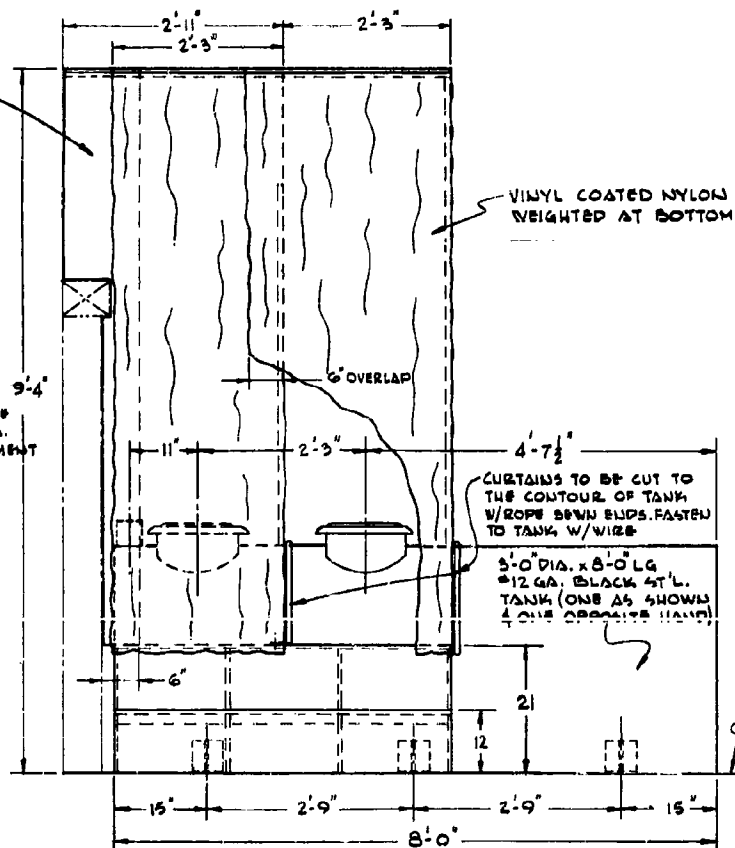
16 APPROVED BY: *James S. Patena* DATE: 22 MAY 62



$\frac{1}{4}"$ THK x 12" WIDE PLYWD.
FIT AROUND & FASTENED TO
WOOD BEAM, CEILING &
PLATFORM.



1



QUANTITIES SHOWN ARE FOR

NO.	NAME	NO. REQ.	MAT'L.

SHELTER CORR.
IRON LINE

1" FLANGE

SCREW TO
WALL/W
SELF-TAPPING
SCREWS

ABT.
120"

*26 GA. x 54" LG. GALV. SHT.
MT'L. GUARD.

SANITARY TANK

LIGHT WEIGHT LT. SERVICE
DESIGN PLASTIC SEAT * LID
SEAT * LID MUST FIT TIGHT

*12 GA. BLACK
STEEL

WATER CLOSET DETAIL

SCALE: 3" = 1'-0"

FLEX VENT DUCT
HOSE, SUPPORT AT
MIDPOINT W/SUITABLE
HANGARS

SAN. TANK

SECTION

SCALE: 1/4"

WD. NAILING
STRIP

7'-9"

2

SAN. TANK

12 3/4"

CRADLE DETAIL (SIX REQ'D)

SCALE: 3" = 1'-0"

*10 GA. GALV
SHT'L.

5 1/4"

12 1/8"

5"

INSIDE SHELTER

MASTIC

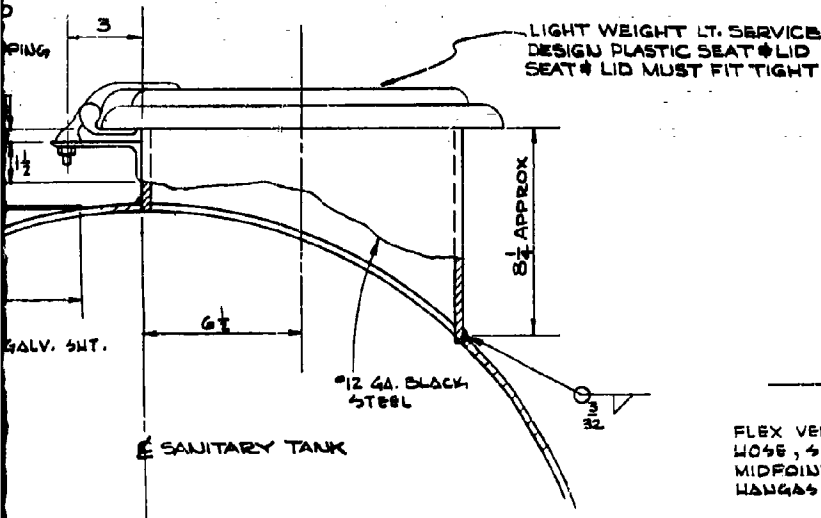
3/4 THK x 1" WIDE WOOD
NAILING STRIP. BEND
TO SUIT CONTOUR OF

REVISION	DATE

LIST OF MATERIAL

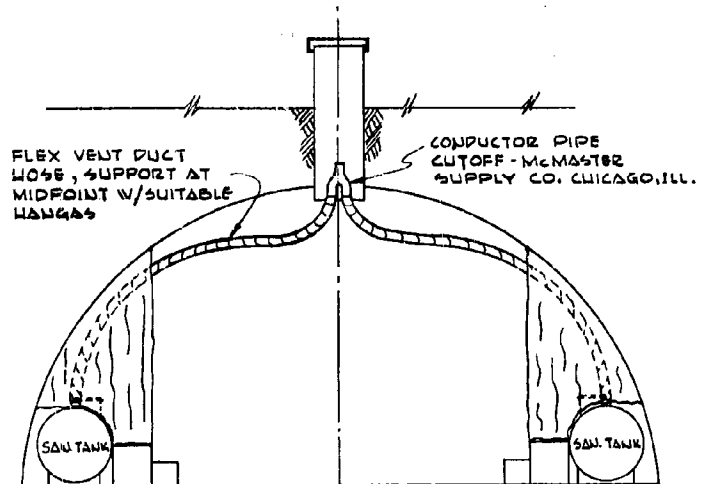
QUANTITIES SHOWN ARE FOR

QTY.	NAME	NO. REQ.	MAT'L.	MAT'L. SPECS.	STOCK SIZE	REMARKS
------	------	----------	--------	---------------	------------	---------



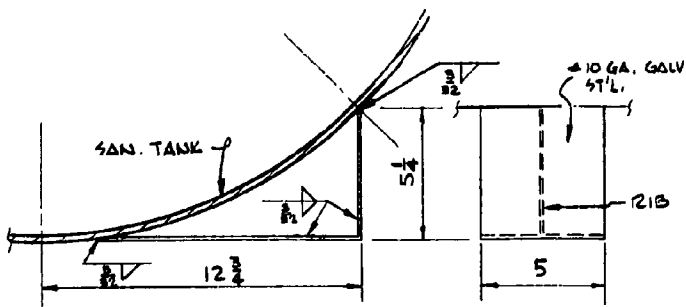
WATER CLOSET DETAIL

SCALE: 3" = 1'-0"



SECTION A-A

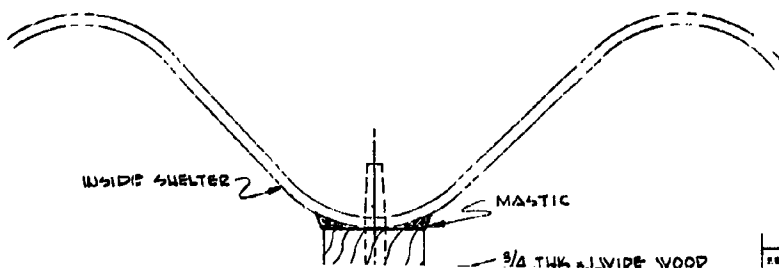
SCALE: 1/4" = 1'-0"



CRADLE DETAIL (SIX REQ'D)

SCALE: 3" = 1'-0"

3



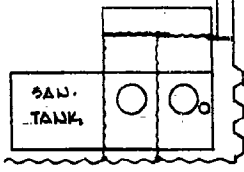
REVISION	DATE	DESCRIPTION	BY	APP.
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REAR OF SHELTER

8"
#24 GA. x 54" LG. GALV. SHT.
MT'L. GUARD.

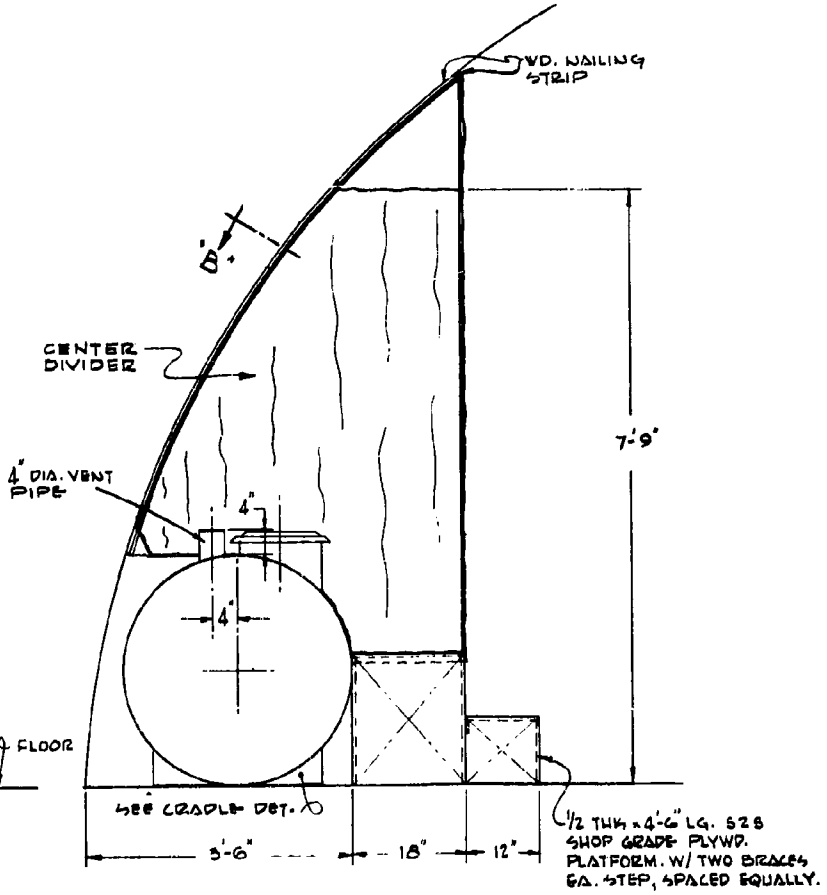
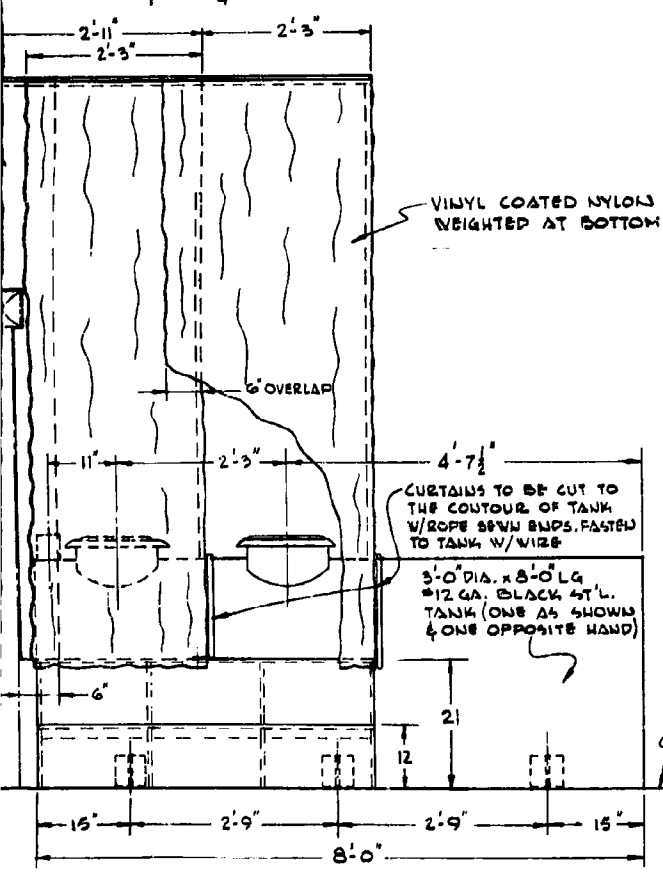
SANITA

WATER
SC



1-A

PLAN-SANITATION
FACILITIES
SCALE: 1/4" = 1'-0"



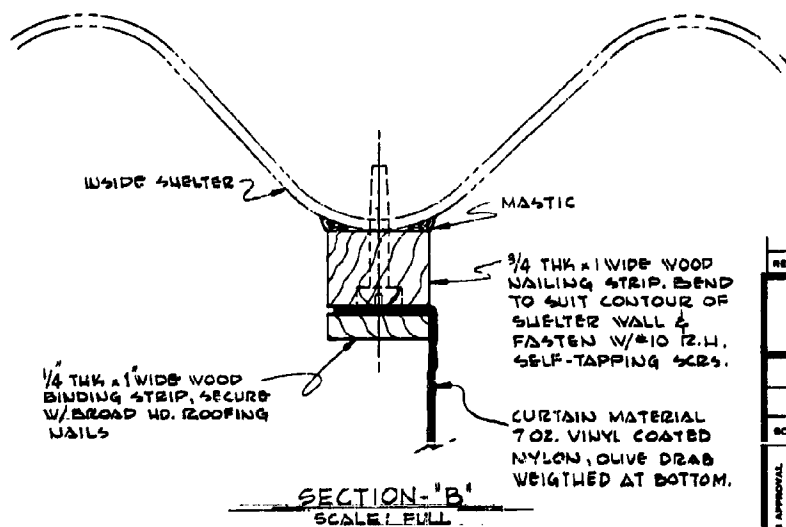
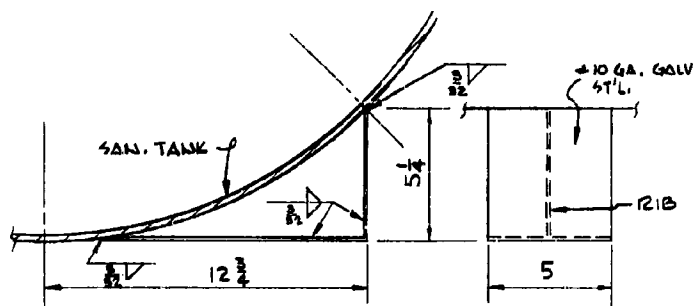
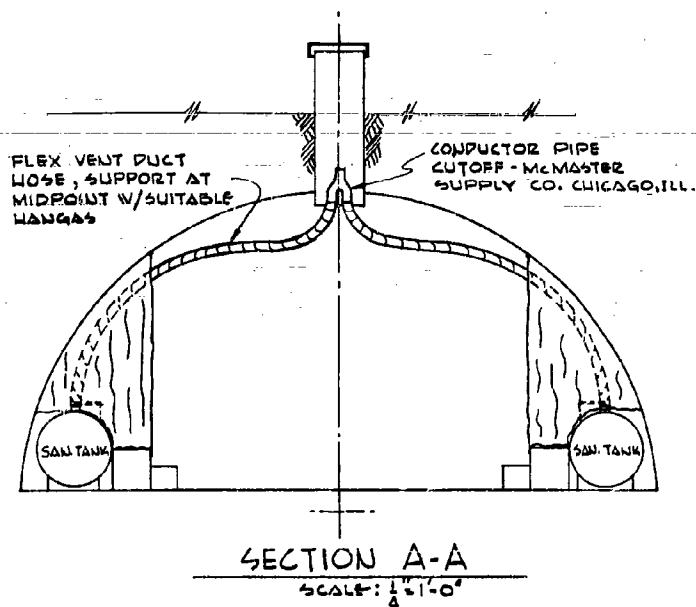
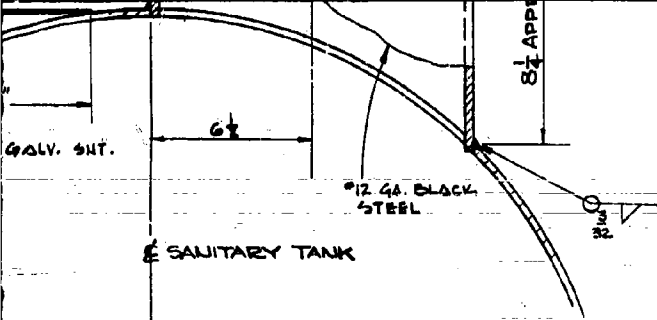
FRONT ELEVATION

SIDE ELEVATION

SANITARY FACILITY
1/4" = 1'-0"

4

1/4 THK x 1'
BINDING
W/ BROAD
NAIL

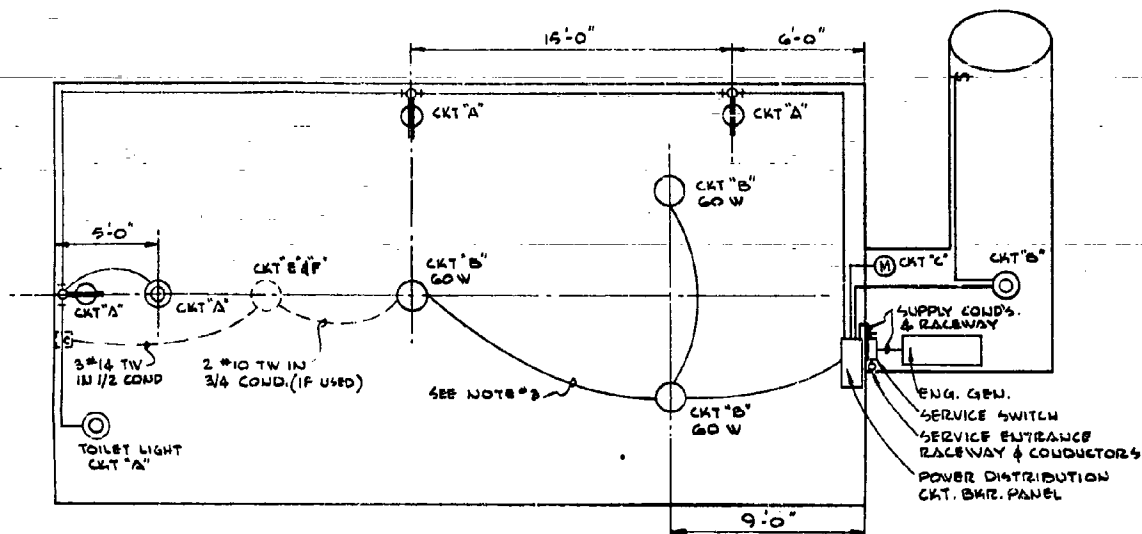


S 26
W.D.
NO BRACES
ID EQUALLY.

ENGINEERING & DESIGN
IS APPROVED BY: *Levin S. Porterson* DATE: 22 May 62

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	DATE	2/26/62	
CHKD	FJA			
SCOPE APPROVED	ASD			
PROJ. ENGR.				
SUPVR.				
BRANCH HEAD				
DIVISION HEAD				
FIG. A-11M SANITARY FACILITY ARRANGEMENTS & DETAILS		SCALE: PROJECT TECH MEMO.		
NOTED		DRAWING NUMBER S-62-970 SHEET 13 OF 19		

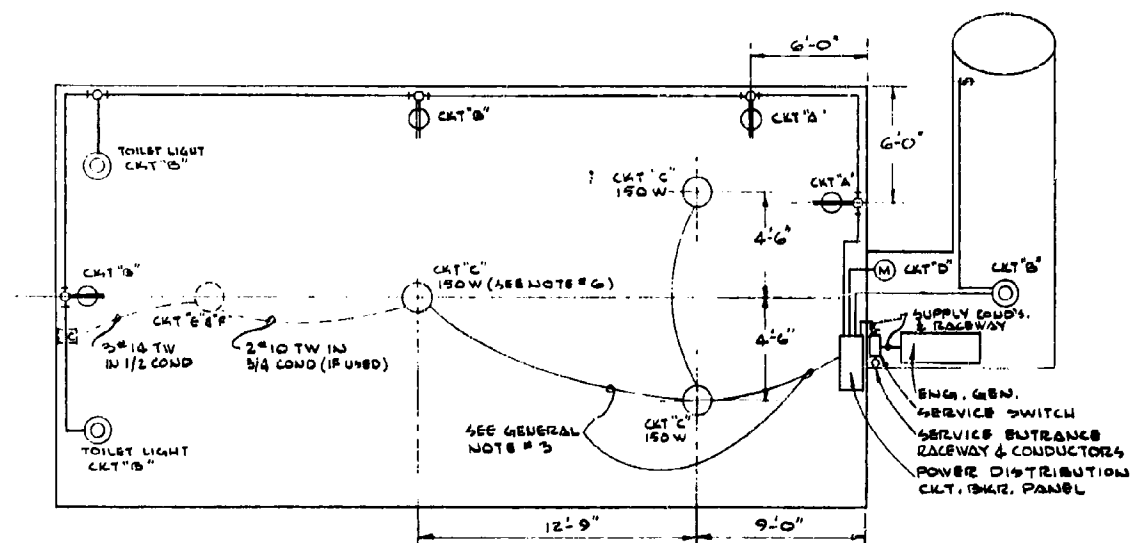
5



ARRANGEMENT 'A' ELECT. PACKAGE

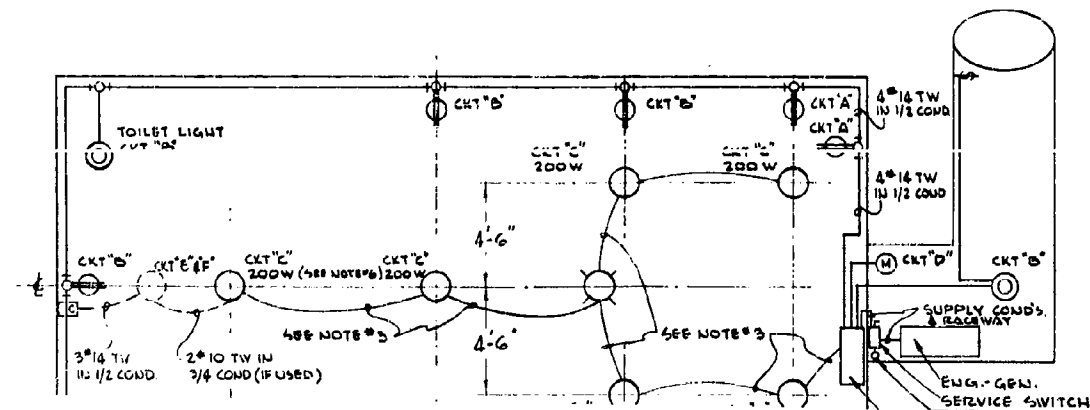
ARRANGEMENT "A" ELECT. CKT BREAKER PANEL				
120V, 2WIRE, 1Ø-70AMP BUS, UNLESS OTHERWISE				
CKT NO	CIRCUIT BREAKER		PURPOSE	
	NO POLES	RATING		
A	1	15	OUTLET RECEPT. & LIGHTS	
B	1	15	LIGHTS	
C	1	15	VENT MOTOR	
E				
F	2	30	AIR CONDITIONER	IF A POW USE 120V PAN

1



ARRANGEMENT "B" ELECT. PACKAGE

ARRANGEMENT "B" ELECT. CKT BREAKER PANEL				
120V, 2WIRE, 1Ø-70AMP BUS, UNLESS OTHERWISE				
CKT NO	CIRCUIT BREAKER		PURPOSE	
	NO POLES	RATING		
A	1	15	HOT PLATE SUPPLY TOILET & ENTRANCE WAY LIGHT PLUS RECEPT.	
B	1	15	LIGHTS	
C	1	15	VENT MOTOR	
D	1	15		
E				
F	2	30	AIR CONDITIONER	IF A POW USE 120V PAN



ARRANGEMENT "C" ELECT. PK CKT BREAKER PANEL				
120V, 2WIRE, 1Ø-70AMP BUS, UNLESS OTHERWISE				
CKT NO	CIRCUIT BREAKER		PURPOSE	
	NO POLES	RATING		
A	1	15	HOT PLATE SUPPLY TOILET ENTRANCE WAY LIGHTS PLUS OUTLET RECEPT.	
B	1	15	LIGHTS	
C	1	15	VENT MOTOR	
D	1	15		
E				
F	2	30	AIR CONDITIONER	IF A POW USE 120V PAN

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

NO.	NAME	NO. REQ.	MAT'L.
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MATERIAL LIST

EMENT "A" ELECT. PACKAGE

CKT BREAKER PANEL

AMP BUS, UNLESS OTHERWISE NOTED IN REMARK COLUMN

WIRING	PURPOSE	REMARKS
5	OUTLET RECEPT. & LIGHTS	
5	LIGHTS	
5	VENT MOTOR	
30	AIR CONDITIONER	IF AIR COND. IS SPECIFIED POWER PKG. P-4 WILL BE USED, THIS WILL REQUIRE 120/240 V, 3 W, 1 Ø PANEL HAVING 100 AMP BUS

DESCRIPTION	SIZE	ITEM NO. & QUANTITY REQ'D. PER HOTEL ARRANGEMENT PKG.						MANUFACTURER	CATALOG NUMBER	REMARKS
		A	B	C	D	E	F			
CONDUCTOR TYPE TW	14 AWG	440	440	500						
OUTLET BOXES		4	5	6				STEEL CITY ELECT. CO. PITTSBURGH, PA.	58361	
DUPLEX RECEPT. 15 AMP		3	4	5				BRAYANT ELECT. CO. BRIDGEPORT CONN.	808	
DUPLEX RECEPT. BOX COVER		3	4	5				STEEL CITY ELECT. CO. PITTSBURGH, PA.	58367	
PENDANT TYPE RLM FIXT. 200 W		0	0	6				APERO ELECT. CORP. CLEVELAND, OHIO	D-516	ALL W/ 200 WATT BULBS
PENDANT TYPE RLM FIXT. 150 W		0	3	0				APERO ELECT. CORP.	D-514	ALL W/ 150 WATT BULBS
PENDANT TYPE RLM FIXT. 60 W		0	3	0				APERO ELECT. CORP.	D-512	ALL W/ 60 WATT BULBS. ALL OTHERS 25 WATT
LAMP BALL ALIGNER		6	6	9				APERO ELECT. CORP.	13A13	
SWITCH 5P	15 AMP	1	1	1				BRAYANT ELECT. CO.	N# 81	
OUTLET BOX 4"		6	6	10				STEEL CITY ELECT.	54151	
OUTLET BOX COVER		0	0	1				STEEL CITY ELECT.	54-C-1	
SWITCH 5P COVER		1	1	1				STEEL CITY ELECT.	583630	
SINGLE POLE CIRCUIT BREAKER	15 AMP	3	4	4				7Q "D" ELECT. CO.	Q0115	
MISC. FITTINGS AS REQ'D.	LOT	1	1	1				STEEL CITY ELECT.		
40T BRK. PANEL 120 V, 2 WIRE, 1 Ø, 100 AMP BUS	2 WIRE 100 AMP BUS	4	4	4				7Q "D" ELECT. CO.	Q045	POWER PANEL FOR HUBBARD WITHOUT A/C
60T BRK. PANEL 120/240 V, 2 WIRE, 1 Ø, 100 AMP BUS	3 WIRE 100 AMP BUS	5	5	5				7Q "D" ELECT. CO.	Q045	POWER PANEL FOR HUBBARD WITH A/C
CONDUIT	1/2"	11	210	11	210	12	250	STEEL CITY ELECT.		AMT REQ'D. IF A/C NOT USED
CONDUIT	1/2"	13	140	13	140	14	170	STEEL CITY ELECT.		AMT REQ'D. IF A/C IS USED
2 POLE BREAKER	30 AMP	1	1	1				7Q "D" ELECT. CO.	Q0250	
CONDUIT	3/4"	80	80	80				STEEL CITY ELECT.		
CONDUCTOR TYPE TW	10 AWG	160	160	160						THESE ITEMS REQ'D. FOR AIR COND. ONLY
OUTLET BOX		9	9	9				STEEL CITY ELECT.	54141	
FLEX CONDUIT	1/2"	2	2	2						
CONDUCTOR TYPE TW	14 AWG	20	20	20						
MISC. FITTINGS AS REQ'D.	LOT	1	1	1						
CONTROL BOX		1	1	1						FURNISHED W/ A/C

MISC. ELECT. SERVICE EQUIP. REQ'D. FOR A SPECIFIC POWER PACKAGE

ITEM	ELECT. EQUIP. REQ'D. PER POWER PKG.	DESCRIPTION	CIRCUIT EQUIP. SEE NOTE #9	SIZE OR RATING	NO. OR FT. REQ'D.	MANUFACTURER	CATALOG NO.	REMARKS
7	P-1 OR P-2	DT SINGLE BLADE FUSED SAFETY SW.	SERVICE SWITCH	30 AMP	1	MEYER SAFETY SW. CO. INC.	322 SCF	
		SEE ENTRANCE CONDUIT SEE NOTE #7	ENT. BUS. RACEWAY & CONDUIT					
		CONDUIT	SUPPLY CONDUIT RACEWAY	1/2"	3	STEEL CITY ELECT.		
8	P-3	CONDUCTOR TYPE TW	SUPPLY CONDUIT 2-REQ'D.	N# 12 AWG	8	GRAYBAR ELECT. CO.		
		DT SINGLE BLADE FUSED SAFETY SW.	SERVICE SWITCH	60 AMP	1	MEYER SAFETY SW. CO. INC.	322 SCF	
		SEE ENTRANCE CONDUIT SEE NOTE #7	ENT. BUS. RACEWAY & CONDUIT					
		CONDUIT	SUPPLY CONDUIT RACEWAY	3/4"	3	STEEL CITY ELECT.		
		CONDUCTOR TYPE TW	SUPPLY CONDUIT 2-REQ'D.	N# 10 AWG	8	GRAYBAR ELECT. CO.		

LEGEND

- DUPLEX RECEPTACLE - 15 AMP
- OUTLET BOX - LIGHTS
- RLM FIXTURE WITH OUTLET
- RLM FIXTURE - 25 WATTS WITH OUTLET
- OUTLET BOX - RECEPTACLE
- AIR CONDITIONER OUTLET
- SINGLE POLE TOGGLE SWITCH
- VENT MOTOR
- CONTROL BOX - FOR AIR

GENERAL

APPLICABLE TO:

- ALL WIRING TO BE INSTALLED
- ALL WIRING SHOWN IS TWO CONDUCTORS UNLESS OTHERWISE INDICATED
- THIS WIRING TO CONSIST OF CONDUCTORS N# 10 TW INST. ANYONE OF THE FOLLOWING: V-12, V-22, V-10, V-20
- ALL DUPLEX RECEPTACLES ABOVE THE FLOOR.
- THE TOILET LIGHTS ARE TO BE THE TWO STALLS.
- WHEN AREA IS USED FOR A SPECIFIED WITH ONE RATED THE MINIMUM SIZE OF 40 TWO CONDUCTORS ARE REQ. WHEN POWER PACKAGE P-4 ENTRANCE CONDUCTORS DESIGNED TO SUIT THE
- ALL WORK TO BE PERFORMED SECTIONS OF THE NATIONAL EDITION)
- REFER TO ELECTRICAL ARRANGEMENT DESCRIPTION OF ELECTRIC

EMENT "C" ELECT. PACKAGE

CKT BREAKER PANEL

AMP BUS, UNLESS OTHERWISE NOTED IN REMARK COLUMN

WIRING	PURPOSE	REMARKS
15	HOT PLATE SUPPLY TOILET & ENTRANCE-WAY LIGHTS PLUS OUTLET RECEPTACLE	
15	LIGHTS	
15	VENT MOTOR	
30	AIR CONDITIONER	IF AIR COND. IS SPECIFIED POWER PKG. P-4 WILL BE USED, THIS WILL REQUIRE 120/240 V, 3 W, 1 Ø PANEL HAVING 100 AMP BUS

2

REVISION	DATE
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MATERIAL LIST

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS
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DESCRIPTION	SIZE	ITEM NO. & QUANTITY REQ'D PER HOTEL ARRANGEMENT PKG.						MANUFACTURER	CATALOG NUMBER	REMARKS
		A		B		C				
		ITEM NO.	QTY.	ITEM NO.	QTY.	ITEM NO.	QTY.			
DUCTOR TYPE TW	#14 AWG	440		440		500				
TOILET BOXES		4		5		6	STEEL CITY ELECT. CO. PITTSBURGH, PA.	58361		
15 AMP RECEPT. BOX		3		4		5	DEVANT ELECT. CO. BRIDGEPORT CONN.	808		
15 AMP RECEPT. COVER		3		4		5	STEEL CITY ELECT. CO. PITTSBURGH, PA.	58367		
DAY TYPE FINT. 200W		0		0		6	SPERO ELECT. CORP. CLEVELAND, OHIO	D-516		ALL W/ 200 WATT BULBS
DAY TYPE FINT. 150W		0		3		0	SPERO ELECT. CORP.	D-514		ALL W/ 150 WATT BULBS
DAY TYPE FINT. 60W		0		3		0	SPERO ELECT. CORP.	D-512		ALL W/ 60 WATT BULBS. ALL OTHERS 25 WATT
AP BALL LIGHTS		6		6		9	SPERO ELECT. CORP.	N-15		
SWITCH 15 AMP	15 AMP	1		1		1	DEVANT ELECT. CO.	N-41		
TOILET BOX		6		6		10	STEEL CITY ELECT.	54151		
TOILET BOX COVER		0		0		1	STEEL CITY ELECT.	54-C-1		
SWITCH 15 AMP		1		1		1	STEEL CITY ELECT.	58360		
2 POLE 15 AMP RECEPT. BOXES	15 AMP	3		4		4	50 "D" ELECT. CO.	Q0115		
2. FITTINGS REQ'D.	LOT	1		1		1	STEEL CITY ELECT.			
TOILET PANEL 2 WIRE, 20 AMP BUS	2 WIRE 20 AMP BUS	4		4		4	50 "D" ELECT. CO.	Q045		POWER PANEL FOR HUBS WITHOUT A/C
TOILET PANEL 2 WIRE, 100 AMP BUS	2 WIRE 100 AMP BUS	5		5		5	50 "D" ELECT. CO.	Q065		POWER PANEL FOR HUBS WITH A/C
CONDUIT 1/2"	1/2	11	220	11	220	12	250	STEEL CITY ELECT.		AMT REQ'D IF A/C NOT USED
CONDUIT 1/2"	1/2	13	140	13	140	14	170	STEEL CITY ELECT.		AMT REQ'D IF A/C IS USED
ITEM NO. & QUANTITY REQ'D. PER HOTEL ARRANGEMENT OR AIR CONDITIONER REQ'D.										
2 POLE BREAKER	30 AMP	1		1		1	50 "D" ELECT. CO.	Q0250		
CONDUIT 3/4"	3/4	80		80		80	STEEL CITY ELECT.			
CONDUCTOR TYPE TW	#10 AWG	160		160		160				THESE ITEMS REQ'D FOR
OUTLET BOX		0		0		0	STEEL CITY ELECT.	54141		AIR COND. ONLY
PLEX CONDUIT	1/2	2		2		2				
CONDUCTOR TYPE TW	#14 AWG	20		20		20				
MISC. FITTINGS AS REQ'D.	LOT	1		1		1				
CONTROL BOX		1		1		1				FURNISHED W/ A/C

LEGEND

- ⊗ DUPLEX RECEPTACLE - 15 AMP
- ⊗ OUTLET BOX - LIGHTS
- RLM FIXTURE WITH OUTLET BOX
- ⊗ RLM FIXTURE - 25 WATTS WITH OUTLET BOX
- ⊗ OUTLET BOX - RECEPTACLE
- ⊗ AIR CONDITIONER OUTLET (IF USED)
- ⊗ SINGLE POLE TOGGLE SWITCH
- ⊗ VENT MOTOR
- ⊗ CONTROL BOX - FOR AIR CONDITIONER

GENERAL NOTES

APPLICABLE TO ALL ARRANGEMENTS

- ALL WIRING TO BE INSTALLED IN RIGID METALLIC CONDUIT.
- ALL WIRING SHOWN IS TWO COND. NO. 14 TW IN 1/2" CONDUIT UNLESS OTHERWISE INDICATED.
- THIS WIRING TO CONSIST OF TWO CONDUCTORS NO. 14 TW & TWO CONDUCTORS NO. 10 TW INSTALLED IN 3/4" CONDUIT IF ANYONE OF THE FOLLOWING VENT PACKAGES ARE SPECIFIED V-1C, V-2C, V-1D, V-2D IN REF. 1.
- ALL DUPLEX RECEPTACLES SHALL BE LOCATED FOUR FEET ABOVE THE FLOOR.
- THE TOILET LIGHTS ARE TO BE LOCATED MIDWAY BETWEEN THE TWO STALLS.
- WHEN AREA IS USED FOR SLEEPING, REPLACE THE LAMP SPECIFIED WITH ONE RATED AT 10 WATTS.
- THE MINIMUM SIZE OF SERVICE CONDUCTOR IS NO. 8 AWG. TWO CONDUCTORS ARE REQUIRED (EXCEPT 3 COND. REQUIREMENT WHEN POWER PACKAGE P-4 & P-5 IS USED) THE SERVICE ENTRANCE CONDUCTORS & RACEWAY SHOULD BE DESIGNED TO SUIT THE SPECIFIC SITE.
- ALL WORK TO BE PERFORMED IN ACCORDANCE WITH APPLICABLE SECTIONS OF THE NATIONAL ELECTRIC CODE (LATEST EDITION)
- REFER TO ELECTRICAL ARRANGEMENT, THIS DWG., FOR DESCRIPTION OF ELECTRICAL EQUIPMENT.

MISC. ELECT. SERVICE EQUIP. REQ'D. FOR A SPECIFIC POWER PACKAGE

ITEM	ELECT. EQUIP. REQ'D. PER POWER PKG.	DESCRIPTION	CIRCUIT REQ'D. SEE NOTE #7	SIZE OR RATING	NO. OR FT. REQ'D.	MANUFACTURER	CATALOG NO.	REMARKS
7	P-1 OR P-2	DT SINGLE BLADE SERVICE FUSED SAFETY SW. SWITCH		30 AMP	1	MEYER'S SAFETY SW. CO. INC.	322 SCF	
		SER. ENTRANCE CONDUIT SEE NOTE #7	SER. ENT. RACEWAY & COND.					
		CONDUIT	SUPPLY COND. RACEWAY	1/2"	3	STEEL CITY ELECT.		
		CONDUCTOR TYPE TW	SUPPLY COND. 2-REQ'D.	NO. 12 AWG	8	GRAYBAR ELECT. CO.		
8	P-3	DT SINGLE BLADE SERVICE FUSED SAFETY SW. SWITCH		60 AMP	1	MEYER'S SAFETY SW. CO. INC.	622 SCF	
		SER. ENTRANCE CONDUIT SEE NOTE #7	SER. ENT. RACEWAY & COND.					
		CONDUIT	SUPPLY COND. RACEWAY	3/4"	3	STEEL CITY ELECT.		
		CONDUCTOR TYPE TW	SUPPLY COND. 2-REQ'D.	NO. 10 AWG	8	GRAYBAR ELECT. CO.		

3

REVISION	DATE	DESCRIPTION	BY	APP.
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E	2	30	AIR CONDITIONER	IF
F				PO

ENG. GEN.
SERVICE SWITCH
SERVICE ENTRANCE
RACEWAY & CONDUCTORS
POWER DISTRIBUTION
CKT. BRK. PANEL

ARRANGEMENT 'A' ELECT. PACKAGE

ARRANGEMENT 'B' ELECT. CKT BREAKER PAN			
120V, 2 WIRE, 10-70 AMP BUS, UNLESS OTHERWISE			
CKT NO	CIRCUIT BREAKER		PURPOSE
	NO. POLES	RATING	
A	1	15	HOT PLATE SUPPLY
B	1	15	TOILET & ENTRANCE WAY LIGHTS PLUS RECEPT.
C	1	15	LIGHTS
D	1	15	VENT MOTOR
E	2	30	AIR CONDITIONER
F			

ARRANGEMENT 'B' ELECT. PACKAGE

ARRANGEMENT 'C' ELECT. CKT BREAKER PAN			
120V, 2 WIRE, 10-70 AMP BUS, UNLESS OTHERWISE			
CKT NO	CIRCUIT BREAKER		PURPOSE
	NO. POLES	RATING	
A	1	15	HOT PLATE SUPPLY
B	1	15	TOILET & ENTRANCE WAY LIGHTS PLUS OUTLET RECEPT.
C	1	15	LIGHTS
D	1	15	VENT MOTOR
E	2	30	AIR CONDITIONER
F			

ARRANGEMENT 'C' ELECT. PACKAGE

4

ENGINEERING & DESIGN
IS APPROVED BY: *James S. P...*

OPTIONER	IF AIR COND. IS SPECIFIED POWER PKG. P-4 WILL BE USED, THIS WILL REQUIRE 120/240 V, 3 W, 1Ø PANEL HAVING 100 AMP BUS
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DUPLEX RECEPT. BOX COVER			3		4		5	STEEL CITY ELECT. CO. PITTSBURGH, PENN.	58 C 7	
PENDANT TYPE ELM FIXT. 200 W			0		0		6	SPERO ELECT. CORP. CLEVELAND, OHIO	D-516	ALL W/ 200 WATT BULBS
PENDANT TYPE ELM FIXT. 150 W			0		3		0	SPERO ELECT. CORP.	D-514	ALL W/ 150 WATT BULBS
PENDANT TYPE ELM FIXT. 60 W			6	N	3	M	3	SPERO ELECT. CORP.	D-512	15 W/60 WATT BULBS ALL OTHERS 25 WATT
LAMP BALL ALIGNER			6		6		9	SPERO ELECT. CORP.	NR 15	
SWITCH 5P	15 AMP		1		1		1	BEYANT ELECT. CO.	NR 41	
OUTLET BOX 4"			6		6		10	STEEL CITY ELECT.	54151	
OUTLET BOX COVER			0		0		1	STEEL CITY ELECT.	54-C-1	
SWITCH 5P COVER			1		1		1	STEEL CITY ELECT.	58 C 30	
SINGLE POLE CIRCUIT BREAK	15 AMP		3		4		4	"SQ. D" ELECT. CO.	Q0115	
MISC. FITTINGS AS REQ'D.	LOT		1		1		1	STEEL CITY ELECT.		
4 OUTLET PANEL 120 V, 2 WIRE, 1Ø, 70 AMP BUS	2 WIRE 70 AMP BUS	4	1	4	1	4	1	"SQ. D" ELECT. CO.	Q046	POWER PANEL FOR SWITCHES WITHOUT A/C
6 OUTLET PANEL 120/240 V, 2 WIRE, 1Ø, 100 AMP BUS	3 WIRE 100 AMP BUS	5	1	5	1	5	1	"SQ. D" ELECT. CO.	Q065	POWER PANEL FOR SWITCHES WITH A/C
CONDUIT	1/2	11	220	11	220	12	250	STEEL CITY ELECT.		AMT REQ'D. IF A/C NOT USED
CONDUIT	1/2	13	160	13	160	14	170	STEEL CITY ELECT.		AMT REQ'D. IF A/C IS USED
		ITEM NO & QUANTITY REQ'D. PER HOTEL ARRANGMT. OR AIR CONDITIONER REQMT.								
2 POLE BREAKER	30 AMP		1		1		1	"SQ. D" ELECT. CO.	Q0250	
CONDUIT	3/4		80		80		80	STEEL CITY ELECT.		
CONDUCTOR TYPE TW	10 AWG		160		160		160			THESE ITEMS REQ'D. FOR AIR COND. ONLY
OUTLET BOX			9		9		9	STEEL CITY ELECT.	54141	
FLEX CONDUIT	1/2		2		2		2			
CONDUCTOR TYPE TW	14 AWG		20		20		20			
MISC. FITTINGS AS REQ'D.	LOT		1		1		1			
CONTROL BOX			1		1		1			FURNISHED W/ A/C

- 12LM FIXTURE WITH OUTLET BOX
- ◎ 12LM FIXTURE - 25 WATTS WITH OUTLET
- OUTLET BOX - RECEPTACLE
- AIR CONDITIONER OUTLET (IF USED)
- ↔ SINGLE POLE TOGGLE SWITCH
- Ⓜ VENT MOTOR
- CONTROL BOX - FOR AIR CONDITIONER

GENERAL NC APPLICABLE TO ALL AREA

- ALL WIRING TO BE INSTALLED IN RIGID
- ALL WIRING SHOWN IS TWO COND. NR 14 UNLESS OTHERWISE INDICATED.
- THIS WIRING TO CONSIST OF TWO CONDUCTORS NR 10 TW INSTALLED IN ANYONE OF THE FOLLOWING VENT F V-1C, V-2C, V-1D, V-2D IN REF. 1
- ALL DUPLEX RECEPTACLES SHALL BE ABOVE THE FLOOR.
- THE TOILET LIGHTS ARE TO BE LOCATE THE TWO STALLS.
- WHEN AREA IS USED FOR SLEEPING, R SPECIFIED WITH ONE RATED AT 10 W
- THE MINIMUM SIZE OF SERVICE CON TWO CONDUCTORS ARE REQUIRED (EX WHEN POWER PACKAGE P-4 & P-5 IS L ENTRANCE CONDUCTORS & RACEW DESIGNED TO SUIT THE SPECIFIC
- ALL WORK TO BE PERFORMED IN ACCOR SECTIONS OF THE NATIONAL ELECTR (EDITION)
- REFER TO ELECTRICAL ARRANGEMENT, T DESCRIPTION OF ELECTRICAL EQUIP

B ELECT. PACKAGE AKER PANEL A OTHERWISE NOTED IN REMARK COLUMN	
PURPOSE	REMARKS
DATE SUPPLY ENTRANCE LIGHTS PLUS PT.	
INTS	
MOTOR	
CONDITIONER	IF AIR COND. IS SPECIFIED POWER PKG. P-4 WILL BE USED, THIS WILL REQUIRE 120/240 V, 3 W, 1Ø PANEL HAVING 100 AMP BUS

MISC. ELECT. SERVICE EQUIP REQ'D. FOR A SPECIFIC POWER PACKAGE

"ELECT. PACKAGE AKER PANEL A OTHERWISE NOTED IN REMARK COLUMN	
PURPOSE	REMARKS
DATE SUPPLY ENTRANCE LIGHTS PLUS RECEPTACUM	
INTS	
T MOTOR	
CONDITIONER	IF AIR COND. IS SPECIFIED POWER PKG. P-4 WILL BE USED, THIS WILL REQUIRE 120/240 V, 3 W, 1Ø PANEL HAVING 100 AMP BUS

ITEM	ELECT EQUIP REQ'D. FOR POWER PKG.	DESCRIPTION	CIRCUIT EQUIP. SEE NOTE #9	SIZE OR RATING	NO OR FT. REQD	MANUFACTURER	CATALOG NO	REMARKS
7	P-1 OR P-2	DT SINGLE BLADE FUSED SAFETY SW.	SERVICE SWITCH	30 AMP	1	MEYERS SAFETY SW. CO. INC.	322 SCF	
		SER. ENTRANCE COND. SEE NOTE #7	SER. ENT. RACEWAY & COND.					
		CONDUIT	SUPPLY COND RACEWAY	1/2"	3	STEEL CITY ELECT.		
8	P-3	CONDUCTOR TYPE TW	SUPPLY COND 2-REQ'D.	NR 12 AWG	8	GRAYBAR ELECT. CO.		
		DT SINGLE BLADE FUSED SAFETY SW.	SERVICE SWITCH	60 AMP	1	MEYERS SAFETY SW. CO. INC.	622 SCF	
		SER. ENTRANCE COND. SEE NOTE #7	SER. ENT. RACEWAY & COND.					
9	P-4	CONDUIT	SUPPLY COND RACEWAY	3/4"	3	STEEL CITY ELECT.		
		CONDUCTOR TYPE TW	SUPPLY COND 2-REQ'D.	NR 10 AWG	8	GRAYBAR ELECT. CO.		
		DT TWO BLADE FUSED SAFETY SW.	SERVICE SWITCH	60 AMP	1	MEYERS SAFETY SW. CO. INC.	632 SCF	
10	P-5	SER. ENTR. COND. SEE NOTE #7	SER. ENT. RACEWAY & COND.					
		CONDUIT	SUPPLY COND RACEWAY	3/4"	3	STEEL CITY ELECT.		
		CONDUCTOR TYPE TW	SUPPLY COND 3-REQ'D.	NR 12 AWG	12	GRAYBAR ELECT. CO.		

5

REVISION	DATE	DESCRIPTION
UNITED STATES NAVAL RADIOLOGICAL DISTRICT SAN FRANCISCO 24, CALIF.		
DRAWN	FJA	FI ELECTRIC
CHECKED		
PROJ. ENGR.		
SUPV.		
BRANCH HEAD		DATE
DIVISION HEAD		
SCALE APPROVED:	DATE: 5/22/62	DWG. NO. S-1

J. P. P. DATE: 22 May 62

RECEPT COVER			3		4		5	STEEL CITY ELECT. CO., PITTSBURGH, PA.	58 C7		
INT. TYPE INT. 200W			0		0		6	APERO ELECT. CORP. CLEVELAND, OHIO	D-516	ALL W/ 200 WATT BULBS	
INT. TYPE INT. 150W			0		3		0	APERO ELECT. CORP.	D-514	ALL W/ 150 WATT BULBS	
INT. TYPE INT. 60W			0		3		0	APERO ELECT. CORP.	D-512	ALL W/ 60 WATT BULBS, ALL OTHERS 75 WATT	
1 BALL HGR			6		6		9	APERO ELECT. CORP.	N-15		
ITCH S.P.	15 AMP		1		1		1	BOYANT ELECT. CO.	N-51		
ET BOX			6		6		10	STEEL CITY ELECT.	54151		
ET BOX OVER			0		0		1	STEEL CITY ELECT.	54-C-1		
ICH S.P. VER			1		1		1	STEEL CITY ELECT.	58 C 30		
LE POLE UIT BULB	15 AMP		3		4		4	50 "D" ELECT. CO.	Q0115		
PITTINGS REQ'D.	LOT		1		1		1	STEEL CITY ELECT.			
NR PANEL 2 WIRE TO AMP BUS			4		4		4	50 "D" ELECT. CO.	Q045	POWER PANEL FOR SHUTTER WITHOUT A/C	
NR PANEL 3 WIRE TO V. 2 WIRE TO AMP BUS			5		5		5	50 "D" ELECT. CO.	Q065	POWER PANEL FOR SHUTTER WITH A/C	
DUIT	1/2		11	220	11	220	12	250	STEEL CITY ELECT.	AMT REQ'D. IF A/C NOT USED	
DUIT	1/2		13	140	13	140	14	170	STEEL CITY ELECT.	AMT REQ'D. IF A/C IS USED	
			ITEM NO & QUANTITY REQ'D. PER HOTEL DEPT. OR AIR CONDITIONER REQ'D.								
POLE POWER	30 AMP		1		1		1	50 "D" ELECT. CO.	Q0250		
DUIT	3/4		80		80		80	STEEL CITY ELECT.			
DUCTOR P-TW	10 AWG		160		160		160			THESE ITEMS REQ'D. FOR	
ILET OX			1		1		1	STEEL CITY ELECT.	54141	AIR COND. ONLY	
EX DUIT	1/2		2		2		2				
DUCTOR P-TW	14 AWG		20		20		20				
C. FITTINGS REQ'D.	LOT		1		1		1				
NEOL OX			1		1		1			FURNISHED W/AC	

- RLM FIXTURE WITH OUTLET BOX
- ⊙ RLM FIXTURE - 25 WATTS WITH OUTLET BOX
- OUTLET BOX - RECEPTACLE
- AIR CONDITIONER OUTLET (IF USED)
- ⊞ SINGLE POLE TOGGLE SWITCH
- Ⓜ VENT MOTOR
- CONTROL BOX - FOR AIR CONDITIONER

GENERAL NOTES

APPLICABLE TO ALL ARRANGEMENTS

- ALL WIRING TO BE INSTALLED IN RIGID METALLIC CONDUIT.
- ALL WIRING SHOWN IS TWO COND. NO. 14 TW IN 1/2" CONDUIT UNLESS OTHERWISE INDICATED.
- THIS WIRING TO CONSIST OF TWO CONDUCTORS NO. 14 TW & TWO CONDUCTORS NO. 10 TW INSTALLED IN 3/4" CONDUIT IF ANYONE OF THE FOLLOWING VENT PACKAGES ARE SPECIFIED V-1C, V-2C, V-1D, V-2D IN REF. 1.
- ALL DUPLEX RECEPTACLES SHALL BE LOCATED FOUR FEET ABOVE THE FLOOR.
- THE TOILET LIGHTS ARE TO BE LOCATED MIDWAY BETWEEN THE TWO STALLS.
- WHEN AREA IS USED FOR SLEEPING, REPLACE THE LAMP SPECIFIED WITH ONE RATED AT 10 WATTS.
- THE MINIMUM SIZE OF SERVICE CONDUCTOR IS NO. 8 AWG. TWO CONDUCTORS ARE REQUIRED (EXCEPT 3 COND. REQUIREMENT WHEN POWER PACKAGE P-4 & P-5 IS USED) THE SERVICE ENTRANCE CONDUCTORS & RACEWAY SHOULD BE DESIGNED TO SUIT THE SPECIFIC SITE.
- ALL WORK TO BE PERFORMED IN ACCORDANCE WITH APPLICABLE SECTIONS OF THE NATIONAL ELECTRIC CODE (LATEST EDITION)
- REFER TO ELECTRICAL ARRANGEMENT, THIS DWG., FOR DESCRIPTION OF ELECTRICAL EQUIPMENT.

MISC. ELECT. SERVICE EQUIP. REQ'D. FOR A SPECIFIC POWER PACKAGE

WATT EQUIP. REQ'D. FOR POWER PAK	DESCRIPTION	CIRCUIT EQUIP. SER. NOTE #	SIZE OR RATING	NO. OR PT. REQ'D.	MANUFACTURER	CATALOG NO.	REMARKS
P-1 OR P-2	DT SINGLE BLADE FUSED SAFETY SW. SER. ENTRANCE COND. SEE NOTE #7	SERVICE SWITCH	30 AMP	1	MEYER'S SAFETY SW. CO. INC.	322 SCF	
	CONDUIT	SUPPLY COND. RACEWAY	1/2"	3	STEEL CITY ELECT.		
	CONDUCTOR TYPE TW	SUPPLY COND. 2-REQ'D.	NO. 12 AWG	8	GRAYBAR ELECT. CO.		
P-3	DT SINGLE BLADE FUSED SAFETY SW. SER. ENTRANCE COND. SEE NOTE #7	SERVICE SWITCH	60 AMP	1	MEYER'S SAFETY SW. CO. INC.	422 SCF	
	CONDUIT	SUPPLY COND. RACEWAY	3/4"	3	STEEL CITY ELECT.		
	CONDUCTOR TYPE TW	SUPPLY COND. 2-REQ'D.	NO. 10 AWG	8	GRAYBAR ELECT. CO.		
P-4	DT TWO BLADE FUSED SAFETY SW. SER. ENTR. COND. SEE NOTE #7	SERVICE SWITCH	60 AMP	1	MEYER'S SAFETY SW. CO. INC.	632 SCF	
	CONDUIT	SUPPLY COND. RACEWAY	3/4"	3	STEEL CITY ELECT.		
	CONDUCTOR TYPE TW	SUPPLY COND. 3-REQ'D.	NO. 12 AWG	12	GRAYBAR ELECT. CO.		
P-5	DT TWO BLADE FUSED SAFETY SW. SER. ENTR. COND. SEE NOTE #7	SERVICE SWITCH	60 AMP	1	MEYER'S SAFETY SW. CO. INC.	632 SCF	
	CONDUIT	SUPPLY COND. RACEWAY	3/4"	3	STEEL CITY ELECT.		
	CONDUCTOR TYPE TW	SUPPLY COND. 3-REQ'D.	NO. 10 AWG	12	GRAYBAR ELECT. CO.		

6

REVISION	DATE	DESCRIPTION	BY	APP
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN		FJA		
CHECKED				
ENG. DESIGN APPROVAL	PROJ. ENGINEER	FIG. A-12N ELECTRICAL ARRANGEMENT		
	SUPV.			
	BRANCH HEAD			
	DIVISION HEAD			
DATE		SCALE	PROJECT	TECH. MEMO
SCORE APPROVED: 9/28/62		DATE: 9/28/62	DWG. NO. S-62-970	SHT. 14/19

ACRILIC OR
GLASS WINDOW

40° SOLID ANGLE
FIELD OF VIEW

18"

3.340 DIA
±.006

RET. RING GROOVE

.120
+.008
-.005
SLOT

3" I.P.S. ALUM. PIPE

6"

8'-0"

LINE OF SIGHT

SCREW ADJUSTED
ASSEMBLY - REMOVABLE
FOR INSTALLATION

RETAINING RING, VALDES
TRU-ARC NO 5108-350
OR EQUAL.

LOCKING COLLAR, SEE
FIG. A-15, PC. 3

HANDLES

MODEL "A"
PERISCOPE
SECTION VIEW
SCALE: 1/2 SIZE

NOTES:

1. SEE FIGS. A-14M & A-15M FOR MOUNTING DET.
(FOR MODEL "A" ONLY)
2. PERISCOPE MOUNTING DETAILS FOR
MODEL "B" HAVE NOT BEEN DESIGNED.
SEE NOTE #3 OF FIG. A-15M.

PERISCOPE MODEL "A"

MFG. BY LENOX INSTR. CO.
PHILA. 3, PA.
MODEL NO L1C0 (OR EQUAL)

1

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

PC. NO.	NAME	NO. REQ.	MATL.	MATL. SPEC.

PE

17° SOLID ANGLE
FIELD OF VIEW

HANDLES

EYEPiece

1. TUBE MATERIAL
OD - 2 1/8"
2. LENGTH - 24 1/2"
3. EQUIPPED WITH
OPTIC SYSTEM
EYEPiece.
5. ALL METAL TO
FLAT BLACK
CHROME PLATE
6. GLASS MIRROR
HARD SURFACE
7. GLASS LENSE
MAGNESIUM
8. 17° SOLID ANGLE
9. DRIIP PROOF COATING
10. WEIGHT - 6 1/2 LBS
11. ADJUSTABLE
TINSLEY DVG
12. THE LENS IS
SEALED & TESTED
AT APPROX.

PERISCOPE MODEL "B"

MFG. BY TINSLEY LAB. INC. (OR EQUAL)
BERKELEY 10, CALIF.

2

EYEPiece

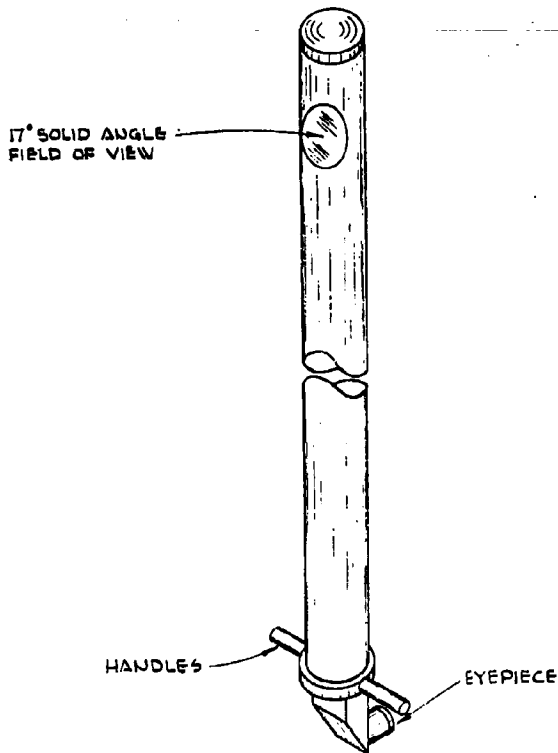
REVISION	DATE	UNIT
		NAVAL RADIOLOGICAL SAN FRANCISCO

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

QTY.	NAME	QTY.	MATL.	MATL. SPEC.	STOCK SIZE	REMARKS

MODEL "B" PERISCOPE SPECS.



1. TUBE MATERIAL ALUM.
2. OD - 2 1/4"
3. LENGTH - AS PER SKETCH.
4. EQUIPPED WITH HANDLES.
5. OPTIC SYSTEM - THREE OPTICAL ELEMENTS & ONE EYEPiece.
6. ALL METAL TO BE BLACK ANODIZED & PAINTED FLAT BLACK EXCEPT BRASS EYEPiece WHICH IS CHROME PLATED.
7. GLASS MIRROR - FRONT SURFACED (ALUMINIZED) & HARD SURFACED.
8. GLASS LENSES - LOW REFLECTION COATING USING MAGNESIUM FLORIDE.
9. 17° SOLID ANGLE.
10. DRIP PROOF CONSTRUCTION
11. WEIGHT - 6 1/2 LBS. (APPROX.)
12. ADJUSTABLE EYEPiece.
13. TINSLEY DVG NO D-0624
14. THE LENS SYSTEM IS TO BE HERMETICALLY SEALED & TO BE FILLED WITH DRY NITROGEN AT APPROX. ATMOSPHERIC PRESSURE.

PERISCOPE MODEL "B"

MFG. BY TINSLEY LAB. INC. (OR EQUAL)
BERKELEY 10, CALIF.

3

REVISION	DATE	DESCRIPTION	BY	APP.

UNITED STATES
NAVAL RADIOLOGICAL DEFENSE LABORATORY
SAN FRANCISCO 24, CALIFORNIA

17° SOLID ANGLE
FIELD OF VIEW

HANDLES

EYEPiece

4. OPTIC SYSTEM - THREE OPTICAL ELEMENTS & ONE EYEPiece.
5. ALL METAL TO BE BLACK ANODIZED & PAINTED FLAT BLACK EXCEPT BRASS EYEPiece WHICH IS CHROME PLATED.
6. GLASS MIRROR - FRONT SURFACED (ALUMINIZED) & HARD SURFACED.
7. GLASS LENSES - LOW REFLECTION COATING USING MAGNESIUM FLORIDE.
8. 17° SOLID ANGLE.
9. DRIP PROOF CONSTRUCTION
10. WEIGHT - 6 1/2 LBS. (APPROX.)
11. ADJUSTABLE EYEPiece.
TINSLEY DVG NO D-0624
12. THE LENS SYSTEM IS TO BE HERMETICALLY SEALED & TO BE FILLED WITH DRY NITROGEN AT APPROX. ATMOSPHERIC PRESSURE.

PERISCOPE MODEL "B"

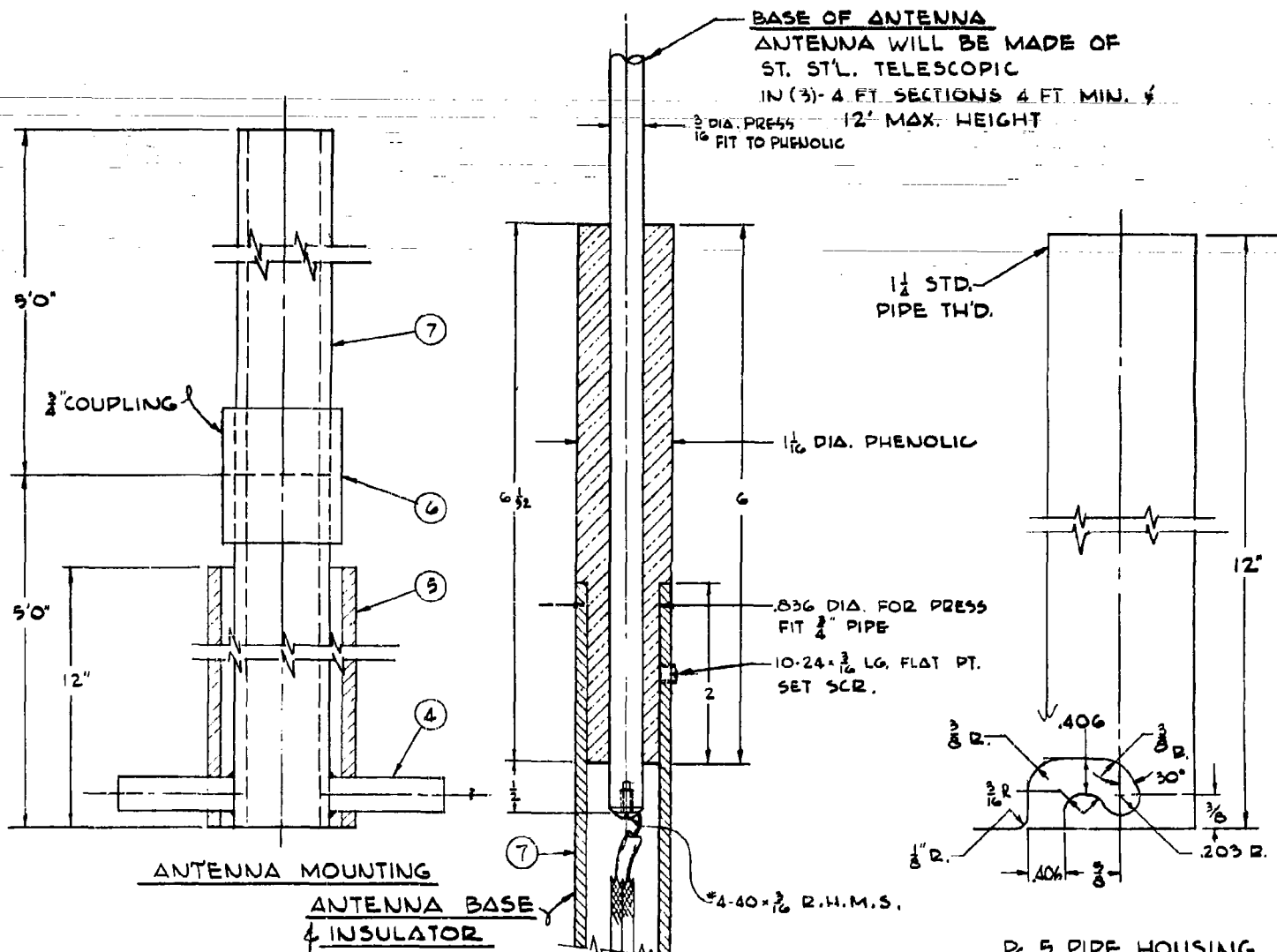
MFG. BY TINSLEY LAB. INC. (OR EQUAL)
BERKELEY 10, CALIF.

4

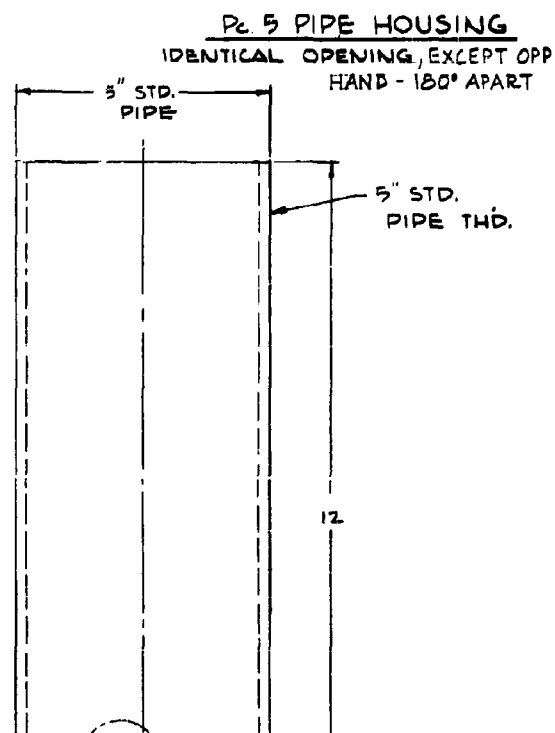
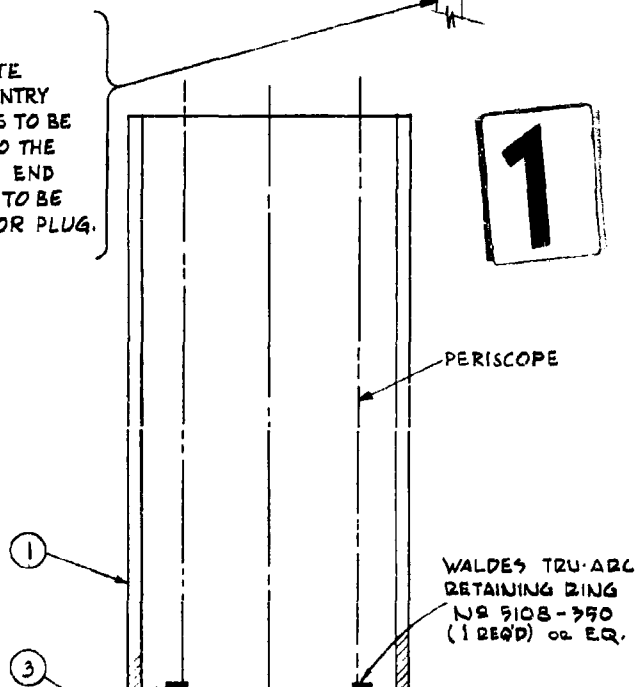
REVISION	DATE	DESCRIPTION	BY	APP.	
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA					
DRAWN	FJA	FIG. A-13M SHELTER PERISCOPE SCHEMATIC			
CHECKED	<i>zda</i>				
SECTION HEAD					
BRANCH HEAD					
DIVISION HEAD					
DATE		SCALE	PROJECT	FINISH	HEAT TREAT
26 FEB 62		NOTED			
SATISFACTORY TO:			DRAWING NUMBER		ALT.
<i>zda</i> Dwg 5-22-62			S-62-970 SHEET 15 OF 19		

ENGINEERING & DESIGN

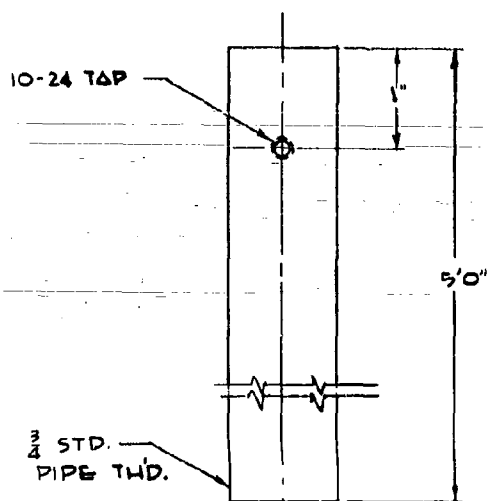
12. APPROVED BY: *Laura A. Portman* DATE: 22 May 62



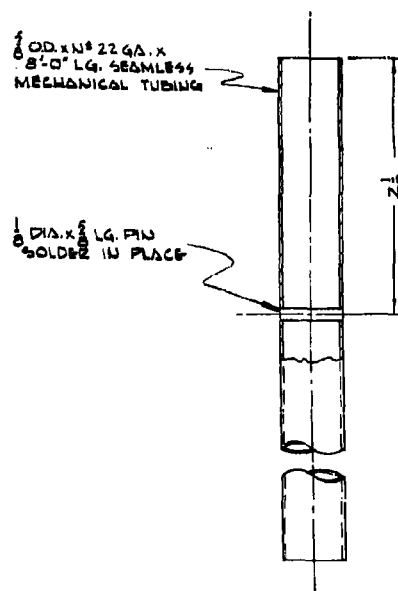
THE COAXIAL CABLE TO BE
 PROVIDED WITH AN ADEQUATE
 CABLE CLAMP AT CONDUIT ENTRY
 POINT. THE CABLE SHEATH IS TO BE
 ELECTRICALLY CONNECTED TO THE
 CONDUIT AND THE OPPOSITE END
 OF THE COAXIAL CABLE IS TO BE
 PROVIDED WITH A CONNECTOR PLUG.



LIST OF MATERIAL					
QUANTITIES SHOWN ARE FOR					
PG. NO.	NAME	NR. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE

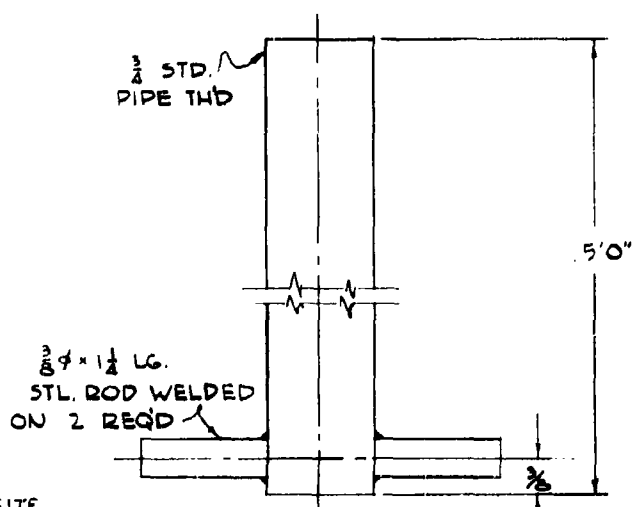


PC. 7 EXTENSION PIPE

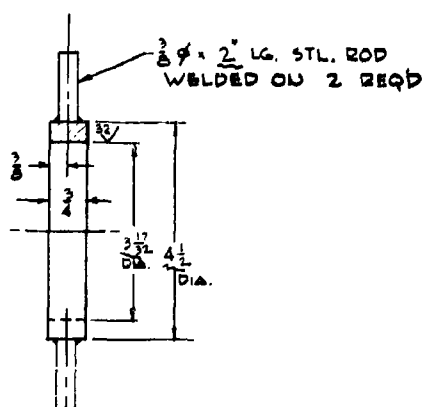


POSIMETER ROD

SCALE: FULL SIZE



PC. 4 LOCKING DEVICE



Pc. 3 LOCKING COLLAR

SCALE - HALF SIZE

NOTES:

1. ANTENNA & MOUNTING REQUIRED FOR PKG. ONLY.
2. ALL DETAILS RELATING TO PERISCOPE MODEL 'A' DESIGN. IT WILL BE NEEDED ALL PERISCOPE MOUNTING DETAILS IF IS USED. SEE NOTE #3 OF FIG. A-15

2

REVISION	DATE	DESCRIPTION
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LAB SAN FRANCISCO 24, CALIFORNIA		
DRAWN	5 1 6	

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

PC. NO.	NAME	NO. REQ.	MAT'L	MAT'L SPEC.	STOCK SIZE	REMARKS
---------	------	----------	-------	-------------	------------	---------

5'0"

1/8" OD. X 1/8" 22 GA. X
8'-0" LG. SEAMLESS
MECHANICAL TUBING

1/8" DIA. X 1/8" LG. PIN
SOLDER IN PLACE

2"

DOSIMETER ROD

SCALE: FULL SIZE

3

5'0"

3/8"

LOCKING DEVICE

3/8" x 2" LG. STL. ROD
WELDED ON 2 REQD

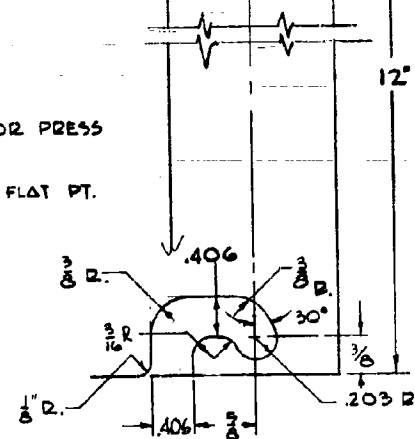
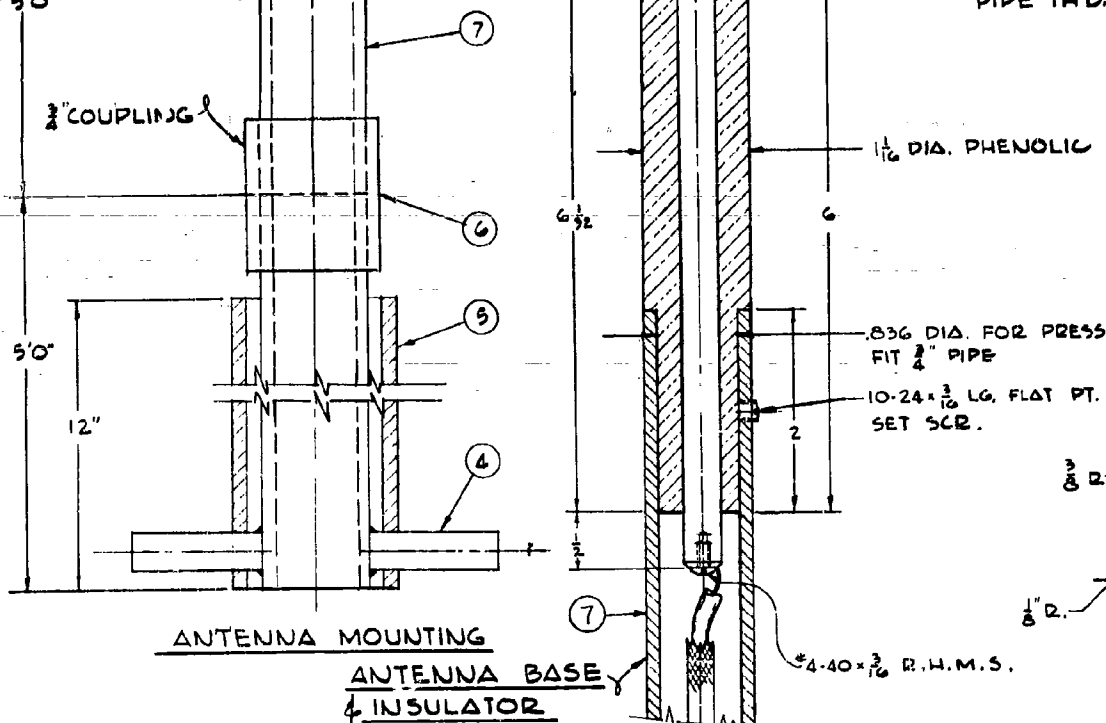
4 1/2"
DIA.

NOTES:

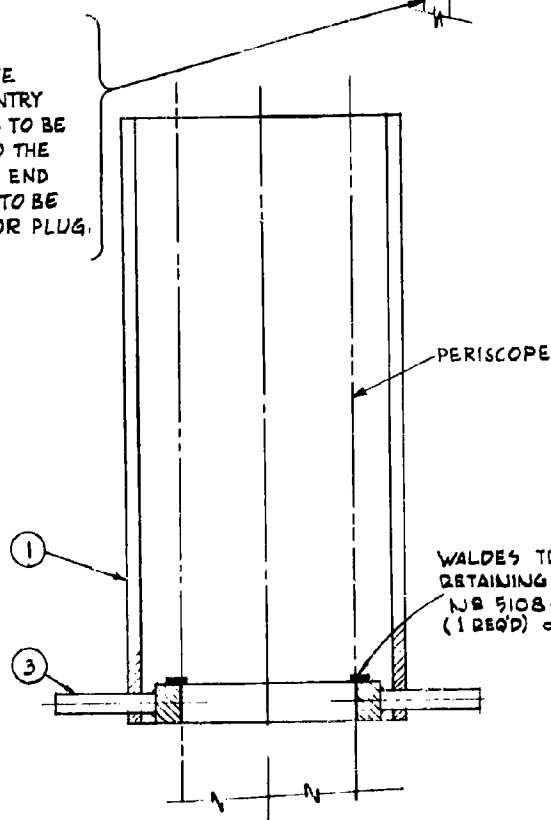
1. ANTENNA & MOUNTING REQUIRED FOR C-3 CONTROL PKG. ONLY.
2. ALL DETAILS RELATING TO PERISCOPE ARE BASED ON MODEL "A" DESIGN. IT WILL BE NECESSARY TO MODIFY ALL PERISCOPE MOUNTING DETAILS IF PERISCOPE "B" IS USED. SEE NOTE #3 OF FIG. A-15M.

ING COLLAR
F SIZE

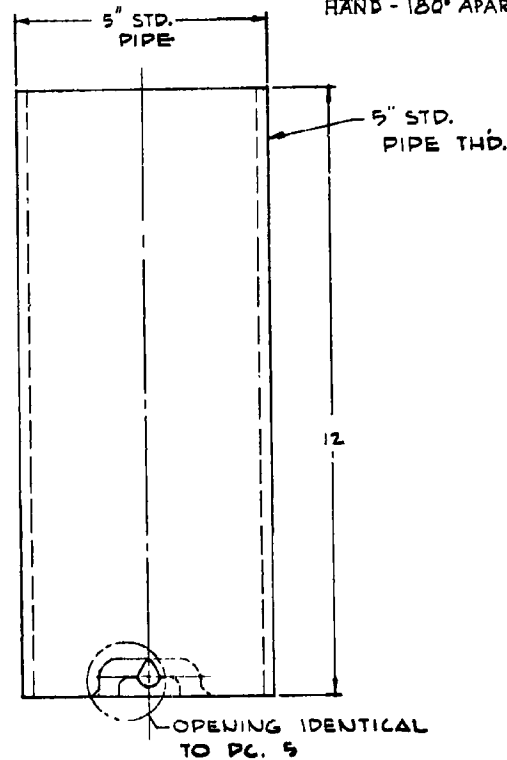
REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA			



THE COAXIAL CABLE TO BE PROVIDED WITH AN ADEQUATE CABLE CLAMP AT CONDUIT ENTRY POINT. THE CABLE SHEATH IS TO BE ELECTRICALLY CONNECTED TO THE CONDUIT AND THE OPPOSITE END OF THE COAXIAL CABLE IS TO BE PROVIDED WITH A CONNECTOR PLUG.



PC 5 PIPE HOUSING
IDENTICAL OPENING, EXCEPT OPPOSITE
HAND - 180° APART



PC 1 PIPE HOUSING
IDENTICAL OPENING, EXCEPT
OPPOSITE HAND - 180° APART
SCALE: HALF SIZE

4

$\frac{3}{4}$ STD.
PIPE THD.

PC. 7 EXTENSION PIPE

$\frac{3}{4}$ STD.
PIPE THD.

$\frac{3}{8}$ ϕ $\times$ $1\frac{1}{2}$ LG.
STL. ROD WELDED
ON 2 REQD

PC. 4 LOCKING DEVICE

PC. 3 LOCKING COLLAR
SCALE - HALF SIZE

OD. ϕ N° 22 GA. $\times$
8'-0" LG. SEAMLESS
MECHANICAL TUBING

$\frac{1}{8}$ DIA. $\times$ $\frac{1}{4}$ LG. PIN
SOLDERED IN PLACE

POSIMETER ROD

SCALE: FULL SIZE

NOTES:

1. ANTENNA & MOUNTING REQUIRED FOR PKG. ONLY.
2. ALL DETAILS RELATING TO PERISCOPE MODEL 'A' DESIGN. IT WILL BE NECESSARY TO USE ALL PERISCOPE MOUNTING DETAILS IF MODEL 'A' IS USED. SEE NOTE #3 OF FIG. A-15.

5

ENGINEERING & DESIGN
IS APPROVED BY: Lewis G. Palmer DATE: 22 May 62

TOLERANCES UNLESS
OTHERWISE NOTED

DECIMALS:

- 4 PLACES $\pm$.001
- 3 PLACES $\pm$.005
- 2 PLACES $\pm$.01

FRACTIONAL

$\pm$ $\frac{1}{16}$

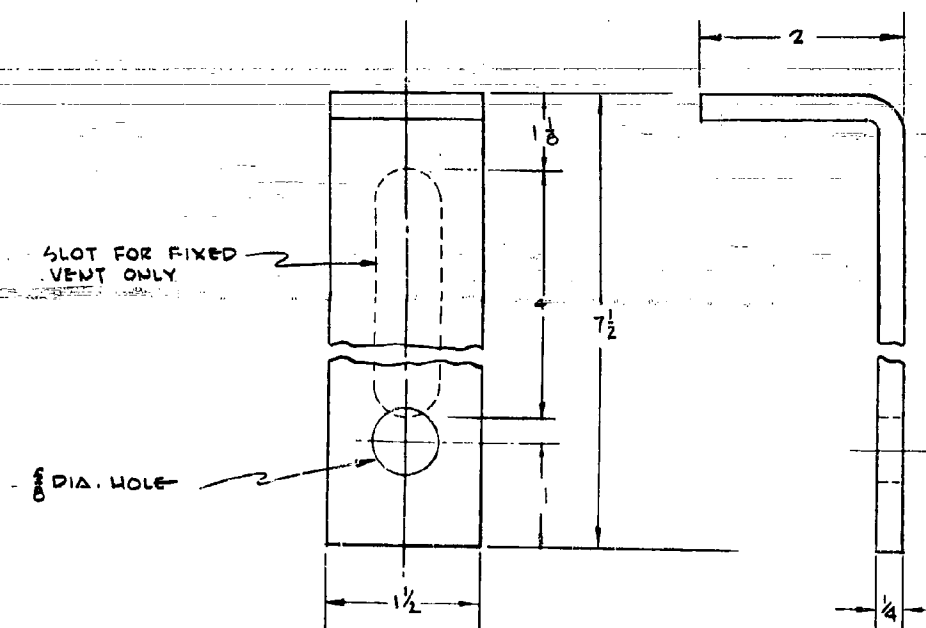
ANGULAR

$\pm$ $\frac{1}{2}^\circ$

✓ GEN. ROUGHNESS
SURFACE UNLESS
SPECIFIED.

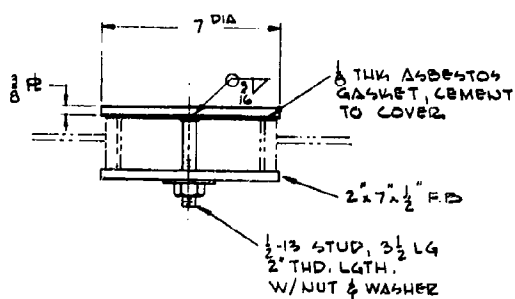
REVISION	DATE	DESCRIPTION
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LAB SAN FRANCISCO 24, CALIFORNIA		
DRAWN	FJA	FIG. A PERISCOPE & MOUNT
CHECKED	FJA	
SECTION HEAD		
BRANCH HEAD		
DIVISION HEAD		
DATE	SCALE	PROJECT
26 FEB 62	FULL & NOTED	
SATISFACTORY TO:	DATE: 5-22-62	
DRAWING S-62		SHEET





DETAIL A
MOUNTING BRACKET
(4 REQ'D.)

MOUNTING
WELD TO C
DETAIL A



DETAIL "B"
PERISCOPE OPENING
COVER PLATE

PERISCOPE (P)

TOWARDS ENTRANCE

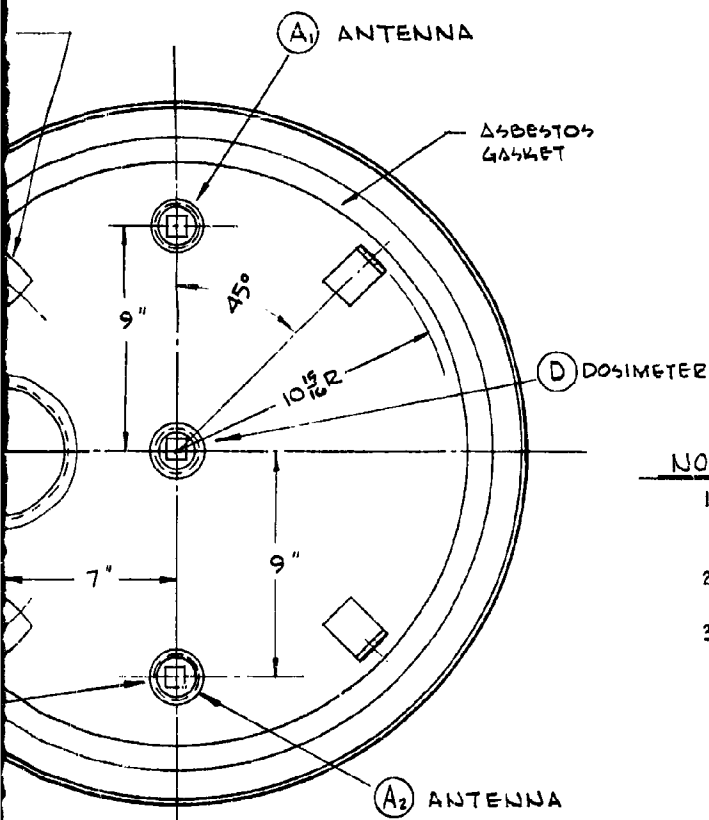
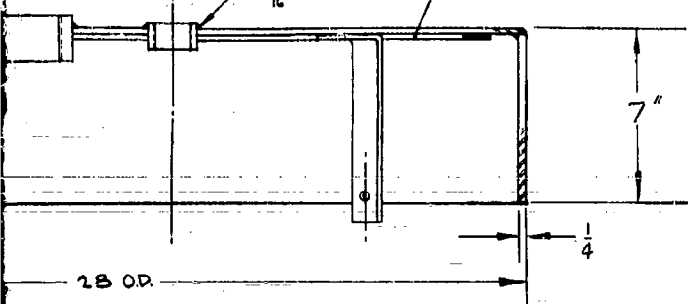
5" XHV HALF CPLG
SEE DET. "B"

1 1/4" XHV HALF CPLG.
3 REQ'D. W/SQ HD.
PLUG INSERTED FROM
UNDER SIDE.

(A), (A2) & (D)

1





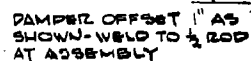
NOTES:

1. ALL UNGALVANIZED STEEL WORK SHALL BE GIVEN ONE SHOP COAT OF RED LEAD PAINT CONFORMING WITH FEDERAL SPECIFICATION TT-P-862, TYPE I OR II.
2. TOTAL FITTINGS ARE SHOWN ON THIS DWG. REFER TO CONTROL PKG. DESIRED FOR ACTUAL N° OF FITTINGS TO BE INSTALLED.
3. ALL DETAILS RELATING TO PERISCOPE ARE BASED ON MODEL "A" PERISCOPE DESIGN. IT WILL BE NECESSARY TO MODIFY ALL PERISCOPE MOUNTING DETAILS IF PERISCOPE "B" IS USED.

BOTTOM VIEW

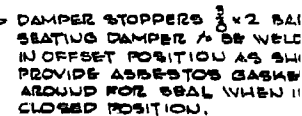
REVISION	DATE	DESCRIPTION	BY	APP.	
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA					
DRAWN	FJA	FIG. A-15M VENTILATOR CAP FOR CONTROL PKG.			
CHECKED	Z/a				
SECTION HEAD					
BRANCH HEAD					
DIVISION HEAD					
DATE		SCALE	PROJECT	FINISH	HEAT TREAT
26 FEB 62		NONE			
ENGINEERING & DESIGN IS APPROVED BY: <u>Louis G. Patten</u> DATE: <u>22 MAY 62</u>		SATISFACTORY TO: <u>Q4D</u>		DRAWING NUMBER S-62-970 SHEET 17 OF 19	
		DATE <u>5-22-62</u>		ALT.	

3



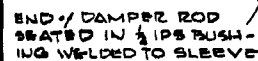
SECTION B-B

SCALE : 3" = 1'-0"



SECTION C-C

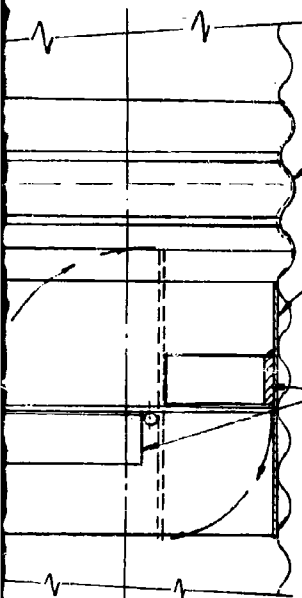
SCALE: 3" = 1'-0"



SECTION A-A

SECTION

A) CULVERT
3' DP.



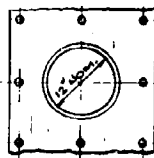
CORR. COUPLING
(TWO REQ'D)

$\frac{3}{16}$ GALV. PLT. SLEEVE

DAMPER STOPPERS $\frac{3}{8} \times 2$ BAR FOR
SEATING DAMPER TO BE WELDED TO SLEEVE
IN OFFSET POSITION AS SHOWN
PROVIDE ASBESTOS GASKET ALL
AROUND FOR SEAL WHEN IN
CLOSED POSITION.

SECTION C-C

SCALE: 5" = 1'-0"



SADDLE BRANCH (MOD.)

SCALE: $\frac{3}{4}$ " = 1'-0"

SADDLE BR. MODIFIED TO EX-
TEND 2" INSIDE $\frac{1}{2}$ SADDLE PLATE
TO RECEIVE CANVAS COUPLING

$\frac{1}{2}$ IPS SLEEVE, LGTH
TO SUIT. WELD TO
ENT. TUNNEL & FILL
WITH ASBESTOS

$\frac{3}{8} \times 1$ FLAT BAR BASE SUPPORT
WELD TO ENTRANCE TUNNEL
WALL & 3" CHANNEL

2" IPS SLEEVE, STUFF
W/ FIBROUS ASPHALT
WELD TO ENT. TUNNEL

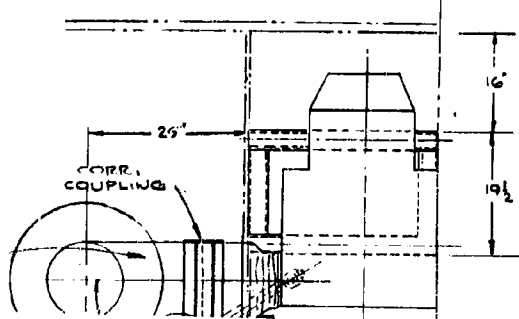
$\frac{3}{8} \times 1$ FLAT BAR
WELD TO $\frac{1}{2}$ ϕ ROD

$\frac{1}{2}$ ϕ ROD, WELD TO F.B.

$\frac{3}{8} \phi \times \frac{1}{2}$ LG. TOGGLE
PIN EYE COLLAR
PROVIDE RETAINING
CHAIN, SECURE &
BUSHING

END BUSHING $\frac{1}{2}$ THK. $\frac{1}{4}$ ϕ D.
PLT. PROVIDE WITH OPEN &
CLOSE MARKS

12" NOM. DIA "ARMCO"
3 PC 90° ELL



ELEVATION

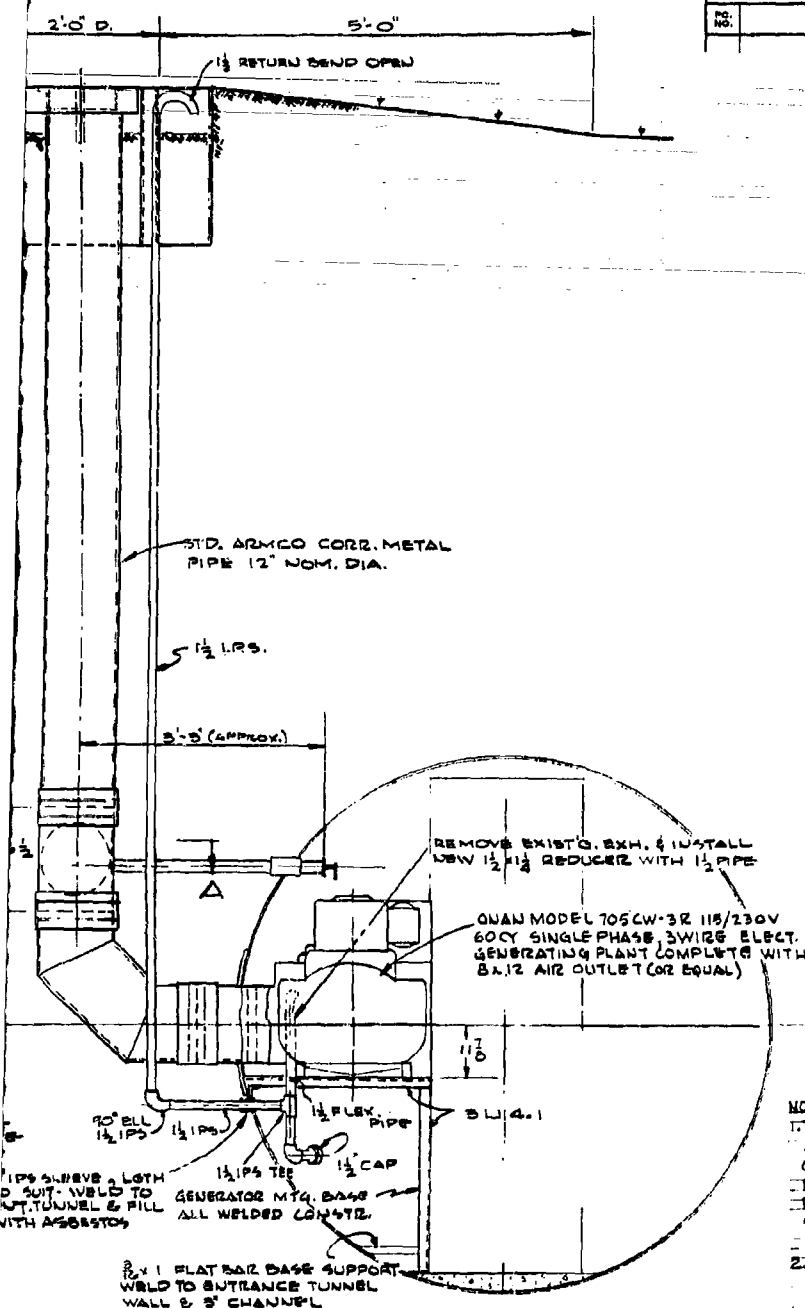
TYPICAL- 7.5 KW ENG. GEN. SHOWN INSTALLED

2

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

QTY.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS
------	------	----------	--------	--------------	------------	---------



ELEVATION

TYPICAL - 7.5 KW ENG. GEN. SHOWN INSTALLED

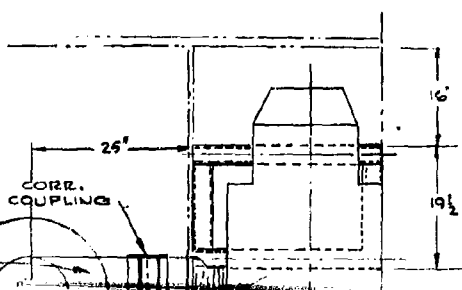
MOTOR-GENERATOR SCHEDULE

PKG NO.	POWER	ONAN GAS TYPE	KOHLER GAS TYPE
P-1	1.2 KW		LM 21
P-2	2.5 KW	2 LK 1M	2.5 H 25
P-3	3.5 KW	305 CCK 1M	3.5 MM 21
P-4	5.0 KW	5 CCK 8M	5 MM 21
P-5	7.5 KW	705 CW 3R	7.5 RM 21

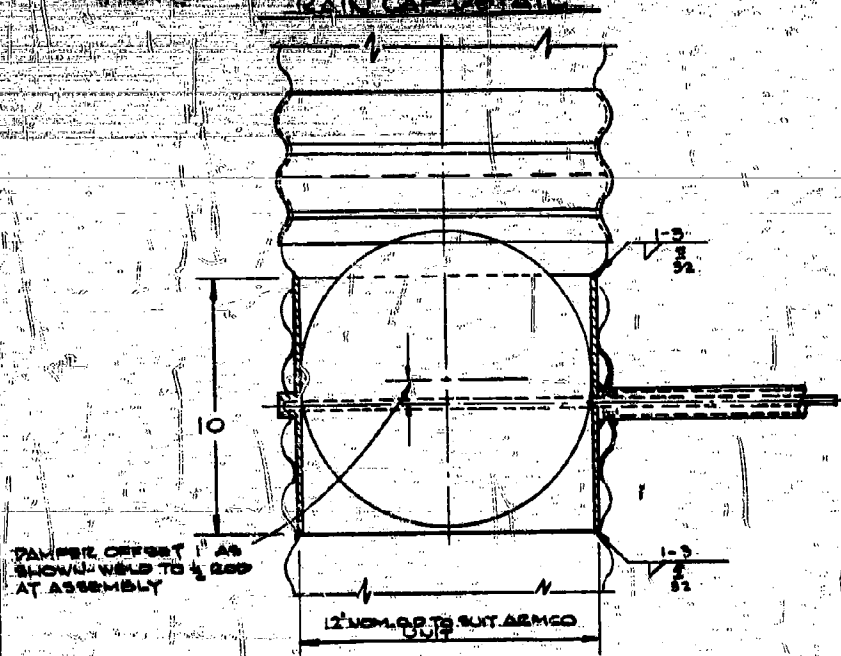
NOTES:

1. THE ENGINE GENERATOR SHALL BE PROVIDED WITH A SUCTION-TYPE AIR-COOLING SYSTEM WITH A DIRECT-CONNECTED CENTRIFUGAL BLOWER. THE ENGINE AND THE GENERATOR SHALL BE PROVIDED WITH AN AIR-COOLING SYSTEM SO AS TO ALLOW HEATED AIR AND EXHAUST GASES TO BE DUCTED OUT OF THE ENTRANCE COMPARTMENT. THE ENGINE GENERATOR, FOR THE CAMP PARKS INSTALLATION, SHALL BE EQUAL TO ONAN ELECTRIC PLANT SERIES NO. 705 CW.
2. THE TOTAL ENGINE GENERATOR ELECTRICAL INSTALLATION COMPLETE WITH FUEL TANKS, GAS DISTRIBUTION SYSTEM, VENT SYSTEM, ETC., SHALL BE TESTED IN THE PRESENCE OF THE OFFICER IN CHARGE OF CONSTRUCTION OR HIS AUTHORIZED REPRESENTATIVE. THE TEST SHALL CONSIST OF REPEATED START AND STOPS AND A FULL-LOAD HEAT RUN FOR A PERIOD OF AT LEAST 2 HOURS. THIS TEST SHALL BE CONDUCTED BY THE CONTRACTOR AT HIS EXPENSE. THE FREQUENCY AND VOLTAGE REGULATION SHALL BE CHECKED TO DETERMINE THAT THE FREQUENCY REGULATION IS WITHIN 3 CYCLES AND THE VOLTAGE REGULATION WITHIN $\pm 3\%$ NO LOAD TO FULL LOAD.
3. ALL EXPOSED EXHAUST PIPING INSIDE SHELTER SHALL BE COVERED WITH GRADE 1, CLASS A INSULATION IN ACCORDANCE WITH SPEC. MIL-P-2781.

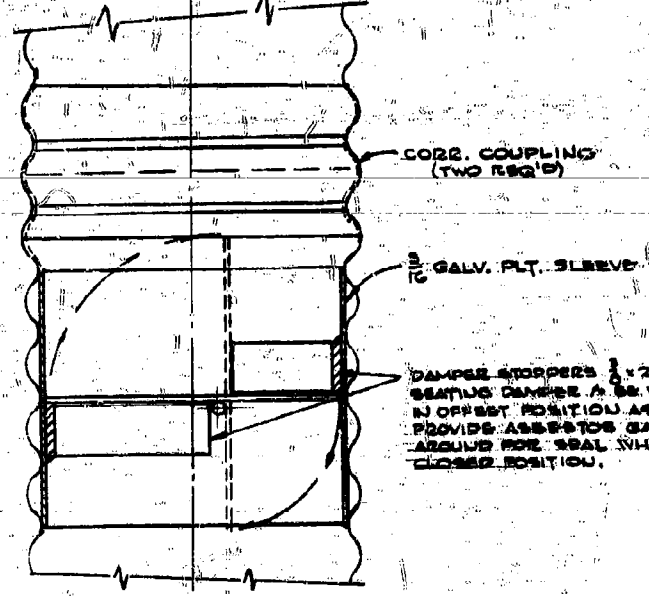
3



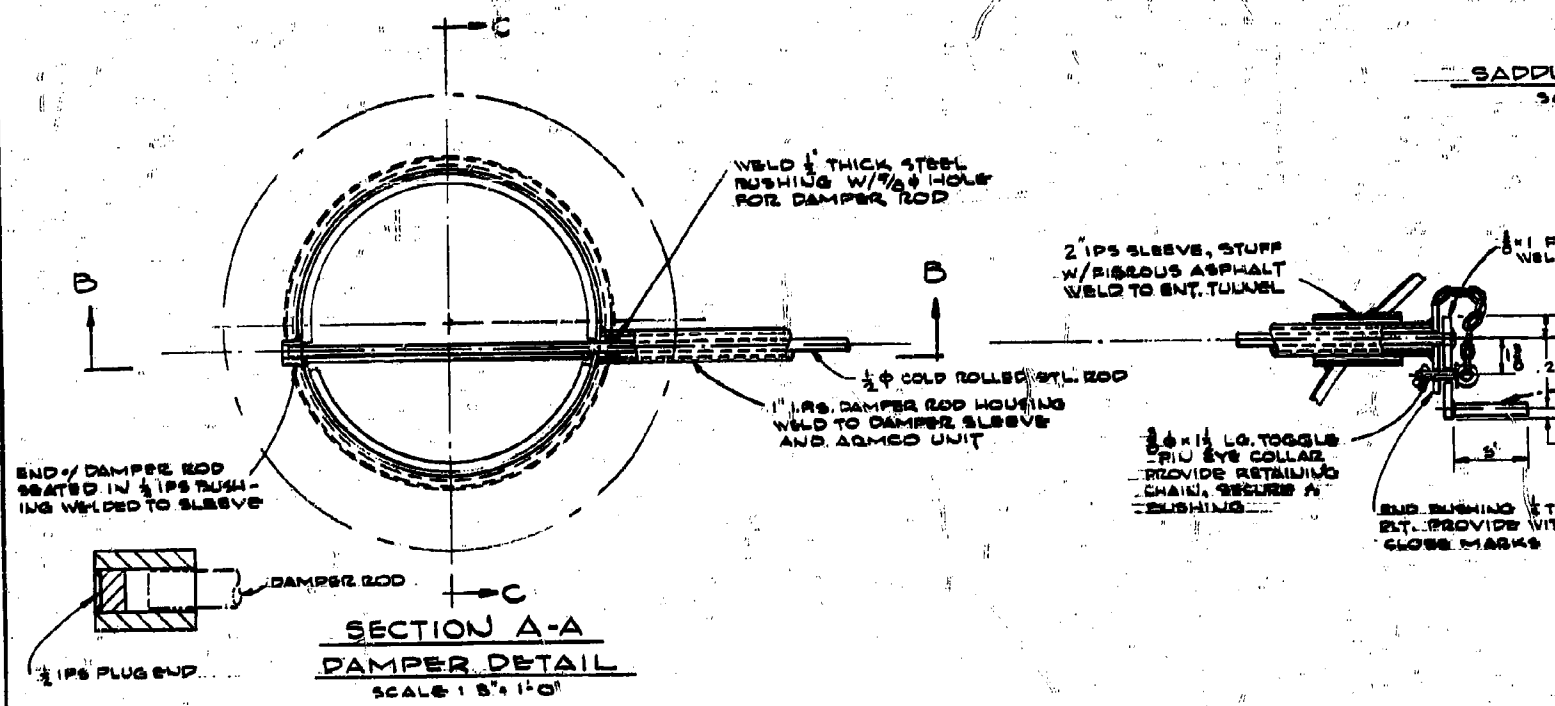
REVISION	DATE	DESCRIPTION	BY	APP.
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SECTION B-B
SCALE: 1 5" = 1'-0"



SECTION C-C
SCALE: 1 5" = 1'-0"



SECTION A-A
DAMPER DETAIL
SCALE: 1 5" = 1'-0"

NO

SLEEVE

ERS 3/4 x 2 BAR AP
ER A BE WELDED TO SLEEVE
ITION AS SHOWN
STDS GASKET ALL
SEAL WHEN IN
OU.



SADDLE BR. MODIFIED TO EX-
TEND 2" INSIDE 4" SADDLE PLATE
TO RECEIVE CANVAS COUPLING

SADDLE BRANCH (MOD.)

SCALE: 1/2" = 1'-0"

3/4 x 1 FLAT BAR
WELD TO 1/2" ROD

USING 1/2 THK 1/4 x 1/2 D.
PROVIDE WITH OPEN &
MARKS

12" NOM. DIA. "ARMCO"
3 PC 90° ELL

24" (NOM.) DIA. "ARMCO"
CORE MET. PIPE 3'-0 LG

12" D. (NOM.) "ARMCO"
CORE METAL PIPE
3'-0 LG

CORR.
COUPLING

PROVIDE FIRE-PROOF COUPLING FROM
GENERATOR AIR OUTLET TO EXHAUST
STACK - SECURE COUPLING WITH
SHEET METAL DUCT CLAMP

PLAN AT ENTRANCE

SCALE: 1/2" = 1'-0"

STD. ARMCO CORR. METAL
PIPE 12" NOM. DIA.

5 1/2 I.P.S.

2'-0" (APPROX.)

16 1/2
2'-1"

REMOVE EXISTG. EXH. & INSTALL
NEW 1 1/2 x 1 1/2 REDUCER WITH 1 1/2 PIPE

QUAN MODEL 705CW-3R 115/230V
60CY SINGLE PHASE 3WIRE ELECT.
GENERATING PLANT COMPLETE WITH
8 x 12 AIR OUTLET (OR EQUAL)

90° ELL
1 1/2 I.P.S.

1 1/2 I.P.S. TEE
GENERATOR MTG. BASE
ALL WELDED CONSTR.

2 x 1 FLAT BAR BASE SUPPORT
WELD TO ENTRANCE TUNNEL
WALL & 3" CHANNEL

ELEVATION

TYPICAL - 7.5 KW ENG. GEN. SHOWN INSTALLED

MOTOR-GENERATOR	
PKG NO	POWER
P-1	1.2 KW
P-2	2.5 KW
P-3	3.5 KW
P-4	5.0 KW
P-5	7.5 KW

- NOTES:
1. THE ENGINE GENERATOR SHALL BE PROVIDED WITH A SYSTEM WITH A DIRECT-CONNECTED CENTRIFUGAL GENERATOR SHALL BE PROVIDED WITH AN AIR-HEATED AIR AND EXHAUST GASES TO BE DUCTED TO THE EXHAUST DEPARTMENT. THE ENGINE GENERATOR, FOR THE PURPOSES OF THIS SPECIFICATION, SHALL BE EQUAL TO ONAN ELECTRIC.
 2. THE TOTAL ENGINE GENERATOR ELECTRIC FUEL TANKS, GAS DISTRIBUTION SYSTEM, TESTED IN THE PRESENCE OF THE OFFICE OR HIS AUTHORIZED REPRESENTATIVE, THE START AND STOPS AND A FULL-LOAD HEAT 2 HOURS. THIS TEST SHALL BE CONDUCTED AT THE FREQUENCY AND VOLTAGE TO DETERMINE THAT THE FREQUENCY IS WITHIN THE VOLTAGE REGULATION WITHIN 1 PERCENT.
 3. ALL EXPOSED EXHAUST PIPING INSIDE THE TUNNEL SHALL BE CLASS A INSULATION 1/2" THICK MIL-P-2781.

5

REVISION	DATE	DESIGN
UNITED NAVAL RADIOLOGICAL SAN FRANCISCO		
DRAWN	POND	DATE 1-11-63
CHECK	ALC	
APPROVED	BY	DATE 1-11-63
PROJ. ENGR.		
SUPVR.		
BRANCH HEAD		
DIVISION HEAD		
ELECT		SCALE NOTED

ENGINEERING & DESIGN
IS APPROVED BY: Laurie G. Pithers DATE: 22 MAY 63

FUEL TANK BREATHER
PIPE - VERTICAL VENT
BUCKEYE N° 4103 OR EQUAL

WATER-TIGHT FUEL
TANK FILLER, BUCKEYE
450 OR EQUAL

TOP OF FINISH GRADE

EXISTING GRA

2" IPS (BLACK PIPE)
FUEL TANK FILLER

2" IPS (BLACK PIPE)
FUEL TANK BREATHER

STANDARD 18"
BOLTED MANHOLE

CONNECT TUBING TO
EXISTING FUEL INLET
ON FUEL PUMP & FUEL
RETURN PORT ON DAY TANK

WATER TANK: 3/16 THK
WELDED STEEL W/ FLAT
FLANGED HEADS, SAND-
BLAST & COAT INTERIOR
W/ COPPER & T & O PAINT
& COAT EXTERIOR W/ N° 50
BITUMASTIC (SEE SCHEDULE)

1/2" IPS GALV. WATER LINE
EMBED IN STYROFOAM
(SEE DETAIL "A")

3/8" FUEL RETURN LINE
(COPPER TUBE)

1/4" FUEL SUPPLY LINE
(COPPER TUBE)

1/4" SHUT-OFF VALVE
(SUPPLY LINE)

SEE PIPE ENTRAN

EMBED BOTH FUEL LINES
IN STYROFOAM PLANKS
SEE DETAIL "A"

GASOLINE STORAGE TANK
(BLACK IRON - SEE SCHEDULE)
#10 GAGE, W/ FLAT FLANGED HEADS.
EXTERIOR COATED W/ N° 50 BITUMASTIC.

TAMP SAND SOLID PRIOR
TO INSTALLATION OF TANK

1

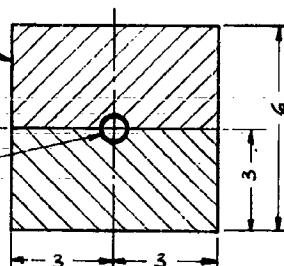
1'-6"
4'-0"

LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR				
AC. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.

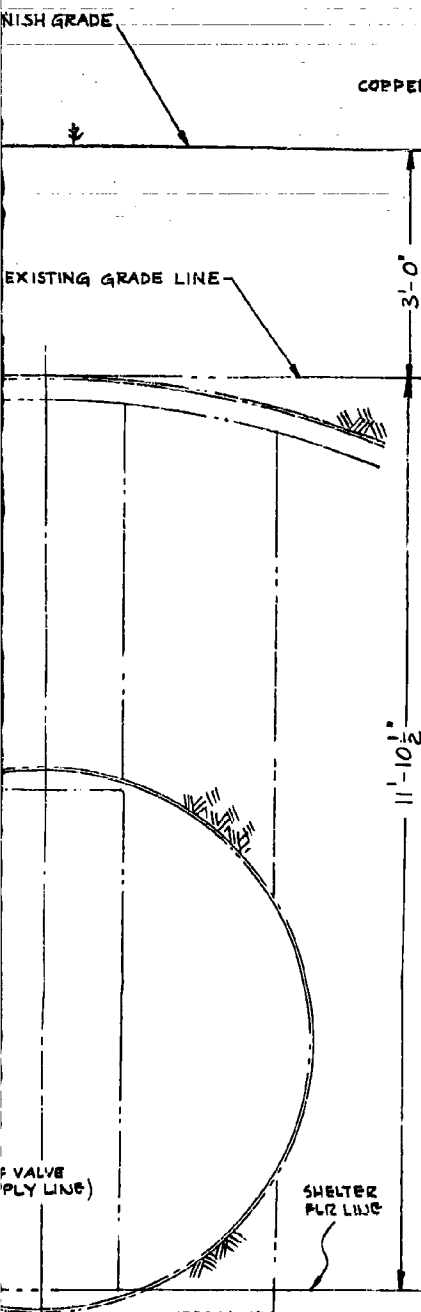
STYROFOAM PLANK
(APPROX. 36 lbs./in² IN SHEAR)

COPPER OR GALV. PIPE



DETAIL 'A'

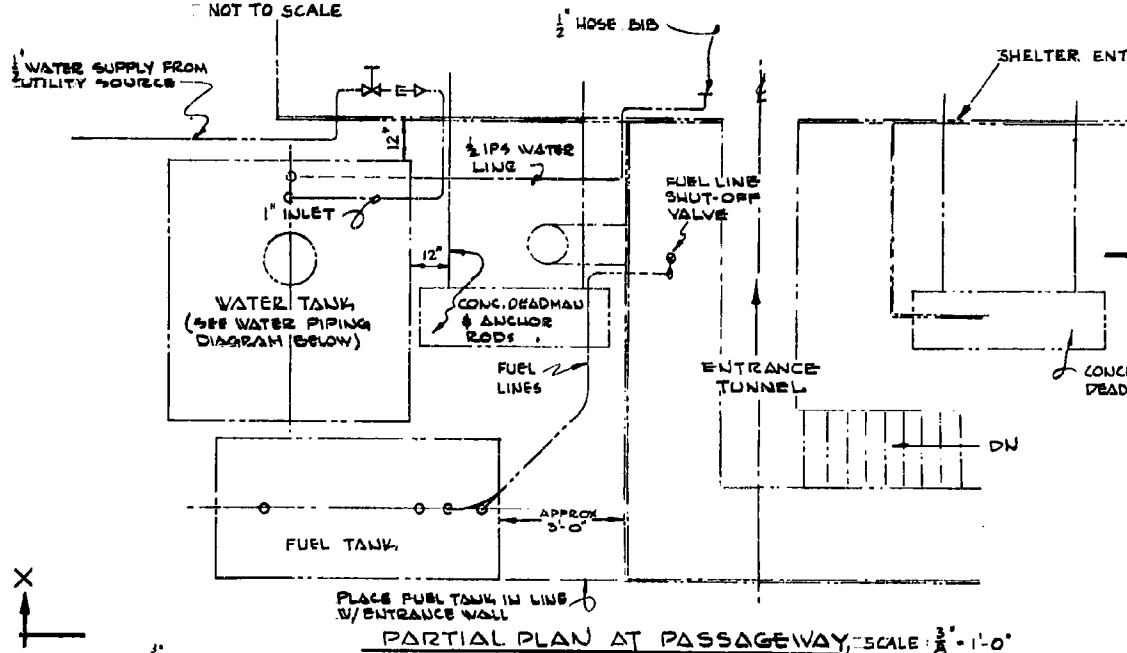
TYPICAL UNDERGROUND
PIPE INSTALLATION
NOT TO SCALE



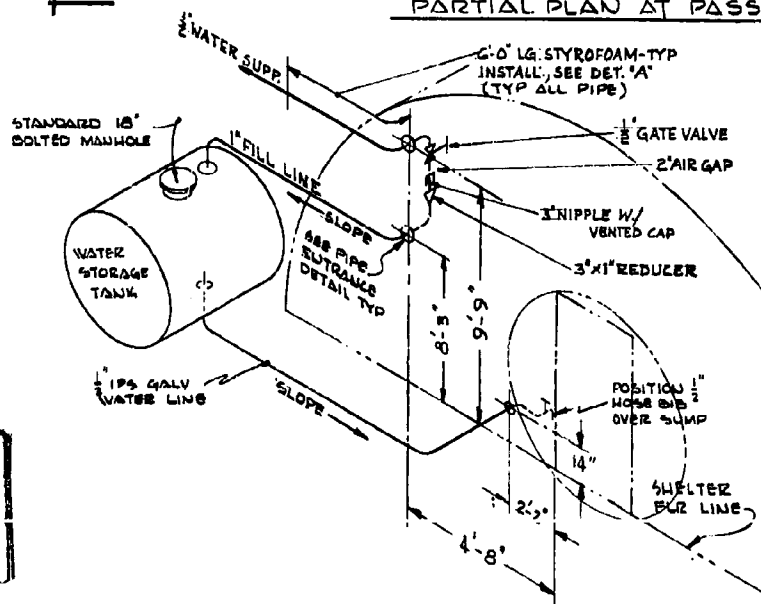
PIPE ENTRANCE DETAIL

FUEL LINES
PLANNING

2



PARTIAL PLAN AT PASSAGEWAY, SCALE: 3/8" = 1'-0"



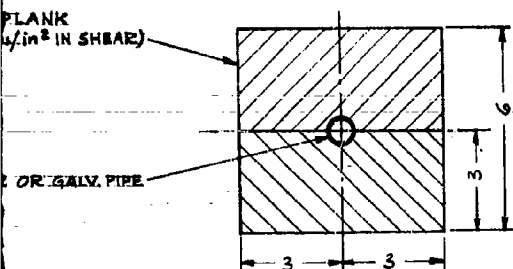
WATER TANK PIPING
DIAGRAM
(SCHEMATIC ONLY)

WELD OR SOLDER
ALL AROUND

NOTES:

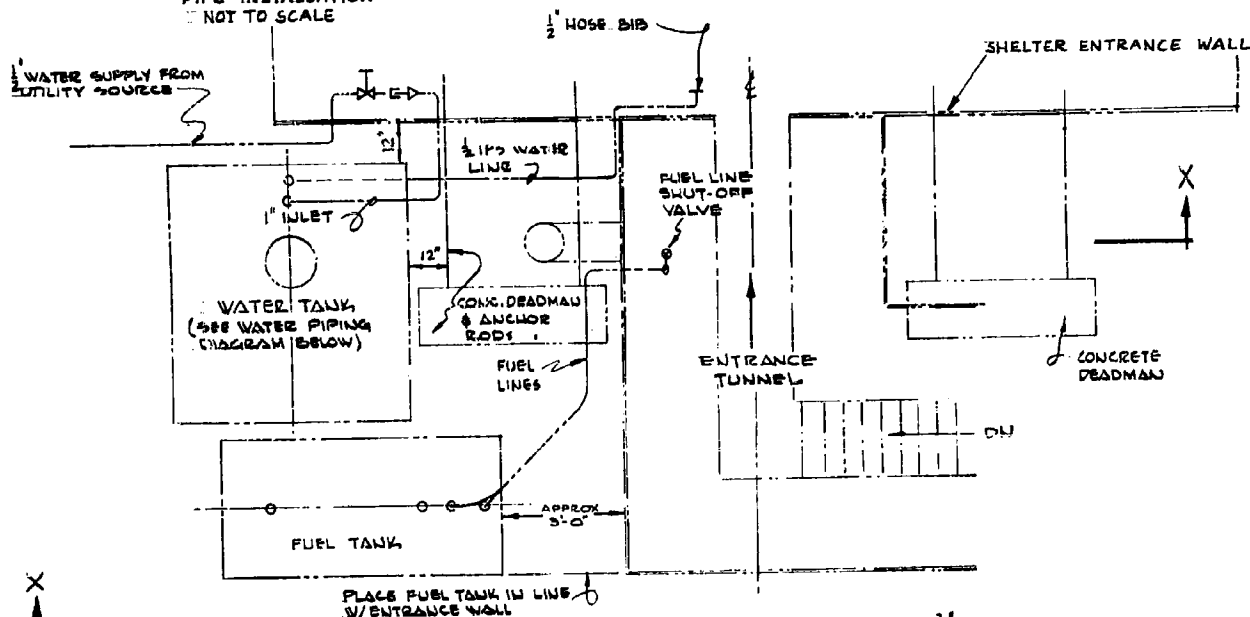
1. ENTRY OF ALL PIPES INTO SHELTER WITH DETAILS SHOWN IN PIPE ENT.
2. PRIOR TO BACKFILLING AROUND TA TEST THE TOTAL GAS & WATER TA PRESSURIZING TO 5 LB/SQ. IN. NEITH AT THIS PRESSURE, AND LEAKS D BE REPAIRED AND THE SYSTEM R
3. THE WATER TANK COMPLETE WITH DISINFECTED WITH CHLORINE BE OPERATION. THE AMOUNT OF CHL SUCH AS TO PROVIDE A DOSAGE PER MILLION. FOLLOWING A CO THAN 8 HOURS, THE HEAVILY C BE FLUSHED OUT WITH CLEAN PLACED IN SERVICE.

REVISION	DATE	DESCRIP

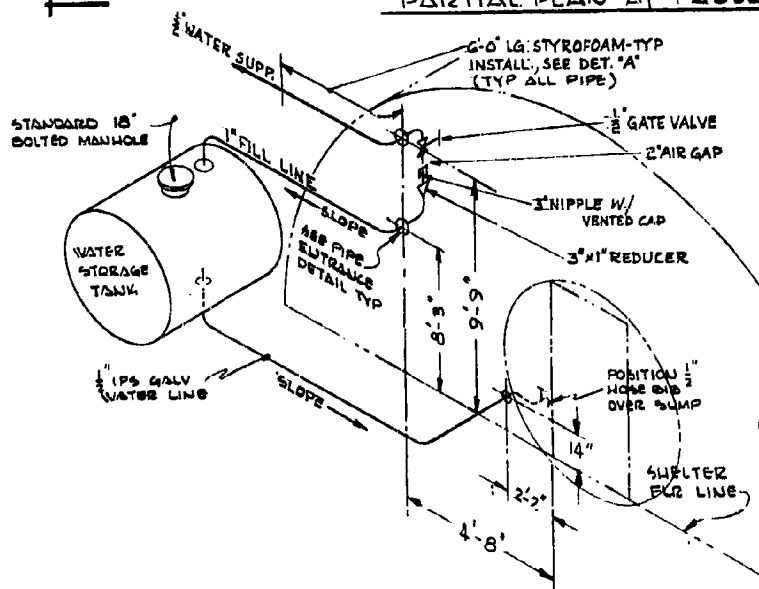


DETAIL "A"

TYPICAL UNDERGROUND
PIPE INSTALLATION
NOT TO SCALE

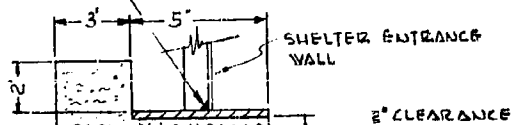


PARTIAL PLAN AT PASSAGEWAY, SCALE: 3/8" = 1'-0"



**WATER TANK PIPING
DIAGRAM
(SCHEMATIC ONLY)**

WELD OR SOLDER
ALL AROUND



LIST OF MATERIAL

QUANTITIES SHOWN ARE FOR

PS. NO.	NAME	NO. REQ.	MAT'L.	MAT'L. SPEC.	STOCK SIZE	REMARKS
------------	------	-------------	--------	-----------------	------------	---------

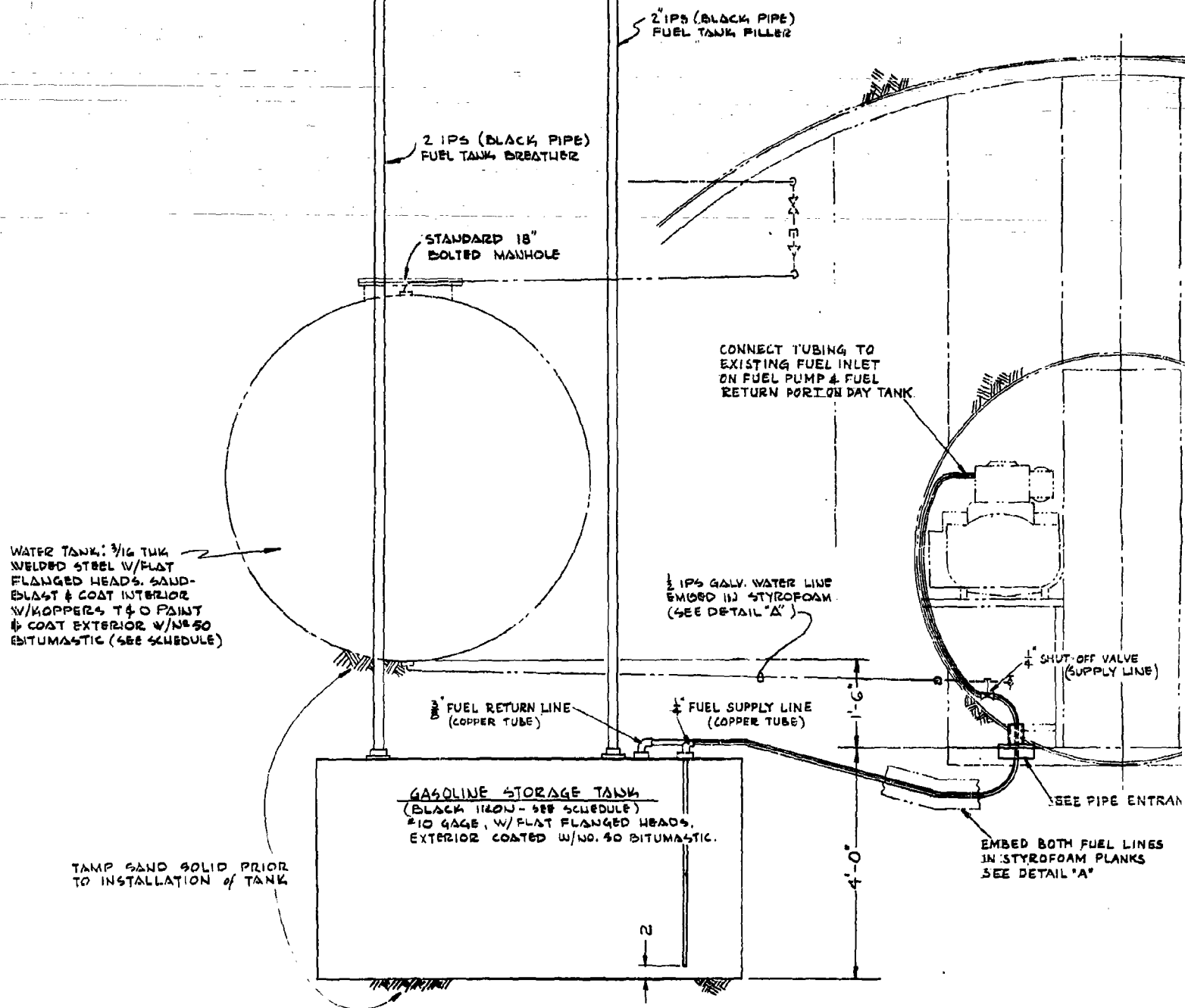
NOTES:

1. ENTRY OF ALL PIPES INTO SHELTER IS TO BE IN ACCORDANCE WITH DETAILS SHOWN IN PIPE ENTRANCE DETAIL ON THIS DRAWING.
2. PRIOR TO BACKFILLING AROUND TANKS, THE CONTRACTOR IS TO TEST THE TOTAL GAS & WATER TANK-PIPE SYSTEM BY AIR PRESSURIZING TO 5 LB/SQ. IN. NEITHER SYSTEM SHALL LEAK AIR AT THIS PRESSURE, AND LEAKS DISCLOSED BY THIS TEST SHALL BE REPAIRED AND THE SYSTEM RETESTED.
3. THE WATER TANK COMPLETE WITH PIPING SHALL BE THOROUGHLY DISINFECTED WITH CHLORINE BEFORE BEING PLACED IN OPERATION. THE AMOUNT OF CHLORINE APPLIED SHALL BE SUCH AS TO PROVIDE A DOSAGE OF NOT LESS THAN 50 PARTS PER MILLION. FOLLOWING A CONTACT PERIOD OF NOT LESS THAN 8 HOURS, THE HEAVILY CHLORINATED WATER SHALL BE FLUSHED OUT WITH CLEAN WATER AND THE SYSTEM PLACED IN SERVICE.

3

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	DATE		
CHECK	3/2			

FIG. A-17M



GASOLINE TANK SCHEDULE			
PKG NO	POWER	CAPACITY	APPROX. DIM.
P-1	1.5 KW	95 GAL	28" DIA. x 42"
P-2	2 KW	120 GAL	28" DIA. x 50"
P-3	3.5 KW	280 GAL	45 1/2" DIA. x 40"
P-4	5 KW	390 GAL	45 1/2" DIA. x 54"
P-5	7.5 KW	620 GAL	45 1/2" DIA. x 88"

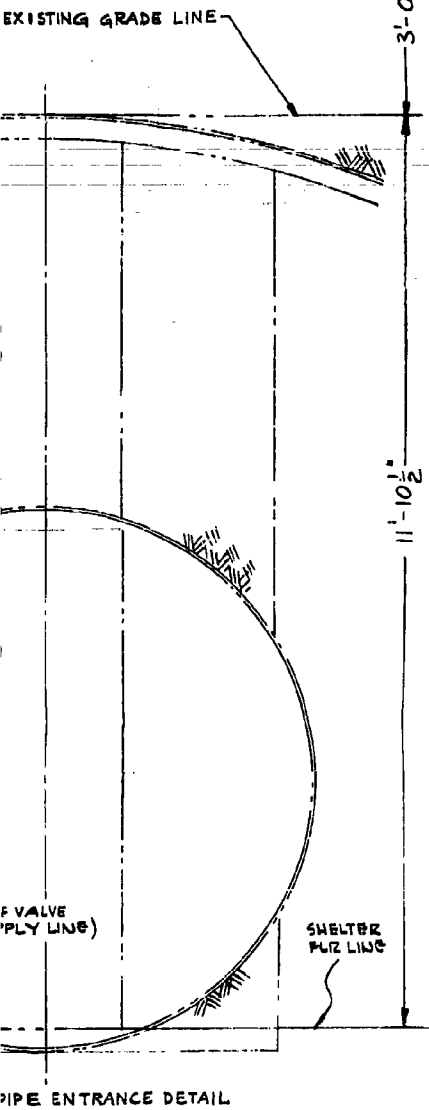
SECTION X-X

SCALE: 3/4" = 1'-0"

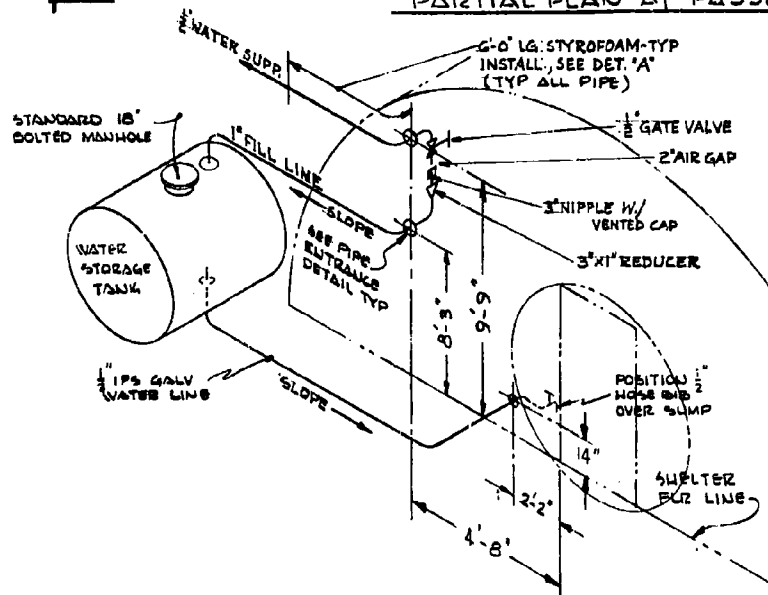
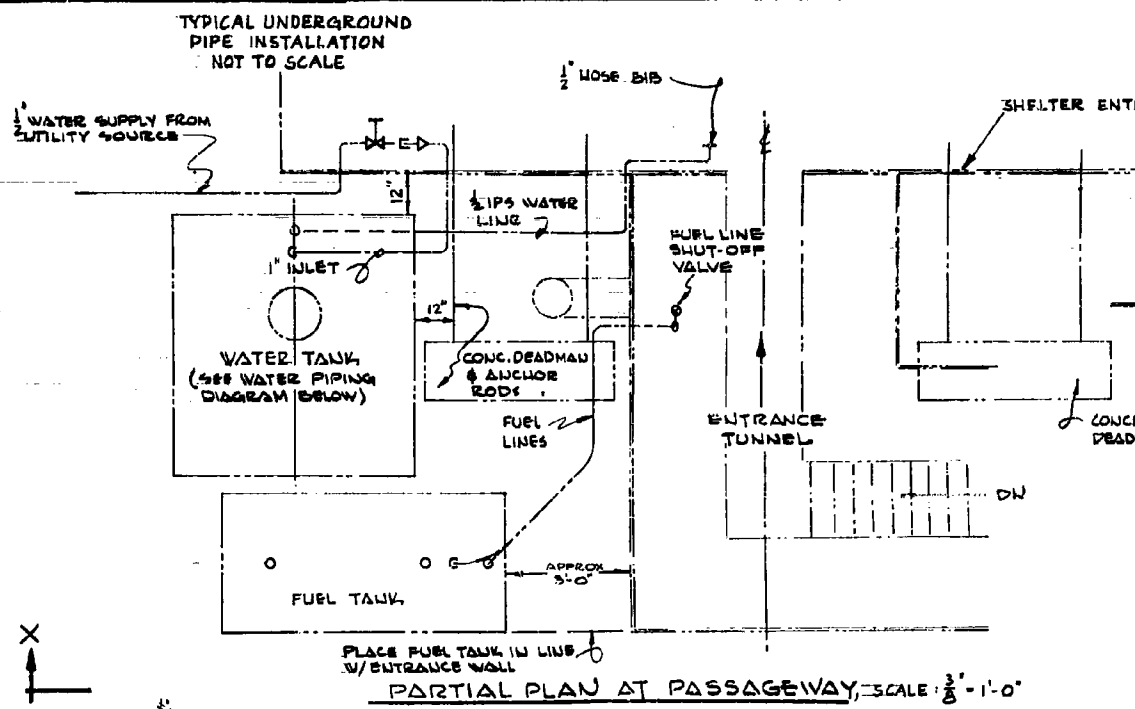
4

WATER TANK	
PKG NO	CAPACITY (GAL)
A	1000
B	1500
C	1500

ENGINEERING & DESIGN
IS APPROVED BY: OX



FUEL LINES
PLANKS



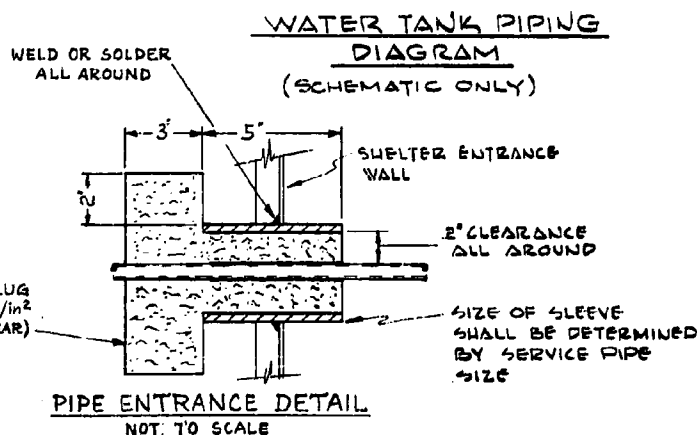
NOTES:

1. ENTRY OF ALL PIPES INTO SHELTER WITH DETAILS SHOWN IN PIPE ENTRY DETAIL.
2. PRIOR TO BACKFILLING AROUND TANK, TEST THE TOTAL GAS & WATER TIGHTNESS BY PRESSURIZING TO 5 LBS/SQ. IN. WITH AIR AT THIS PRESSURE, AND LEAKS MUST BE REPAIRED AND THE SYSTEM RE-TESTED.
3. THE WATER TANK COMPLETE WITH DISINFECTED WITH CHLORINE BLEACH SOLUTION. THE AMOUNT OF CHLORINE SUCH AS TO PROVIDE A DOSAGE OF 100 PPM. FOLLOWING A CONTACT TIME OF MORE THAN 8 HOURS, THE HEAVILY CONTAMINATED WATER MUST BE FLUSHED OUT WITH CLEAN WATER AND PLACED IN SERVICE.

5

TANK SCHEDULE	
CAPACITY (GAL)	APPROX. DIM.
1000	4'-6" DIA x 8'-6"
1500	75 1/2" DIA x 82"
1500	75 1/2" DIA x 82"

ENGINEERING & DESIGN
DRAWN BY: *[Signature]* DATE: 2/1/68



REVISION	DATE	DESCRIPTION

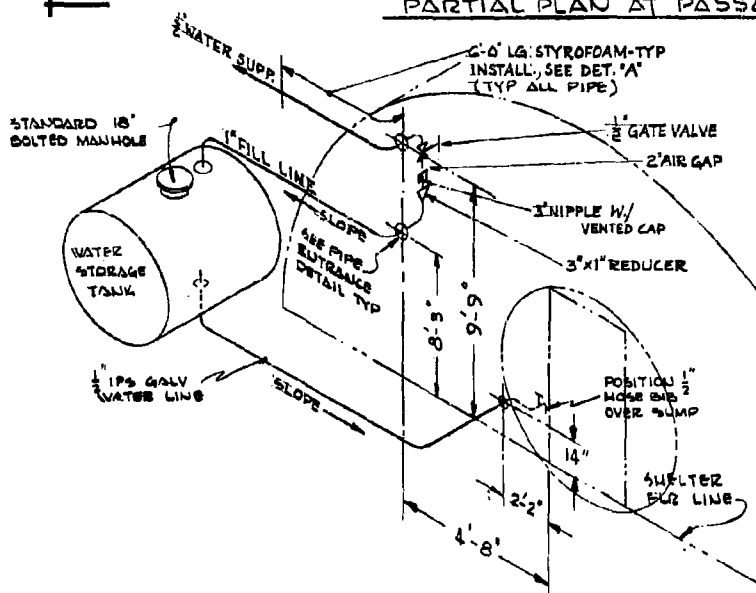
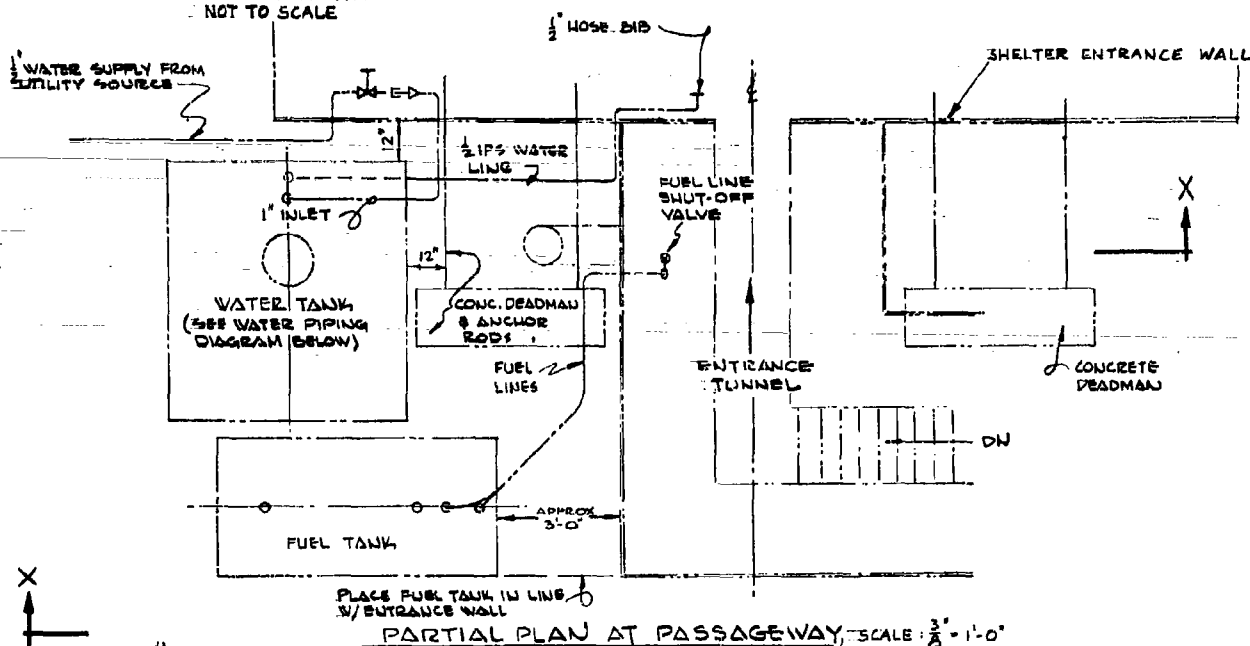
UNITED STATES
NAVAL RADIOLOGICAL
SAN FRANCISCO 24

DRAWN	FJA	DATE
CHECKED	FJA	
SCOPE APPROVED	FJA	
PROJ. ENGR.		
SUPVR.		
BRANCH HEAD		
DIVISION HEAD		

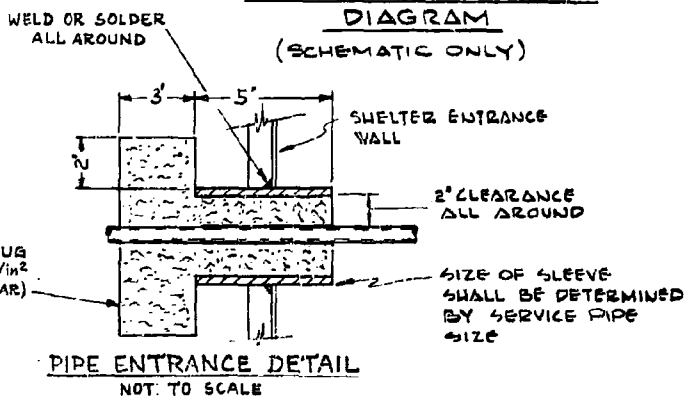
WATER

SCALE

TYPICAL UNDERGROUND
PIPE INSTALLATION
NOT TO SCALE



**WATER TANK PIPING
DIAGRAM**
(SCHEMATIC ONLY)



NOTES:

1. ENTRY OF ALL PIPES INTO SHELTER IS TO BE IN ACCORDANCE WITH DETAILS SHOWN IN PIPE ENTRANCE DETAIL ON THIS DRAWING.
2. PRIOR TO BACKFILLING AROUND TANKS, THE CONTRACTOR IS TO TEST THE TOTAL GAS & WATER TANK-PIPE SYSTEM BY AIR PRESSURIZING TO 5 LB/SQ. IN. NEITHER SYSTEM SHALL LEAK AIR AT THIS PRESSURE, AND LEAKS DISCLOSED BY THIS TEST SHALL BE REPAIRED AND THE SYSTEM RETESTED.
3. THE WATER TANK COMPLETE WITH PIPING SHALL BE THOROUGHLY DISINFECTED WITH CHLORINE BEFORE BEING PLACED IN OPERATION. THE AMOUNT OF CHLORINE APPLIED SHALL BE SUCH AS TO PROVIDE A DOSAGE OF NOT LESS THAN 50 PARTS PER MILLION. FOLLOWING A CONTACT PERIOD OF NOT LESS THAN 6 HOURS, THE HEAVILY CHLORINATED WATER SHALL BE FLUSHED OUT WITH CLEAN WATER AND THE SYSTEM PLACED IN SERVICE.

6

REVISION	DATE	DESCRIPTION	BY	APP.
UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY SAN FRANCISCO 24, CALIFORNIA				
DRAWN	FJA	DATE		
CHECKED	FLA			
SCOPE APPROVED	FLA			
PROJ. ENGR.				
SUPVR.				
BRANCH HEAD				
DIVISION HEAD				
FIG. A-17M WATER & FUEL TANKS			SCALE	PROJECT
DRAWING NUMBER S-62-970			TECH. MEMO.	ALT.
SHEET 19 OF 19				

APPENDIX B

COST TABLES

Table 1
MATERIAL AND LABOR COSTS BY ITEM FOR BASIC-SHELTER PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR-1959 ^a			MATERIAL AND LABOR COSTS-1962 ^a			
				Unit Labor- Req. Man- hours	Hourly Rate	Material and Labor Unit Cost (\$: Mat./Lab.)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (\$: Mat./Lab.)		
								1	10	100- 1,000
1	Multi plate steel arch 12 gage - 10 psi	Armed Drainage and Metal Products Inc. Youngstown, Ohio or U.S. Steel Corp. Amer. Bridge Div. Pittsburgh, Pa.	(25' - 0" Span by 11'- 8 1/2" Rise and 48' long)					2662/	2662/	2662/
2	Multi plate steel arch 10 gage - 35 psi	"	"			2550/		3127/	3127/	3127/
3	Front endwall, steel 3 gage	"	Fig. A-3M and A-5M			672/		1379/	1259/	955/
4	Rear endwall, steel 3 gage	"	"			608/		1253/	1144/	870/
5	Rear and front endwall bracing (includes steel rods)	General Contractor	Fig. A-3M	41	3.375	114/138	3.98	114/64	114/62	100/57
6	Foundation and dead men	"	Sidewall detail type 1, Fig. A-2M-1. Endwall type 4, Fig. A-2M-2.	44	3.41	245/150	4.07	245/179	203/175	200/155
7	Floor slab complete with drain trough and hump	"		26.6	3.38	175/90	3.98	175/106	170/104	164/104
8	Expansion joint filler	"		5.1	3.34	16/17	3.92 ^a	8/15	7/14	6/10
										5/6

^a Material costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs-material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

Table 2
UNIT COST DIFFERENTIALS FOR BASIC-SHELTER PACKAGE ITEMS
(See Table 1)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 1		
1		225/	266	+ 437/	Cost rise is due to increase in cost of labor for fabrication of the item and its transportation.
2	2590/		3227/	+ 577/	"
3	672/		1379/	+ 707/	Cost rise in due to expense gained by the fabricator in producing the snowall for the Camp Parks prototype shelter.
4	606/		1253/	+ 845/	"
5	114/138		116/84	/ - 74	Labor cost reduction is due to (a) a redesign of the support brackets that tie the vertical struts to the horizontal struts; (b) the shaping of the horizontal struts.
6	245/150		245/179	/ + 29	Labor cost increase is due to wage increase.
7	175/90		175/106	/ + 16	"
8	16/17		8/15	- 8/ - 2	Material cost reduction is due to redesign of expansion filler. Labor cost reduction is due to reduced labor cost resulting from design modifications.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

TABLE 3

1962 SUMMARY COSTS FOR BASIC-SHEETER PACKAGES

NO. S-1 (10 psi)

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	2662	2662	2662	2662
3	1	1379	1259	955	820
4	1	1253	1144	870	748
5	1	178	176	157	138
6	1	424	378	355	307
7	1	282	274	268	258
8	1	23	21	16	11
TOTAL Average Cost Per Package (\$)		6201	5914	5283	4944

NO. S-2 (35 psi)

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
2	1	3127	3127	3127	3127
3	1	1379	1259	955	820
4	1	1253	1144	870	748
5	1	178	176	157	138
6	1	424	378	355	307
7	1	282	274	268	258
8	1	23	21	16	11
TOTAL Average Cost Per Package (\$)		6666	6379	5748	5409

Table 4
MATERIAL AND LABOR COSTS BY ITEM FOR ENTRANCE PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR-1952 ^a			MATERIAL AND LABOR COSTS - 1962 ^b				
				Unit Labor Req'd.	Hourly Rate	Material and Labor Unit Cost (\$-Mat./Labor)	Cost Per Unit in Quantities Indicated (#) Material/Labor				
							1	10	100	1,000	
1	Corrugated steel 84" diameter conduit - 12 gage (10 psi) complete with elbow endwall ring, connecting band and inner liner (semi-buried and buried configuration)	Armco Drainage and Metal Products, Inc.	Fig. A-4 and A-5				89c/	890/	890/	890/	
2	Same as Item 1 except for above ground configuration.						1040/	1040/	1040/	1040/	
3	Corrugated steel 84" diameter conduit - 10 gage (35 psi) complete with elbow endwall ring, connecting band and inner liner.					700/	1050/	1050/	1050/	1050/	
4	Endwall entrance door with frame in place. Complete with weather strip	Emco Plywood Co. 922 19th Ave. Oakland, Calif.	Fig. A-5M	5	3.37	29/17	3.98	14/20	13/20	12/19	11/16
5	Dished head, bulkhead with door locking device (35 psi) material 5/16" thick steel	Lukens Steel Co. Coatsville, Penn.	Fig. A-4M		3.85	307/100	4.60	206/120	165/119	144/113	130/84

^aMaterial costs are P.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs--material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

(Table Continues)

Table 4 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR ENTRANCE PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR-1959 ^a			MATERIAL AND LABOR COSTS-1962 ^b				
				Unit Labor Req. man-hours	Hourly Rate	Material and Labor Unit Cost (\$: Mat./Lab.)	Labor Hourly Rate	Cost per Unit in Quantities Indicated (\$: Mat./Lab.)			
								1	10	100	1,000
6	Dished head, bulkhead with door-locking device (10 psi), material-1/4" thick steel	W.R. Cole Co. Oakland, Calif. Lukens Steel Co. Coatsville, Penn.	Fig. A-4M		3.85		4.60	177/120	140/119	122/113	116/84
7	Blast door complete with handle and hinges installed (10 psi)	Gen. Veneer Mfg. Co. 8652 Otis St. So. Gate, Calif.	Fig. A-4M					142/30	91/30	67/30	56/28
8	Blast door complete with handle and hinges installed (35 psi)		Fig. A-4M	7	3.85	150/30	4.60	150/36	101/36	75/36	63/31
9	Steps and hand rail completely installed in entrance tube	General Contractor	Fig. A-4M	13	3.37	29/44	3.98	32/44	32/39	28/37	28/28
10	Concrete walkway in entry tube (buried and seal-buried configuration)	"	Fig. A-4M	1.8	3.37	11/6	3.97	6/6	6/6	4/5	4/5
11	Same as Item 10 except for above ground configuration	"	"					18/12	18/12	12/8	12/8

Table 5
UNIT COST DIFFERENTIALS FOR ENTRANCE-PACKAGE ITEMS
(See Table 4.)

Item No.	One-off Item Cost (Material/Labor)		Net Unit Cost Differential* (Net./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractors	Estimate In Ref. 1	1962 From Table 4	
1		510/	890/	+ 380/
2		690/	1040/	+ 350/
3	700/		1090/	+ 390/
4	83/17		14/20	- 15/ + 3
5	307/100		206/120	- 101/ + 20
6		180/100	177/120	- 3/ - 20
7		142/25	142/30	1 + 5
8	150/30		150/36	1 + 6

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost over its cost in 1959.

(Table continues)

Table 5 (Continued)
UNIT COST DIFFERENTIALS FOR ENTRANCE-PACKAGE ITEMS
(See Table 4)

Item No.	One-off Item Cost (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 4		
9	29/44		32/44	+ 3/	Increase in material cost is due to increased cost of fabrication labor.
10	11/6		6/6	- 5/	Decrease in material cost is due to error in contracting cost.
11		7/5	18/12	+ 11/ + 6	Increase in material and labor cost is due to error in Ref. 1 costing.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 6 (Continued)
1962 SUMMARY COSTS FOR ENTRANCE PACKAGES

NO. E-1B

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
2	1	1040	1040	1040	1040
4	1	34	33	31	27
6	1	297	259	235	200
7	1	147	96	72	60
11	1	30	30	20	20
TOTAL Average Cost Per Package (\$)		1548	1458	1398	1347

NO. E-2

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
3	1	1050	1050	1050	1050
4	1	34	33	31	27
5	1	326	284	257	214
8	1	155	106	80	67
9	1	76	71	65	56
10	1	12	12	9	9
TOTAL Average Cost Per Package (\$)		1653	1556	1492	1423

(Table Continues)

TABLE 6 (Continued)
1962 SUMMARY COSTS FOR ENTRANCE PACKAGES
NO. E-1A

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	890	890	890	890
4	1	34	33	31	27
6	1	297	259	235	200
7	1	147	96	72	60
9	1	76	71	65	56
10	1	12	12	9	9
TOTAL Average Cost Per Package (\$)		1456	1361	1302	1242

Table 7
MATERIAL AND LABOR COSTS BY ITEM FOR VENT PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a				MATERIAL AND LABOR COSTS - 1962 ^a				
				Unit Labor Reqt.	Hourly Rate	Material and Labor Unit Cost (32 Mat./Labor)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (\$/Material/Labor)				
								1	10	100	1,000	
1	575 cfm at 0.2 in. w.g. blower with 1/7 HP Motor Single phase, 110 volt Model B-15	ITA Electric Ventilating Co., Illinois	Fig. A-6M					72/	72/	72/	56/	
2	975 cfm at 0.7 in. w.g. blower with 1/3 HP Motor Single phase, 110 volt Model B-18	"						119/	119/	119/	96/	
3	1600 cfm at 0.2 in. w.g. blower with 1/3 HP Motor Single phase, 110 volt Model B-122	"						152/	152/	152/	154/	
4	1600 cfm at 1.0 in. w.g. blower with 1/2 HP Motor Single phase, 110 volt Model B-122	"				235/		202/	202/	202/	172	
5	Absolute filter Ultra air space filter rated at 99.97% efficiency on the 0.3 micron dia. 102 test at 1000 SCFM at 0.9 in. w.g.	Kline Safety Appliances Co. 201 Braddock Ave., Pittsburgh 5, Pa.				35/		57/	52/	52/	31/	
6	Combustion filter support, transition duct and blower base (675 cfm system)	General contractor					2.00	49/97	45/91	38/58	47/36	
7	Combustion filter support, transition duct and blower base (1600 cfm system)	"		23	3.85	52/89		1106	54/105	53/77	52/41	
8	Just work from vent fan duct to center line of shelter complete ready to accept diffuser (675 cfm)	"					3.315	8/69	8/69	8/67	8/55	

^aMaterial costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs—material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

(Table Continues)

Table 7 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR VENT PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR-1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a				
				Unit Man-hours	Labor Req'd. Hourly Rate	Material and Labor Unit Cost (\$)/Mat'l./Labor	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (3) Material/Labor			
								1	10	100	1,000
9	Same as for item No. 8 above except duct system is for 1600 cfm	General Contractor	Fig. A-6M	18	3.60	12/65	4.315	12/78	12/78	12/76	12/62
10	Diffuser (675 cfm) equivalent to Titus Model S-277-6" x 12"	The Titus Mfg.Co. Waterloo, Iowa	"				"	9/2	9/2	5/2	5/1
11	Diffuser (1600 cfm) equivalent to Titus Model S-277 8" x 30"	"	"			17/1	"	17/2	17/2	11/2	11/1
12	2 Ton Air conditioning unit equivalent to Pedders Model C-924A-3 complete with mounting springs, control act.	Pedders Corporation Maspeth 76, New York	Fig. A-9M				"	453/	453/	372/	321/
13	Exhaust ventilator fixed -10 psi	General Contractor	Fig. A-7M				4.60	110/53	102/53	96/52	96/43
14	Retractable ventilator 35 psi	Tanner Welding Co. 888 Folsom St. San Francisco, Calif.	"	26	3.60	92/100	"	105/73	99/73	92/70	92/58
15	Installation of air conditioner complete with ducting	General Contractor	Fig. A-9M				4.315	40/74	40/74	40/70	40/51
16	Intake ventilator 10 psi or 35 psi	General Contractor	Fig. A-4M		3.85	17/42	4.60	17/51	15/50	14/56	14/41
17	Base for 675 cfm blower		Fig. A-6M					9/16	9/16	9/12	9/7
18	Base for 1600 cfm blower		"					10/19	10/19	10/14	10/8

Table 8
UNIT COST DIFFERENTIALS FOR VEET PACKAGE ITEMS
(See Table 7)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differential: as when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available from General Contractor	Estimate in Ref. 1		
1		178/	71/	- 107/
2		182/	119/	- 63/
3		224/	185/	- 39/
4	238/		202/	- 36/
5	55/		67/	+ 12/
6		52/103	49/97	- 3/- 6
7	52/89		56/106	+ 4/+ 17
8		5/50	8/69	+ 3/+ 19
9	12/65		12/78	0/ + 13
10		9/2	9/2	
11	17/1		11/2	0/ + 1

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 8 (Continued)
UNIT COST DIFFERENTIALS FOR WEST PACKAGE ITEMS
(See Table 7)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate 1: Ref. 1 1962 From Table 7		
12		100/	453/	Cost increase in material is due to an increase in sales price by the manufacturer.
13		10/0	110/53	Increase in cost of labor is attributed to an error in costing as listed in Ref. 1.
14	92/100		105/73	The increase in cost for material and the decrease in cost for labor is the result of current cost study findings.
15		0/0	40/74	The increase in cost for the installation of this equipment is due to this item being inadvertently omitted from the estimate in Ref. 1.
16	17/42		17/51	The increase in cost for labor is the result of a rise in the fabrication wages.
17		0/0	9/16	The increase in cost for the installation of this equipment is due to this item being inadvertently omitted from the estimate in Ref. 1.
18		0/0	17/19	

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 9
1962 SUMMARY COST FOR VENT PACKAGES

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	72	72	71	58
3	1	77	77	75	63
10	1	11	11	7	6
13	1	163	155	148	139
16	1	68	65	64	55
17	1	25	25	21	16
TOTAL Average Cost Per Package (\$)		415	404	386	337

NO. V-1B

Item	No. Req'd	Average Labor and Material Cost Item			
		1	10	100	1000
2	1	119	119	119	96
5	1	67	61	58	41
6	1	146	140	116	83
8	1	77	77	75	63
10	1	11	11	7	6
13	1	163	155	148	139
16	1	68	65	64	55
TOTAL Average Cost Per Package (\$)		651	628	587	493

(Table Continues)

Table 9 (Continued)
1962 SUMMARY COST FOR VENT PACKAGES

NO. V-1C

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
3	1	185	185	185	154
9	1	90	90	88	74
11	1	19	19	13	12
12	1	453	453	372	321
13	1	163	155	148	139
15	1	114	114	110	91
16	2	136	130	128	110
18	1	29	29	24	18
TOTAL Average Cost Per Package (\$)		1189	1175	1168	919

NO. V-1D

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
4	1	202	202	202	172
5	2	134	122	116	82
7	1	162	159	130	93
9	1	90	90	83	74
11	1	19	19	13	12
12	1	453	453	372	321
13	1	163	155	148	139
15	1	114	114	110	91
16	2	136	130	128	110
TOTAL Average Cost Per Package (\$)		1473	1444	1307	1094

(Table Continues)

NO. V-2A

Table 9 (Continued)
1962 SUMMARY COST FOR VENT PACKAGES

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	71	71	71	58
8	1	77	77	75	63
10	1	11	11	7	6
14	1	189	172	162	150
16	1	68	65	64	55
17	1	25	25	21	16
TOTAL					
Average Cost Per Package (\$)		430	421	400	346

NO. V-2B

(Table Continues)

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
2	1	119	119	119	96
5	1	67	61	58	41
6	1	146	140	116	83
8	1	77	77	75	63
10	1	11	11	7	5
14	1	178	172	162	150
16	1	58	65	64	55
TOTAL					
Average Cost Per Package (\$)		666	645	601	494

Table 9 (Continued)
1962 SUMMARY COST FOR VENT PACKAGES

NO. V-2C

Item	No. Req'd	Average Labor and Material Cost Per Item				
		1	10	100	1000	
3	1	185	185	185	185	154
9	1	90	90	88	74	74
11	1	19	19	13	12	12
12	1	453	453	372	321	321
14	1	178	170	162	150	150
15	1	114	114	110	90	90
16	2	136	130	123	110	110
18	1	29	29	24	18	18
TOTAL		1204	1192	1082	930	

NO. V-2D

Item	No. Req'd	Average Labor and Material Cost Per Item				
		1	10	100	1000	
4	1	202	202	202	172	172
5	2	134	122	116	82	82
7	1	172	159	130	93	93
9	1	90	90	88	74	74
11	1	19	19	13	12	12
12	1	453	453	372	321	321
14	1	178	172	162	150	150
15	1	114	114	110	90	90
16	2	136	130	128	110	110
TOTAL		1488	1461	1321	1105	

Table 10

MATERIAL AND LABOR COSTS BY ITEM FOR HOTEL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a		MATERIAL AND LABOR COSTS - 1962 ^a					
				Unit Labor Hourly Rate	Material and Labor Unit Cost (\$/sq. ft./Labor)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (\$)				
				1	10	100	1,000				
1	Upper bunk rail support and upright floor bolus complete for Hotel Package "H-1." 95 bunks	General contractor	Fig. A-108	3.85	*158/134	4.60	42/50	40/46	40/46	35/32	
2	Upper bunk rail support and upright floor bolus complete for Hotel Package "H-2." 43 bunks	"	"				21/25	20/23	20/23	18/16	
3	Upper bunk rail support and upright floor bolus complete for Hotel Package "H-3." 32 bunks	"	"				15/17	14/16	14/16	12/11	
4	Box sheets complete for Hotel Package "H-1." 96 bunks	"	"	3.75	*397/205	4.00	167/202	166/197	159/176	121/102	
5	Box sheets complete for Hotel Package "H-2." 48 bunks	"	"				84/101	83/99	80/85	64/51	
6	Box sheets complete for Hotel Package "H-3." 32 bunks	"	"				56/68	56/66	53/57	41/34	
7	Upright support for bunks complete - Hotel Package "H-1." 96 bunks	"	"	26	3.45	*178/131	4.60	106/152	185/144	185/144	166/103
8	Upright support for bunks complete - Hotel Package "H-2." 48 bunks	"	"				98/79	93/74	93/74	83/52	
9	Upright support for bunks complete - Hotel Package "H-3." 32 bunks	"	"				65/53	62/50	62/49	56/34	
10	Box poles (horizontal) complete - Hotel Package "H-1." 96 bunks	"	"		*154/162		185/20	173/18	173/18	156/13	

^a This price represents cost (per item listed) for 96 bunks, the design of which is shown in Fig. 3-66.

^a Material costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs--material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco--for detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report. (Table Continues)

Table 10 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR HOTEL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^b				
				Unit Labor Man- hours	Hourly Rate	Material and Labor Unit Cost (\$ Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$ Material/Labor)			
								1	10	100	1,000
11	Bank poles (horizontal) complete - Hotel Package "B-2" 48 bunks	General Contractor	Fig. A-10N					91/10	87/9	87/9	78/7
12	Bank poles (horizontal) complete - Hotel Package "B-3" 32 bunks	"	"					61/7	58/6	58/6	52/5
13	Table with two benches complete	Montgomery Ward & Co.	Fig. A-9M			57/		35/	35/	34/	28/
14	Step ladder - 8 foot	"	"			12/		12/	12/	12/	10/
15	Toilet tank - 415 gallon (one unit)	Rheem Mfg. Co. Richmond, Calif. or Butler Mfg. Co. Richmond, Calif.	Fig. A-11M			256/		183/	158/	141/	140/
16	Toilet tank platform with steps (one unit)	General contractor	"	3	3.32	24/10	3.95	12/8	12/8	12/8	12/6
17	Toilet curtains complete (one unit)	Stuart-Seiber Co. 100 Utah Ave. South San Francisco or Sullivan Co. 245 South Van Ness Ave. San Francisco.	"	6	"	40/20	"	10/16	10/16	10/16	10/11
18	Toilet Seat-Installed (one unit)	Montgomery Ward & Co.	"		3.62	4/1	4.315	3/1	3/1	3/1	3/1
19	Toilet 4" Vent hose completely installed (for one tank)	Plumbart Co. 100 Park Ave. New York	"		"	35/5	"	18/3	18/3	16/2	15/2
20	Toilet vent 4" "I" connection	McMaster Car Supply Co. Chicago	"			10/1		3/1	3/1	3/1	3/1

(Table Continues)

Table 10 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR IRRIG. PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1979 ^a		MATERIAL AND LABOR COSTS - 1966 ^b				
				Unit Labor Req. - Hourly Rate	Material and Labor Unit Cost (\$/unit./labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$)			
							1	10	100	1,000
21	Toilet chemical, limesteel or equal per gallon	West Chemical Product Co., 1490 - 66th St., Berkeley, Calif.			3/		3/	3/	3/	2/
22	1000 gallon water tank	Rosen Mfg. Co., Richmond, Calif. or Butler Mfg. Co., Richmond, Calif.	Fig. A-17M				250/	232/	215/	144/
23	1500 gallon water tank	"	"		489/		400/	395/	345/	222/
24	Water piping complete less the utility connection	General contractor	"	4.05	18/24	4.93	18/30	18/30	18/29	18/24
25	Pump and kit complete.	"			11/		19/	19/	19/	19/
26	Electric lantern with two batteries.	Montgomery Ward & Co.			3/		6/	6/	5/	4/
27	Flashlight complete with two batteries.	"			1/		2/	1/	2/	1/
28	Blanket-wool 3/4 bed size	"			5/		9/	9/	9/	7/
29	14" adjustable pipe wrench	"			4/		4/	4/	4/	3/
30	Steel sledge 8 pound	"					5/	5/	5/	4/

(Table Continues)

Table 10 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR HOTEL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a		MATERIAL AND LABOR COSTS - 1962 ^a			
				UNIT LABOR Man- hours	Rate	Material and Labor Unit Cost (\$/Unit./Labor)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (\$/Material/Labor)	
								1	10
31	Round point shovel.	Montgomery Ward & Co.						3/	3/
32	Wrecking bar four feet long	Wheeler Co. Chicago, Ill.						7/	7/
33	Roll-Toilet paper- One roll	Baker/Hamilton San Francisco, Calif.						0.14/	0.14/
34	Toilet seat covers (1 pack)	"	200 covers per pack					0.14/	0.14/
35	Insecticide - 1007	"	Baker Hamilton (Cat. No. 222751)					0.64/	0.64/
36	Paper towels (1 carton)	"	(6.875 per carton)					1/	1/
37	Disposable wash-cloths (1 cloth)	R.B. Williams Inc. Canaan, Conn.						4/	4/
38	Broom	Montgomery Ward & Co.						0.023/	0.023/
39	Misc. recreational equip- ment - includes playing cards, games and paperback books (Lot.)							1.3/	1.3/
								7/	7/

(Table Continues)

Table 10 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR HOTEL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR REQUIREMENTS - 1954			MATERIAL AND LABOR COSTS - 1962 b				
				Unit Labor Req't.		Material and Labor Unit Cost (\$/sec./labor)	Labor as Indicated	Total Price Per Unit in Quantities as Indicated (\$)			
				Man-hours	Hourly Rate			1	10	100	1,000
40	Food allowance--same as listed in Appendix C of Ref. 1						700	700	700	700	
41	Refuse bags, Reg. 24 x 72 x .0025 thick, two bags per unit						0.28	0.28	0.28	0.22	
42	Detergent, pow. Gen. use one per unit						1/	1/	1/	1/	
43	Sauce pan. Aluminum, one per unit	Dunham Garble., and Haydon	(Mirror No. 4234-3 qt., capacity .18 gage)				2/	2/	1/	1/	
44	Hot plate, elect., one per unit	Barnstead Mfg. Div. of McGraw Edison Co.	(Two-burner, total wattage 1600.)				7/	5/	5/	4/	
45	Immersion Heater, one per unit	Arthur H. Thomas Co.	(250 watt, 115 volts.)				5/	5/	3/	3/	
46	Ball, one per unit	Montgomery Ward and Co.	(10 qt. metal-rust-resistant)				1/	1/	1/	1/	
47	Plastic cups, disposable, 200 cups per unit	Zellerbach Paper Co., Special Div.	(Commercial grade)				3/	3/	2/	1/	

(Table Continues)

Table 10 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR HOTEL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR REQUIREMENTS - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^b			
				Unit Labor Req't.	Material and Labor Unit Cost (\$/Mat./Labor)	Labor Hourly Rate	Labor Hourly Rate	Total Price Per Unit as Indicated	Material	Labor
				Man-hours	Hourly Rate	1	10	100	1,000	
48	Waterless hand cleaner, 1 gal.	Hanlon Chem.Co., Oakland, California						3/	3/	2/
49	Plastic soup spoons, 1000 each	Crest Sales Co., San Francisco, Calif						7/	6/	6/
50	Paper food plates, 8", 1000 each	"						9/	8/	7/
51	Disposable diapers, 6 doz.	Montgomery Ward and Co.						3/	3/	2/
52	Sanitary napkins, 8 doz.	"						3/	3/	2/

^a Material costs listed are F.O.B. San Francisco. The material cost includes labor and material in the event the specific item is presently mass-produced by a manufacturer. The labor prices for 1959 are actual costs reported by the general contractor who was responsible for the construction of the Camp Parks Shelter located at Pleasanton, California. Item costs marked with an * were modified because contractor data was found to be incorrect.

^b Labor and material prices have been adjusted to 1962 costs where necessary.

Table 11
UNIT COST DIFFERENTIALS FOR ROYAL PACKAGE ITEMS
(See Table 10)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available from General Contractor	Estimate in Ref. 1	1962 Price Table 10		
1	158/134		42/90	- 116/- 84	The decrease in material cost is the result of: (1) design changes; (2) correcting error made by the contractor in costing material. The decrease in labor cost is the result of design changes.
2	79/67		21/25	- 58/- 42	
3	53/45		15/17	- 39/- 28	
4	397/206		167/202	- 230/- 4	The decrease in material cost is the result of deleting the requirement for the bulk to be fabricated from plastic sheeting. The decrease in labor cost is the result of less labor requirement to fabricate the bulk free canvas instead of plastic material.
5	199/103		84/101	- 115/- 2	"
6	133/70		56/68	- 77/- 2	"
7	378/131		196/159	- 182/+ 28	The decrease in material cost is the result of: (1) design changes; (2) correcting error made by the contractor in costing material. The increase in labor is the result of wage increases to labor.
8	139/65		98/79	- 91/+ 14	

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 11 (Continued)
UNIT COST DIFFERENTIALS FOR HOTEL PACKAGE ITEMS
(See Table 10)

Item No.	One-off Item Cost (Material/Labor)		Net Unit Cost Differential (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1 1962 From Table 10		
9	126/45		65/53	The decrease in material cost is the result of: (1) design changes; (2) correcting error made by the contractor in costing material. The increase in labor is the result of wage increases to labor.
10	154/162		183/20	The increase in material cost is the result of design changes. The decrease in labor cost is the result of design changes.
11	76/81		91/10	
12	52/55		61/7	
13	57/		35/	The decrease in cost is the result of table and bench design changes.
14	12/		12/	
15	256/		185/	The decrease in cost is the result of tank design changes.
16	24/10		12/8	The decrease in cost is the result of design changes.
17	40/20		10/16	The decrease in material cost is the result of deleting the requirement for plastic curtains and miscellaneous other changes. The decrease in labor cost is the result of less labor required to fabricate canvas curtains in place of plastic.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 11 (Continued)
UNIT COST DIFFERENTIALS FOR HOUSE PACKAGE ITEMS
(See Table 10)

Item No.	One-Off Item Cost* (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate In Ref. 1	1962 From Table 10		
18	4/1		3/1	- 1/	The decrease in material cost is the result of locating a supplier having greater learning experience in the fabrication of the item.
19	35/5		13/3	- 11/- 2	The decrease in material cost is the result of locating a supplier having greater learning experience in the fabrication of the item. The decrease in labor cost is the result of installation requirements for the purchased item being minimized.
20	10/1		3/1		
21	3/		3/		
22		255/	230/	- 15/	The decrease in cost is the result of design modifications to the tank.
23	489/		400/	- 89/	The cost reduction is the result of design changes that provide for the installation of tanks that are standard with the supplier.
24	18/34		18/30	1 + 6	The increase in the cost of labor is the result of labor wage increases.
25	11/		19/	+ 2/	The increase in cost of the kit is the result of general increases in basic labor and material req'd.
26	3/		6/	+ 3/	The increase in the cost reflects additional funds that are required to purchase the item from retail outlets rather than from Federal stock.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 11 (Continued)
UNIT COST DIFFERENTIALS FOR HOEL PACKAGE ITEMS
(See Table 10)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate In Ref. 1	1962 From Table 10		
27	1/		1/		
28	5/		9/	+ 4/	The increase in cost reflects additional funds that are required to purchase the item from retail outlets rather than from Federal stock.
29	4/		4/		
30		0/	5/	+ 5/	This item has been added as it was inadvertently left off Ref. 1 material list.
31		2/	3/	+ 1/	As a result of this investigation the square pointed shovel (Ref. 1) has been replaced with a round pointed shovel.
32		1/	7/	+ 6/	This item has been changed from a small 18" wrecking bar to that of a four foot bar.
33		0.085/	0.14/	+0.055/	The increase in cost reflects additional funds required to purchase the item from retail outlets rather than from Federal stock.
34		0.64/	0.64/		
35		1/	1/		
36		1.60/	4/	+ 2.40/	The increase in cost reflects additional funds required to purchase the item from retail outlets rather than from Federal stock.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 11 (Continued)
UNIT COST DIFFERENTIALS FOR HOTEL PACKAGE ITEMS
(See Table 10)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (notified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1 1962 From Table 10		
37		0.83/	0.23/	
38		0.89/	1.3/	+ 0.41/ The increase in cost reflects additional funds required to purchase the item from retail outlets rather than from federal stock.
39		0/	7/	+ 7/ This item has been added as a result of HMDL habitable test findings.
40		700/	700/	Detailed information regarding the status of current similar food research is not available. Costing listed in Ref. 1 has been specified without change.
41		0.20	0.28/	+0.08/ The increase in cost reflects additional funds required to purchase the item from retail outlets rather than from federal stock.
42		0.18/	1/	+ 0.12/
43		1.60/	2/	+ 0.10/
44		7/	7/	
45		4.80/	5/	+ 0.20/ The increase in material cost is the result of rise in cost for item
46		1.13/	1/	- 0.13/ The decrease in cost for the item is the result of locating a minimum cost supplier.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 11 (continued)
UNIT COST DIFFERENTIALS FOR HONEY PACKAGE ITEMS
(See Table 10)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 10		
47		3/	3/		
48		0/	3/	+ 3/	
49		0/	7/	+ 7/	
50		0/	9/	+ 9/	
51		0/	3/	+ 3/	
52		0/	3/	+ 3/	

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 12
1962 SUMMARY COSTS FOR HOTEL PACKAGES

NO. E-1A

NO. E-1B

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
1	1	92	86	86	68
4	1	369	363	329	223
7	1	355	333	333	269
10	1	203	191	191	169
13	1	35	35	34	28
14	1	12	12	12	10
15	1	183	158	141	140
16	1	20	20	20	18
17	1	26	26	26	22
18	1	8	8	8	8
19	1	21	21	18	17
21	1	21	6	6	6
22	1	250	232	215	144
24	1	48	48	47	42
25	1	19	19	19	19
27	1	1	1	1	1
29	1	4	4	4	4
30	1	5	5	5	5
31	1	5	5	5	5
32	1	7	7	7	7
33	1	13	11	11	11
34	1	10	10	9	9
35	1	10	10	10	8
36	1	2	2	2	1
38	1	700	700	700	700
40	1	3	5	5	5
41	1	5	5	5	5
42	1	38	38	25	13
43	1	6	6	5	5
44	1	14	14	12	12
45	1	18	18	16	14
47	1	24	24	21	21
49	1	21	21	21	14
51	1	21	21	21	14
52	1	21	21	21	14
TOTAL Average Cost Per Package (\$)		2532	2441	2348	2015

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
1	1	92	86	86	68
4	1	369	363	329	223
7	1	355	333	333	269
10	1	203	191	191	169
13	1	175	175	170	140
14	1	12	12	12	10
15	1	360	316	282	280
16	1	40	40	40	36
17	1	52	52	52	44
18	1	16	16	16	14
19	1	42	42	36	34
20	1	4	4	4	4
21	1	12	12	12	8
23	1	400	355	345	222
24	1	48	48	47	42
25	1	19	19	19	19
26	1	6	6	6	4
29	1	4	4	4	4
30	1	5	5	5	5
31	1	7	7	7	7
32	1	13	11	11	11
33	1	10	10	9	9
34	1	10	10	10	8
35	1	2	2	2	1
36	1	700	700	700	700
38	1	3	5	5	5
40	1	5	5	5	5
41	1	5	5	5	5
42	1	38	38	25	13
43	1	6	6	5	5
44	1	14	14	12	12
45	1	18	18	16	14
47	1	24	24	21	21
49	1	21	21	21	14
51	1	21	21	21	14
52	1	21	21	21	14
TOTAL Average Cost Per Package (\$)		3102	2999	2845	2420

(Table Continues)

Table 12 (Continued)
1962 SUMMARY COSTS FOR HOTEL PACKAGES

NO. B-1C

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
1	1	92	86	86	86
4	1	369	363	329	223
7	1	355	333	333	269
10	1	303	191	191	169
13	1	175	175	175	140
14	5	12	12	12	10
15	2	366	316	282	280
16	2	40	40	40	36
17	2	52	52	52	44
18	2	16	16	16	16
19	2	42	42	36	34
20	2	4	4	4	4
21	4	12	12	12	8
22	4	400	395	345	222
23	1	48	48	47	42
24	1	2	2	19	19
25	1	6	6	5	7
26	1	9	9	9	7
28	1	5	5	5	4
29	1	5	5	5	3
30	1	3	3	3	3
31	1	7	7	7	6
32	1	13	11	11	11
33	1	10	10	11	9
34	1	1	1	1	1
35	1	20	20	20	16
36	5	32	32	32	25
37	1400	2	2	1	1
38	1	7	7	7	6
39	1	700	700	700	700
40	1	4	4	4	4
41	15	5	5	5	5
42	5	8	8	8	8
43	1	7	7	7	7
44	1	1	1	1	1
45	25	76	76	50	26
46	4	12	12	10	10
47	4	28	28	24	24
48	4	36	36	32	28
49	4	24	24	24	16
50	8	21	21	21	14
51	7				
52					
TOTAL	Average Cost Per Package (\$)	3246	3191	2968	2533

NO. B-2A

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
2	1	46	43	43	34
5	1	185	182	165	112
8	1	177	167	167	132
11	1	101	96	96	82
13	1	35	35	34	28
14	1	12	12	12	10
15	1	183	158	141	141
16	1	20	20	20	18
17	1	26	26	26	21
18	2	8	8	8	8
19	1	21	21	18	17
20	1	6	6	6	4
21	2	250	232	215	144
22	1	48	48	47	42
23	1	19	19	19	19
24	1	4	4	4	4
25	1	5	5	5	5
27	1	3	3	3	3
29	1	7	7	7	6
30	1	13	11	11	11
31	1	10	10	10	9
32	1	1	1	1	1
33	1	2	2	2	2
34	1/2	700	700	700	700
35	1	5	5	5	5
36	1	38	38	35	31
37	1/2	12	12	12	12
38	2	6	6	6	6
39	2	14	14	13	13
40	2	18	18	16	16
41	2	24	24	21	21
42	2	21	21	21	21
43	2	21	21	21	21
44	2	21	21	21	21
45	2	21	21	21	21
46	2	21	21	21	21
47	2	21	21	21	21
48	2	21	21	21	21
49	2	21	21	21	21
50	2	21	21	21	21
51	2	21	21	21	21
52	2	21	21	21	21
TOTAL	Average Cost Per Package (\$)	2022	1956	1880	1646

(Table Continues)

Table 12 (Continued)
1962 SIMPACT COSTS FOR HOTEL PACKAGES

NO. B-2B

NO. B-2C

Item	No. d. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1,000
2	1	46	43	43	34
5	1	185	182	165	112
8	1	177	167	167	135
11	1	101	96	96	85
13	1	175	172	170	140
14	1	366	316	282	280
15	2	40	40	40	36
16	2	52	52	52	42
17	2	16	16	16	16
18	2	42	42	39	34
19	2	4	4	4	4
20	1	12	12	12	8
21	1	400	395	345	222
22	1	48	48	47	42
23	1	19	19	19	19
24	1	4	4	4	4
25	1	5	5	5	3
26	1	37	37	37	26
29	1	13	11	11	11
30	1	10	10	10	9
31	1	1	1	1	1
32	1	1	1	1	1
33	1	1	1	1	1
34	1	1	1	1	1
35	1	1	1	1	1
36	1	1	1	1	1
38	1	1	1	1	1
40	1	700	700	700	700
41	1	2	2	2	2
42	1	5	5	5	5
43	1	5	5	5	5
44	1	5	5	5	5
45	1	5	5	5	5
46	1	38	38	25	13
47	1	14	14	12	12
48	1	18	18	16	14
49	1	21	21	21	16
50	1	21	21	21	14
51	1	21	21	21	14
52	1	21	21	21	14
TOTAL		2594	2458	2380	2054
Average Cost Per Package (\$)					

Item	No. d. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1,000
2	1	46	43	43	34
5	1	185	182	165	112
8	1	177	167	167	135
11	1	101	96	96	85
13	1	175	172	170	140
14	1	366	316	282	280
15	2	40	40	40	36
16	2	52	52	52	42
17	2	16	16	16	16
18	2	42	42	39	34
19	2	4	4	4	4
20	1	12	12	12	8
21	1	400	395	345	222
22	1	48	48	47	42
23	1	19	19	19	19
24	1	4	4	4	4
25	1	5	5	5	3
26	1	37	37	37	26
29	1	13	11	11	11
30	1	10	10	10	9
31	1	1	1	1	1
32	1	1	1	1	1
33	1	1	1	1	1
34	1	1	1	1	1
35	1	1	1	1	1
36	1	1	1	1	1
38	1	1	1	1	1
40	1	700	700	700	700
41	1	2	2	2	2
42	1	5	5	5	5
43	1	5	5	5	5
44	1	5	5	5	5
45	1	5	5	5	5
46	1	38	38	25	13
47	1	14	14	12	12
48	1	18	18	16	14
49	1	21	21	21	16
50	1	21	21	21	14
51	1	21	21	21	14
52	1	21	21	21	14
TOTAL		2737	2652	2504	2151
Average Cost Per Package (\$)					

(Table Continues)

Table 12 (Continued)

1962 SUMMARY COSTS FOR HOTEL PACKAGES

NO. H-3A

NO. H-3B

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
3	1	32	30	30	23
6	1	124	122	110	75
9	1	118	112	111	90
12	1	68	64	64	57
13	1	35	35	34	28
14	1	12	12	12	10
15	1	183	158	141	140
16	1	20	20	20	18
17	1	26	26	26	22
18	1	8	8	8	8
19	1	21	21	18	17
21	1	6	6	6	6
22	1	250	232	215	144
24	1	48	48	47	42
25	1	19	19	19	19
27	1	4	4	4	4
29	1	5	5	5	5
30	1	3	3	3	3
31	1	7	7	7	7
32	100	13	11	11	11
33	15	10	10	9	9
34	1	1	1	1	1
35	2 1/2	10	10	10	8
36	1	2	2	1	1
38	1	700	700	700	700
40	1	2	2	2	2
41	7 1/2	5	5	5	5
42	1	38	38	35	31
46	12 1/2	6	6	5	5
47	2	14	14	13	13
48	2	18	18	16	16
50	8	24	24	21	21
51	7	21	21	21	14
52					
TOTAL Average Cost Per Package (\$)		1855	1796	1724	1531

Item	No. Req'd.	Average Labor and Material Cost Item			
		1	10	100	1000
3	1	32	30	30	23
6	1	124	122	110	75
9	1	118	112	111	90
12	1	68	64	64	57
13	1	35	35	34	28
14	1	12	12	12	10
15	1	183	158	141	140
16	1	20	20	20	18
17	1	26	26	26	22
18	1	8	8	8	8
19	1	21	21	18	17
21	1	6	6	6	6
22	1	250	232	215	144
24	1	48	48	47	42
25	1	19	19	19	19
27	1	4	4	4	4
29	1	5	5	5	5
30	1	3	3	3	3
31	1	7	7	7	7
32	100	13	11	11	11
33	15	10	10	9	9
34	1	1	1	1	1
35	2 1/2	10	10	10	8
36	1	2	2	1	1
38	1	700	700	700	700
40	1	2	2	2	2
41	7 1/2	5	5	5	5
42	1	38	38	35	31
46	12 1/2	6	6	5	5
47	2	14	14	13	13
48	2	18	18	16	16
50	8	24	24	21	21
51	7	21	21	21	14
52					
TOTAL Average Cost Per Package (\$)		2385	2214	2088	1821

(Table Continues)

Table 12 (Continued)

1962 SURVIVANT COSTS FOR HOTEL PACKAGES

NO. H-3C

Item	No. of Hotels	Average Labor and Material Cost Item			
		1	10	100	1000
3	1	32	30	30	23
6	1	12	122	110	75
9	1	118	112	111	90
12	1	68	64	64	57
13	1	35	35	34	28
14	1	12	12	12	10
15	2	366	316	282	260
16	2	40	40	40	36
17	2	52	52	52	42
18	2	16	16	16	16
19	2	42	42	39	34
20	4	4	4	4	4
21	4	12	12	12	18
22	4	400	385	345	222
23	1	48	48	47	42
24	1	12	12	12	18
25	1	12	12	12	18
26	1	12	12	12	18
27	1	12	12	12	18
28	1	12	12	12	18
29	1	12	12	12	18
30	1	12	12	12	18
31	1	12	12	12	18
32	1	12	12	12	18
33	1	12	12	12	18
34	1	12	12	12	18
35	1	12	12	12	18
36	1	12	12	12	18
37	1	12	12	12	18
38	1	12	12	12	18
39	1	12	12	12	18
40	1	12	12	12	18
41	1	12	12	12	18
42	1	12	12	12	18
43	1	12	12	12	18
44	1	12	12	12	18
45	1	12	12	12	18
46	1	12	12	12	18
47	1	12	12	12	18
48	1	12	12	12	18
49	1	12	12	12	18
50	1	12	12	12	18
51	1	12	12	12	18
52	1	12	12	12	18
TOTAL					
Average Cost Per Package (\$)		2423	2350	2208	1924

Table 13
MATERIAL AND LABOR COSTS BY ITEM FOR CONTROL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a				
				Unit Labor Per Hourly Rate	Material and Labor Unit Cost (\$/Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (3) Material/Labor				
							1	10	100		
1	AM Broadcast Receiver	Allied Radio 100 N. Western Ave. Chicago 80, Ill.	(A Tube-AC/DC 110-120V 50-60 cycle-plastic case)				8/	8/	3/	100	1,000
2	Citizens band 5 watt transceiver, 120 VAC, 50 to 60 cycles equivalent to vocalline complete model ED-27M complete with one crystal, microphone and microphone mounting clip less mobile mounting bracket-one channel.	Vocalline Corp. Old Saybrook, Conn.	(Vocalline Model ED-27M one channel - or equivalent)				123/	114/	106/		101/
3	Same as unit No. 2 above except transceiver is furnished with 4 crystals		"				129/	120/	112/		107/
4	Radiation measurement set. Consists of one dosimeter - range 0-120 x/hr 0-600 R and one dosimeter charger.	Heath Company Beacon Harbor, Mich.	Refer to Heath Catalog Supplement 80/02 Oct. No. GDR-341 (Not a kit)				26/	26/	26/		26/

^a Material costs are P.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs—material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Paris prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

(Table Continues)

Table 13 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR CONTROL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a				
				Unit Labor Part- hours	Hourly Rate	Material and Labor Unit Cost (\$/part./labor)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (%)			
								1	10	100	1,000
5	Antenna for 27M trans- ceiver complete with rigid transmission line; coax cable and opening with support fitting.	General contractor	Fig. A-14M	2	3.85	8/8	4.60	8/9	8/9	8/8	7/7
6	Periscope	Thinsley Lab Inc. Berkeley, Calif.	Fig. A-13M		--	4.90/		152/	145/	137/	60/
7	Periscope support fitting opening	General contractor	Fig. A-14M	6	3.85	8/24	4.60	8/28	8/28	8/27	7/22
8	Testmeter rod complete with opening and support fitting.	"	"	1	3.85	7/4		7/5	7/5	7/5	5/4
9	Antenna - AM Receiver complete with opening and support fitting.	"	"	2	3.85	8/8		8/9	8/9	8/8	7/7

Table 14
UNIT COST DIFFERENTIALS FOR CONTROL PACKAGE ITEMS
(See Table 13)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 13		
1	12		8/	- 4/	Cost decrease is the result of locating a least cost supplier.
2	105/		123/	+ 18/	The unit specified in Ref. 1 is no longer manufactured by the Vocaline Co. This unit was found to have an unstable transmitting frequency/oscillator, therefore the Federal Communication Commission restricted its use. In addition this unit did not have sufficient range. The unit specified as a result of this study has a reliable transmitting range of at least 2 miles where the terrain is hilly.
3	120/		129/	+ 9/	The increase in price is due to an error in Ref. 1.
4		18/	26/	+ 8/	Cost quoted in Ref. 1 were based on 1961 estimates. Current 1962 Bendix sales price is \$45.00. The cost listed in the cost of set being sold by Allied Radio and Heath Kit Co.
5	8/8		8/9	+1	Cost rise due to wage increase.
6	450/		152/	- 298/	Cost decrease is due to a redesign of this periscope.
7	8/24		8/28	+4	Cost rise due to wage increase.
8	7/4		7/5	+1	"
9	8/8		8/9	+1	"

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 15
1962 SUMMARY COSTS FOR CONTROL PACKAGES
No. C-1

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	8	8	8	8
9	1	17	17	16	14
TOTAL Average Cost Per Package (\$)		25	25	24	22

No. C-2

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	3	8	8	8
2	1	123	114	106	101
4	1	26	26	26	26
5	1	17	17	16	14
6	1	152	145	137	60
7	1	36	36	35	29
8	1	12	12	12	9
9	1	17	17	15	14
TOTAL Average Cost Per Package (\$)		391	375	356	261

Table 15
1962 SUMMARY COSTS FOR CONTROL PACKAGES
No. C-3

Item	No. Req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	8	8	8	8
3	1	129	120	112	107
4	1	26	26	26	26
5	1	17	17	16	14
6	1	152	145	137	60
7	1	36	36	35	29
8	1	12	12	12	9
9	1	17	17	16	14
TOTAL Average Cost Per Package (\$)		397	381	362	267

Table 16
MATERIAL AND LABOR COSTS BY ITEM FOR AUXILIARY-POWER PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a			
				Unit Labor Req'd. Man-Hours	Hourly Rate	Material and Labor Unit Cost (\$/Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$ Material/Labor)		
								1	10	1,000
1	1.2 KW Engine generator	Kohler Co. Kohler, Wisconsin D.W. Ogan & Sons, Inc. Minneapolis, Minn.	Fig. A-16M					305/	305/	282/
2	3 quarts of oil per unit, one spark plug wrench, one 8" screw driver, one 8" crescent wrench (2 week supply for 1.2 kw engine generator)	General contractor	"					4/	3/	3/
3	2 KW Engine generator	Kohler Co. Kohler, Wisconsin D.W. Ogan & Sons, Inc. Minneapolis, Minn.	"					295/	295/	243/
4	8 quarts of oil per unit, one spark plug wrench, one 8" screw driver, one 8" crescent wrench (2 week supply for 2 kw engine generator)	General contractor	"					4/	4/	3/

^aMaterial costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs--material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

(Table Continues)

Table 16 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR AUXILIARY-POWER PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1990 ^c		MATERIAL AND LABOR COSTS - 1962 ^d				
				Unit Labor Bkgt. Hourly Rate	Material and Labor Unit Cost (\$/Bkgt./Labor)	Labor Hourly Rate	Cost Per Unit in Quantities Indicated (\$)			
							1	10	100	1,000
5	3.5 KW Engine generator	Kohler Co. Kohler, Wisconsin D. W. Osan & Sons, Inc. Minneapolis, Minn.	Fig. A-164				475/	475/	441/	412/
6	6 quarts of oil per unit, one spark plug wrench, one 8" screw driver, one 8" crescent wrench (2 week supply for 3.5 kw engine generator)	General contractor	"				4/	4/	4/	3/
7	5 KW Engine generator	Kohler Co. Kohler, Wisconsin D. W. Osan & Sons, Inc. Minneapolis, Minn.	"				569/	569/	572/	530/
8	11 quarts of oil per unit, one spark plug wrench, one 8" screw driver, one 8" crescent, one pair pliers, one feeler gage set	General contractor	"				5/	5/	4/	4/
9	7.5 KW Engine generator complete with battery, cable, and battery box-Elco, Elgin	Kohler Co. Kohler, Wisconsin	"		1,103		893/	893/	893/	731/
10	11 quarts of oil per unit, one spark plug wrench, one 8" screw driver, one 8" crescent, one pair pliers, one feeler gage set	General contractor	"				5/	5/	4/	4/

(Table Continues)

Table 16 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR AUXILIARY-POWER PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a				
				Mat.- Hours	Unit Labor Hourly Rate	Material and Labor Unit Cost (\$:Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$: Material/Labor)			
								1	10	100	1,000
11	95 gal gas storage tk.	Reese Mfg. Co. Richmond, Calif.	Fig. A-17M					58/	53/	53/	53/
12	160 gal gas storage tk.	"	"								
13	270 gal-gas storage	"	"					61/	67/	62/	62/
14	390 gal-gas storage	"	"					71/	71/	65/	65/
15	620 gal-gas storage	"	"					76/	78/	73/	73/
16	Exhaust duct with butterfly closure, complete with raincap and 2' dia. exit pipe	Armac Drainage and Metal Products American Bridge	Fig. A-16M	5	3.85	308/	4.60	124/	124/	117/	117/
						168/17		159/30	147/30	145/30	136/29
17	Fuel piping complete with shut off valve, tank vent & filter	General contractor	Fig. A-17M	5	4.05	36/19	4.93	36/23	36/23	36/23	34/22
18	MOTOR generator foundation	"	Fig. A-16M	4	3.85	9/16	4.60	9/19	9/19	9/19	8/18
19	Engine exhaust	"	"	6	4.05	6/25	4.93	6/30	6/30	6/30	5/29

Table 17
UNIT COST DIFFERENTIALS FOR AIRCRAFT-POWER-PACKAGE ITEMS
(See Table 26)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 26	
1		355/	305/	- 50/ Engines generators listed to be furnished in Ref. 1 are electric starting and require an electric storage battery. The battery, with its associated cable and battery box, was inadvertently omitted from Ref. 1. The cost decrease listed reflects the cost differential between that specified in Ref. 1 and the cost for manually started units which have been specified to be used as a result of this study.
2		0/	4/	+ 4/ This item was inadvertently omitted from Ref. 1.
3		422/	295/	- 127/ Same remarks as presented for item 1.
4		0/	4/	+ 4/ Same remarks as presented for item 2.
5		494/	475/	- 19/ Same remarks as presented for item 1.
6		0/	4/	+ 4/ Same remarks as presented for item 2.
7		782/	589/	- 193/ Same remarks as presented for item 1.
8		0/	5/	+ 5/ Same remarks as presented for item 2.
9	1,103/		893/	- 110/ This cost reduction is based on cost data furnished by a different engine generator manufacturer.
10		0/	5/	+ 5/ Same remarks as presented for item 2.

*4 plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table continues)

Table 17 (Continued)
UNIT COST DIFFERENTIALS FOR AUXILIARY-POWER-PACKAGE ITEMS
(See Table 16)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate In Ref. 1 1962 From Table 16		
11		35/	58/	The original cost estimate for this tank as it is presented in Ref. 1 is not sufficient to provide for material purchase and fabrication per Ref. 1 design. Evidence of this low estimate is apparent when one considers the actual contractor cost of the 600-gallon tank vs the Ref. 1 cost. The tank has been redesigned so that more efficient use of material results, and the tank can be purchased for the costs indicated.
12		54/	67/	"
13		100/	71/	"
14		140/	78/	"
15	308/		124/	"
16	168/17		159/30	Cost changes are due to fabricator gaining experience and raise in wages.
17	36/19		36/23	The increase in labor cost is due to wage increases.
18	9/16		9/19	"
19	6/25		6/30	"

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 18

1962 SIMPARI COSTS FOR AUXILIARY POWER PACKAGES

MO. P-1

Item	No. req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	305	305	282	255
2	1	4	3	3	3
11	1	58	53	53	53
16	1	189	177	175	165
17	1	59	59	59	56
18	1	28	28	28	26
19	1	36	36	36	34
TOTAL Average Cost Per Package (\$)		679	661	636	592

MO. P-2

Item	No. req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
3	1	295	295	273	243
4	1	4	4	4	3
12	1	67	67	62	62
16	1	189	177	175	165
17	1	59	59	59	56
18	1	28	28	28	26
19	1	36	36	36	34
TOTAL Average Cost Per Package (\$)		678	666	637	589

(Table Continues)

Table 18 (Continued)
1962 SUMMARY COSTS FOR AUXILIARY-FINER PACKAGES

NO. P-3

Item	No. req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
5	1	475	475	441	412
6	1	4	4	4	3
13	1	71	71	65	65
16	1	189	177	175	165
17	1	59	59	59	56
18	1	28	28	28	28
19	1	36	36	36	34
TOTAL Average Cost Per Package (\$)		862	850	808	761

NO. P-4

Item	No. req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
7	1	539	589	572	530
8	1	5	5	4	4
14	1	78	78	73	73
16	1	189	177	175	165
17	1	59	59	59	56
18	1	28	28	28	26
19	1	36	36	36	34
TOTAL Average Cost Per Package (\$)		984	972	947	888

(Table Continues)

Table 18 (Continued)
1962 STEAMER COSTS FOR AUXILIARY POWER PACKAGES
NO. P-5

Item	No. req'd.	Average Labor and Material Cost Per Item			
		1	10	100	1000
9	1	878	878	878	716
10	1	5	5	4	4
15	1	124	124	117	117
16	1	189	177	175	165
17	1	59	59	59	56
18	1	28	28	28	26
19	1	36	36	36	34
TOTAL Average Cost Per Package (\$)		1319	1307	1297	1118

Table 19

MATERIAL AND LABOR COSTS BY ITEM FOR FIRE-PROTECTION PACKAGE

Item No.	DESCRIPTION	MANUFACTURER	SPECIFICATIONS	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^a			
				Unit Labor Reqt.	Material and Labor Unit Cost (\$/Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$)			
							1	10	100	Material/Labor
1	405 pounds of baralyme	Mc-Gray Edison Stuyvesant Falls, New York	Consists of 20% calcium hydroxide & 80% calcium hydride without any inert material or free water. It is to be provided in the form of eight mesh granular size. This material is to be packaged in 40 lb. airtight containers, with each container provided with an indicator that registers the materials exhaustion of O ₂ absorbent capacity.		20¢/		102/	102/	102/	1,000
2	Oxygen bottles completely filled with breathing grade oxygen		7 200-cu ft bottles				301/	298/	281/	20¢/
3	Oxygen regulator - single stage. Cylinder content gage only. One regulator.	Victor Equipment Co. 844 Folsom San Francisco	Approx. 500 cubic feet per hour at 40 pounds per sq. in. Victor cat. No. 5B-200 MS-967				28/	28/	26/	19/

^aMaterial costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs-material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for these items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

Table 20
UNIT COST DIFFERENTIALS FOR FIRE-PROTECTION PACKAGE ITEMS
(See Table 19)

Item No.	One-off Item Cost (Material/Labor)		Net Unit Cost Differential* (Net./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1 From Table 19		
1	304/	102/	- 102/	A more efficient carbon dioxide absorber has been developed by the supplier.
2		301/	+ 101/	The increase in cost reflects additional funds required to purchase the item from retail outlets rather than from federal stock.
3		23	+ 5/	

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

Table 21
1962 SUMMARY COSTS FOR FIRE-PROTECTION PACKAGE
NC. P-1

Item	No. Req'd	Average Labor and Material Cost Item			
		1	10	100	1000
1	1	102	102	102	102
2	1	301	298	281	209
3	1	28	28	26	19
TOTAL					
Average Cost Per Package (\$)		431	428	409	330

Table 22
MATERIAL AND LABOR COSTS BY ITEM FOR INSTALLATION PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a		MATERIAL AND LABOR COSTS - 1962 ^a			
				Unit Labor Bkft. Hourly Rate	Material and Labor Unit Cost (\$/Unit./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$/Material/Labor)		
							1	10	100
1	Steel erection which includes basic arch, endwalls (without bracing) entrance tube complete (without entrance bulkhead)	Arco Steel Youngstown, Ohio Commercial Shearing and Stamping Youngstown, Ohio Republic Steel Corp. Cleveland, Ohio	Figs. A-1M and A-3M	266 3.85	C/1025	4.50	0/1200	7 950	1,000 9 950
2	Shelter, entrance way and tank excavation Semi-Buried configuration	General Contractor	FIG. A-1M Section B-B Excavation equal to 583 cubic yards			4.54	554/159571	139303/224204	94
3	Shelter, entrance way and tank excavation Buried configuration	"	FIG. A-1M Section C-C Excavation equal to 860 cubic yards	54 3.75	830/203	4.54	958/234837	30 418/30342	131
4	Connected backfill (Volume up to 8 feet above foundations-basic shelter and entrance way Above-ground configuration)	"	FIG. A-1M Sections A-A Assume hand or equivalent machine type compaction of 24 cubic yards. 490 cubic yards to be compacted with "sheep foot" technique.			4.54	514/713480	684384/512238	286
5	Connected backfill (Volume up to 8 feet above foundations-basic shelter and entrance way Semi-Buried)		FIG. A-1M Section B-B Connected backfill equal to 200 cubic yards			4.54	325/543309	504221/374121	197

* Material costs shown reflect machine amortization or rental cost.

** Assume material is available without cost within 1 mile of site. Excavation and hauling of this material to site are included in charge.

^a Material costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs--material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report. (Table Continues)

Table 22 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR INSTALLATION PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	UNIT LABOR		MATERIAL AND LABOR		MATERIAL AND LABOR COSTS - 1962 ⁴				
				Man- hours	Hourly Rate	Unit Cost (\$/Mat./Labor)	Labor Hourly Rate	Cost Per Unit Installed (\$)	1	10	100	1,000
6	Compacted backfill (Volumes up to 8 feet above foundations- basic shelter and entrance way. Buried configuration)	General Contractor	Fig. A-17C Section C-C Compacted backfill equal to 206 cu. yards	145	3.75	329/544	4.54	325/540	309/504	227/372		121/137
7	Non-compacted backfill Above-ground config- urations	"	Fig. A-17C Section A-A 131 cubic yards**				4.54	91/47	86/44	63/33		33/17
8	Non-compacted backfill Semi-Buried config- urations		Fig. A-17C Section B-B 380 cubic yards				4.54	262/135	247/127	182/94		95/45
9	Non-compacted backfill Buried configuration		Fig. A-17C Section C-C 652 cubic yards	59	3.75	429/221	4.54	450/232	424/219	312/161		163/84
10	Select backfill under fuel and water tanks		Fig. A-17C 4 cubic yards of sand	8	3.75	18/30	4.54	18/36	18/31	16/20		15/10
11	Arch and endwall basalt joint seal complete- one lot	General Contractor	Fig. A-3K	16	3.75	30/60	4.54	30/72	30/72	30/57		29/42

Table 23
UNIT COST DIFFERENTIALS FOR INSTALLATION-PACKAGE ITEMS
(See Table 22)

Item No.	One-Off Item Cost (Material/Labor)		Net Unit Cost Differential* (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate In Ref. 1 1962 From Table 22		
1	0/1025	0/1000	/ + 175	Increase in labor is due to wage increases.
2		600/185	+ 54/ + 14	Increase in material cost is due to increase in cost of excavating equipment. Increase in labor cost is due to wage increases. The 1962 cost for excavation per yard is \$1.386.
3	830/203	958/234	+ 128/ + 31	
4		310/434	+ 204/ + 279	Increase in cost of material is due to increase in cost of earth-handling equipment. Increase in labor cost is due to wage increases. The 1962 cost for compacted backfill is \$4.158 per cubic yard in place.
5		144/199	+ 121/ + 341	
6		180/249	+ 145/ + 291	
7		115/60	- 24/ - 13	Some remarks as listed for item 4 except that the 1962 cost for backfill is \$1.046 per cubic yard in place.

*A plus mark indicates an increase in 1962 item cost over its cost in 1959.
A minus mark indicates a decrease in 1962 item cost based on its cost in 1959.

(Table Continues)

Table 23 (continued)
UNIT COST DIFFERENTIALS FOR INSTALLATION-PACKAGE ITEMS
(See Table 22)

Item No.	One-Off Item Cost (Material/Labor)			Net Unit Cost Differential (Mat./Labor)	Remarks relating to one-off item cost differentials when original unit cost quoted in Ref. 1 and/or actual contractor cost (modified as required) is used as a basis for comparison with 1962 prices.
	Available From General Contractor	Estimate in Ref. 1	1962 From Table 22		
8		54/38	262/135	+ 206 1/2 107	Cost differential with respect to that listed in Ref. 1 is partially due to an error in volume as listed in Ref. 1. Labor cost increase is due to wage increases.
9	4/29/221		4/30/232	+ 21/-11	"
10		18/30	18/36	0/+6	Labor cost increase is due to wage increases.
11		30/60	30/72	0/+12	"

Plus sign indicates an increase in 1962 item cost over its cost in 1959.
A minus sign indicates a decrease in 1962 item cost based on its cost in 1959.

Table 24
1962 SUMMARY COSTS FOR INSTALLATION PACKAGES

NO. I-1

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	1200	1000	950	950
2	1	1227	1161	896	524
7	1	138	130	96	50
10	1	54	49	36	25
11	1	102	102	87	71
TOTAL Average Cost Per Package (\$)		2721	2442	2065	1620

NO. I-2

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	1200	1000	950	950
2	1	813	710	528	333
5	1	865	813	599	318
8	1	397	374	276	144
10	1	54	49	36	25
11	1	102	102	87	71
TOTAL Average Cost Per Package (\$)		3431	3048	2476	1846

NO. I-3

Item	No. Req'd	Average Labor and Material Cost Per Item			
		1	10	100	1000
1	1	1200	1000	950	950
3	1	1192	1042	728	473
6	1	865	813	599	318
9	1	682	643	473	247
10	1	54	49	36	25
11	1	102	102	87	71
TOTAL Average Cost Per Package (\$)		4095	3649	2873	2084

Table 25

MATERIAL AND LABOR COSTS BY ITEM FOR ELECTRICAL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURE NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a		MATERIAL AND LABOR COSTS - 1962 ^a				
				Unit Labor Rate	Material and Labor Unit Cost (\$/unit/labor)	Labor Hourly Rate	Cost per Unit in Quantities Indicated (\$)			
				100- hours			1	10	100	1,000
1	Electrical system for arrangement "A" hotel package One lot	Graybar Electric San Francisco, Calif.	Fig. A-16M			4.27	63/99	59/95	55/96	54/80
2	Electrical system for arrangement "B" hotel package One lot	"	"			"	67/126	63/125	58/123	57/100
3	Electrical system for arrangement "C" hotel package One lot	"	"	1.066	209/510*	"	92/130	86/130	79/128	78/103
4	4 alt breaker panel completely installed	"	"			"	3/23	3/23	3/22	3/19
5	6 alt breaker panel completely installed	"	"			"	5/34	5/34	4/33	4/27
6	Electrical items required for the air conditioner One lot	"	"			"	30/70	30/70	28/66	26/56
7	Service equipment required for power package p-1 or p-2 One lot	Graybar Electric S.F. Calif. (for conduit and wire) Meyers Safety Sv. Co. S.F. Calif. (for safety switch)	"			"	17/14	16/14	14/14	13/11

* This contractor cost includes the cost for electrical package items 3, 5, 6, 10, and 14 as listed in this schedule.

^a Material costs are F.O.B. San Francisco. The material cost for a mass-produced item includes all manufacturing costs--material, labor, overhead, profit, etc. Labor costs have not been entered for items that do not require installation labor or whose installation labor has been included as a part of another package. Material and labor costs for 1959 are for those items installed in the Camp Parks prototype shelter, and are based on actual costs reported by the General Contractor. The 1962 hourly rates are based on the U.S. Department of Labor 1962 schedule for building trades in San Francisco. For detailed discussion of 1959 and 1962 material and labor costs listed see 4.1 of this report.

(Table Continues)

Table 25 (Continued)
MATERIAL AND LABOR COSTS BY ITEM FOR ELECTRICAL PACKAGES

Item No.	DESCRIPTION	MANUFACTURER	FIGURES NO.	ACTUAL MATERIAL AND LABOR - 1959 ^a			MATERIAL AND LABOR COSTS - 1962 ^b				
				Unit Labor Rate	Material and Labor Unit Cost (\$ Mat./Labor)	Labor Hourly Rate	Cost Per Unit In Quantities Indicated (\$ Material/Labor)				
							1	10	100	1,000	
8	Service equipment required for power package P-3 <u>One Lot</u>	Graybar Electric S.F. Calif. (for conduit and wire) Heymans Safety Sv. Co. S.F. Calif. (for safety switch)	FIG. A-1074			4.47	25/17	24/17	22/17	19/14	
9	Service equipment required for power package P-4 <u>One Lot</u>	"	"			"	36/17	35/17	31/17	28/14	
10	Service equipment required for power package P-5 <u>One Lot</u>	"	"			"	36/17	35/17	31/17	28/14	
11	1/2" conduit required if the air conditioner is not used. (Arrangement "A" & "B" Hotel Package) <u>One Lot</u>	"	"			"	38/116	36/116	36/113	33/92	
12	1/2" conduit required if the air conditioner is not used. (Arrangement "C" Hotel Package) <u>One Lot</u>	"	"			"	43/134	38/134	38/130	37/10	
13	1/2" conduit required if the air conditioner is used. (Arrangement "A" & "B" Hotel Package) <u>One Lot</u>	"	"			"	25/76	23/76	23/74	21/61	
14	1/2" conduit required if the air conditioner is used. (Arrangement "C" Hotel Package) <u>One Lot</u>	"	"			"	30/63	28/63	28/62	25/50	

UNIT COST DIFFERENTIALS FOR ELECTRICAL-PACKAGE TYPES

Since the construction and cost information in Ref. 1 and that provided by the general contractor on electrical items are insufficient, no attempt has been made to obtain cost differentials between those electrical items and the items in the new electrical packages (itemized in Table 25).

Table 25

1962 SIMPACT COSTS FOR ELECTRICAL PACKAGES

Item or Lot	No. or Ft. Req'd.	Package H-1				Package H-2			
		Total Price Per Unit in Quantities as Indicated				Total Price Per Unit in Quantities as Indicated			
		1	30	100	1000	1	10	100	1000
1	1	162	158	151	121	162	158	151	121
2									
3									
4	1	26	26	25	22				
5	1					30	39	37	31
6	1					100	100	94	82
7	1	31	30	26	24				
8									
9	1					53	52	48	42
10									
11	220	154	152	149	125				
12									
13	140					101	99	97	82
14									
TOTAL		373	366	353	295	455	448	427	361

Item or Lot	No. or Ft. Req'd.	Package H-3				Package H-4			
		Total Price Per Unit in Quantities as Indicated				Total Price Per Unit in Quantities as Indicated			
		1	10	100	1000	1	10	100	1000
2	1	193	189	181	157	193	189	181	157
4	1	26	26	25	22				
11	220	154	152	149	125				
7	1	31	30	26	24				
5	1					39	39	37	31
6	1					100	100	94	82
9	1					52	52	48	42
13	140					101	99	97	82
TOTAL		404	397	383	328	486	479	457	394

(Table Continues)

Table 26 (Continued)
1962 SUMMARY COSTS FOR ELECTRICAL PACKAGES

Item or Lot	No. or Pl Reqd.	Package W-5					Package W-6				
		Total Price Per Unit in Quantities as Indicated					Total Price Per Unit in Quantities as Indicated				
		1	10	100	1000	1	10	100	1000	1	10
3	1	222	216	205	181	222	216	205	181		
4	1	26	26	25	22						
12	250	177	172	168	144						
8	1	42	41	39	33						
5	1					39	39	37	31		
14	170					93	91	90	75		
6	1					100	100	94	82		
10	1					53	52	48	42		
TOTAL		467	455	437	380	507	498	474	411		

Table 27
ELECTRICAL PACKAGE FOR A GIVEN COMBINATION OF
HUMID. AND VENTILATION PACKAGES

Elect. Pkg.	Elect. Sys. Affct.	Power Pkg./hr	Packages Served	Load Range (hr)
W-1	A	P-1/1.2	V-1A, V-2A, V-1B, V-2B, H-1A, H-2A, H-3A, any control package	0.65 to 1.1
W-2	A	P-4/5	V-1C, V-2C, V-1D, V-2D, H-1A, H-2A, H-3A, H-1B, H-2B, H-3B, any control package	3.7 to 4.7
W-3	B	P-2/2	V-1A, V-2A, V-1B, V-2B, H-1B, H-2B, H-3B, any control package	1.25 to 1.75
W-4	B	P-4/5	V-1C, V-2C, V-1D, V-2D, H-1A, H-2A, H-3A, H-1B, H-2B, H-3B, any control package	3.7 to 4.7
W-5	C	P-3/3.5	V-1A, V-2A, V-1B, V-2B, H-1C, H-2C, H-3C, any control package	3.1 to 3.6
W-6	C	P-5/7.5	V-1C, V-2C, V-1D, V-2D, H-1C, H-2C, H-3C, any control package	6.25 to 6.6

Table 28

**PERCENTAGE CONTRIBUTIONS OF PACKAGES TO AVERAGE ONE-OFF
SHELTER COST FOR FOUR PACKAGE COMBINATIONS**

Minimum (Least Austere) 10-pai Shelter
Average One-Off Cost = \$14,848

Package No.	Package \$ Cost	Percent of Avg. One-Off Cost
S-1	6801	43.52
E-1B	1548	10.86
V-1A	415	2.91
H-3A	1855	13.02
C-1	25	0.18
P-1	679	4.77
F-1	431	3.02
I-1	2721	19.10
W-1	373	2.62
Total	\$14,848	100%

Minimum (Least Austere) 35-pai Shelter
Average One-Off Cost = \$16,207

Package No.	Package \$ Cost	Percent of Avg. One-Off Cost
S-2	6666	41.13
E-2	1653	10.20
V-2A	430	2.65
H-3A	1855	11.45
C-1	25	0.15
P-1	679	4.19
F-1	431	2.66
I-3	4095	25.27
W-1	373	2.30
Total	\$16,207	100%

Minimum (Most Austere) 10-pai Shelter
Average One-Off Cost = \$18,461

Package No.	Package \$ Cost	Percent of Avg. One-Off Cost
S-1	6801	33.59
E-1A	1456	7.89
V-1D	1473	7.98
E-1C	3246	17.58
C-3	397	2.15
P-5	1319	7.14
F-1	431	2.33
I-2	3431	18.39
W-6	507	2.75
Total	\$18,461	100%

Minimum (Most Austere) 35-pai Shelter
Average One-Off Cost = \$19,802

Package No.	Package \$ Cost	Percent of Avg. One-Off Cost
S-2	6666	33.66
E-2	1652	8.35
V-2D	1488	7.52
E-1C	3246	16.39
C-3	397	2.00
P-5	1319	6.66
F-1	431	2.18
I-3	4095	20.68
W-6	507	2.56
Total	\$19,802	100%

Table 23

COMPARISON OF 1959 AND 1962 AVERAGE ONE-DECK SHELTER COSTS FOR FOUR PACKAGE COMBINATIONS

Most Austere 10-psi Shelter					
Package No.	1959 Est. Cost Per Sq. Ft. This Study	1962 Est. Cost Per Sq. Ft. This Study	Cost Difference	Percent Increase or Decrease	
S-1	\$ 4130	\$ 6201	+\$1771	+40	
E-1B	1229	1548	+319	+25	
V-1A	371	415	+44	+12	
E-3A	2585	1855	-730	-28	
C-1	24	25	+1	+4	
P-1	724	679	-45	-6	
I-1	433	431	-2	-0.5	
A-1	2419	2721	+302	+13	
Total	\$12245	\$14248	+\$2033 or 17%		
Least Austere 35-psi Shelter					
Package No.	1959 Est. Cost Per Sq. Ft. This Study	1962 Est. Cost Per Sq. Ft. This Study	Cost Difference	Percent Increase or Decrease	
S-2	\$ 4845	\$ 6666	+\$1821	+38	
E-2	1408	1653	+245	+17	
V-2A	566	430	-136	-24	
E-3A	2585	1855	-730	-28	
C-1	24	25	+1	+4	
P-1	724	679	-45	-6	
I-1	433	431	-2	-0.5	
A-1	3517	4095	+578	+16	
Total	\$14062	\$16207	+\$2145 or 15%		
Least Austere 10-psi Shelter					
Package No.	1959 Est. Cost Per Sq. Ft. This Study	1962 Est. Cost Per Sq. Ft. This Study	Cost Difference	Percent Increase or Decrease	
S-1	\$ 4130	\$ 6201	+\$1771	+40	
E-1A	1133	1456	+323	+29	
V-1D	1144	1473	+329	+29	
H-1C	4847	3246	-1601	-33	
C-3	728	397	-331	-45	
P-5	1483	1319	-164	-11	
P-1	433	431	-2	-0.5	
I-2	2679	3431	+752	+28	
A-6	--	507	+507	+100	
Total	\$16937	\$20461	+\$3524 or 9%		
Least Austere 35-psi Shelter					
Package No.	1959 Est. Cost Per Sq. Ft. This Study	1962 Est. Cost Per Sq. Ft. This Study	Cost Difference	Percent Increase or Decrease	
S-2	\$ 4845	\$ 6666	+\$1821	+38	
E-2	1408	1553	+145	+10	
V-2D	1299	1438	+139	+11	
H-1C	4847	3246	-1601	-33	
C-3	728	397	-331	-45	
P-5	1483	1319	-164	-11	
P-1	433	431	-2	-0.5	
I-3	3517	4095	+578	+16	
A-6	--	507	+507	+100	
Total	\$18560	\$20802	+\$2242 or 7%		

APPENDIX C

HISTORY OF BUNK-SYSTEM TESTING AND DEVELOPMENT

C.1 GENERAL

After the Camp Parks shelter had been constructed and outfitted in August 1959, the shelter underwent the following human occupancy tests: (1) a preliminary test in November 1959 in which 17 ERNL volunteers lived 2 days in the shelter; (2) the first full-capacity test in December 1959 in which 100 male volunteers lived 14 days in the shelter; (3) a second full-capacity test in July 1960 in which 100 male volunteers lived for 5 days in the shelter in hot weather; and (4) a third full-capacity test in November 1960 in which a mixed population of 100 men, women, and children lived 2 days in the shelter. The bunk system was part of the least suitable, 1-shaft sleeper, B-1C hotel package, which is described in detail in Ref. 1. The design drawings of Appendix A of the present report contain modifications of the bunk system based on the findings of these tests.

C.2 PRELIMINARY TEST

This test revealed several defects in the bunk system. A number of bunk poles bent under the weight of the bunk occupants. The continuous-sheet arrangement of the bunks caused some discomfort, since the movements of one person were felt by all others in the same tier. Some bending and breaking of the pins connecting the bunk poles to the uprights also occurred. However, no major action was taken to correct these defects because of the short time between the preliminary test and the first full-capacity test and because it was believed that the defects would remain minor. The lasting connecting the bunk sheeting to the poles were tightened in the hope of reducing the tendency to transmit movements along the tier. Spare bunk pins were also procured.

C.3 FIRST FULL-CAPACITY TEST

C.3.1 Findings of Test

The first full-capacity human occupancy test was conducted 3-17 December 1959 when 100 male volunteers lived for 14 days in the shelter. A number of defects developed in the bunk system (of Ref. 1) during this rigorous test. In many cases, the horizontal bunk poles of 3/4-inch pipe were too light--the weight of the heavier men bent these poles. The lower tiers of bunks were too close to the floor, so that sagging of the occupied bunk sheet allowed the occupant's body to bear on the floor. Bunk sheets tore because occupants stepped on the ends of the sheets instead of using the ladder. The bolt (washer type) fasteners in the floor holding the lower bunk channels started to pull out of the concrete.

C.3.2 Corrective Actions Taken During Test

Early in this test, it became obvious that the bunk system would not hold up for the remainder of the test. Therefore, the following changes were made: the 3/4-inch-pipe bunk poles were replaced by 1-inch-pipe bunk poles; the lowest tiers of bunks were raised by relocating the support brackets on the vertical uprights; the torn bunk sheets were sewn up by the shelterees; and the bolt fasteners in the floor were only hand tightened.

C.4 MODIFICATIONS MADE AFTER FIRST FULL-CAPACITY TEST

C.4.1 Modifications in Bunk Sheets

To prepare the bunk system for the second full-capacity test, the bunk sheets and bunk structure were modified. New canvas bunk sheets were procured that were 3 inches longer than the plastic bunk sheets (6 feet) used in the test. Several innovations were attempted in the shape of the bunk sheets to provide more comfort, such as providing simulated pillows.

Two basic layouts were developed: Type I, individual bunk sheets, and Type II, continuous bunk sheets. The individual bunk sheets were designed so that adjacent sheets were supported by a common bunk pole inserted through a tube of canvas, part of which was formed from one sheet and part from the other. In addition, these sheets were cut so that the width at the head end was 1 inch less than that at the foot end. In place, the head end would be more taut than the foot end, thus raising the head in line of a pillow. Pilot models of the Type I bunk sheets failed to fulfill expectations. Because of the shape of the bunk sheets, they provided uneven support to the body. Therefore, the individual bunk sheets were not used in the second full-capacity test, and instead two new types of the continuous canvas bunk sheets were tried: a rectangular shape, and a tapered shape to provide a vast head end to simulate a pillow. To prevent tearing along the edges, a 1/4-inch Manila rope was sewn directly into the hem. The tie flaps that connect the continuous sheet to the bunk poles were provided with a double stitch to prevent separation of the flap from the main sheet. Two weights of canvas (No. 10 duck and No. 12 duck) were tried with each shape of continuous canvas sheet to obtain adequate comfort at minimum cost.

For the second full-capacity test, only four bunk sheets could be procured: one of each weight in each of the two types of continuous canvas sheets. Therefore, four plastic sheets were selected from those used in the first full-capacity test. This arrangement of different type bunk sheets enabled a comparison between the new canvas designs and the old plastic sheets.

C.4.2 Modifications in Bunk Structure

The horizontal bunk poles were made longer than the previous poles to accommodate the increased length of the new bunk sheets. To permit the use of these longer poles, the rows of short uprights near the shelter

sidealls were moved closer to the sidealls. This necessitated lowering the total height of the bunk system to maintain clearance, and since the lowest tiers of bunks had been raised an additional 3 inches above the floor (to about 8 inches) during the test, the distance between tiers of bunks was reduced from 30 inches to 26 inches.

Guard rails were provided at each end of each tier to replace the unsatisfactory fabric straps used in the test. Since the present connections for supporting the bunk poles at the uprights had proved unsatisfactory during the test, 12 prototype connectors were constructed at NMDL and a mockup was made. Experience with the mockup resulted in the selection of 4 different connectors for the second full-capacity test. These connectors were as follows: (1) a simple U-shaped cup of 1/8-inch sheet steel welded to the upright; (2) a stirrup-type support made of 1/4-inch steel round stock bent into a long U and welded to the upright at the ends so as to project downward at an angle of about 45°; (3) a hook-type support of bent 1/4-inch steel round stock, designed to hook into two drilled holes in the upright and two drilled holes in the end of the bunk pole; and (4) a slot-type connector consisting of a notched piece of flat bar pressed in the end of the bunk pole which engaged a slot cut in the upright. Each type of connector was provided on two tiers of bunks.

The bottom channels (of Ref. 1) that held the lower ends of the uprights were deleted from the design, and 2-inch diameter holes were drilled 1 inch deep in the concrete floor. A considerable saving in material, labor, and bunk-assembly effort was effected by the elimination of the bottom channels.

C.5 SECOND FULL-CAPACITY TEST

All the foregoing changes in the bunk system were highly satisfactory except for the defects discussed below.

Each shelter slept 2 nights on canvas and 2 nights on plastic sheets. The canvas sheets were preferred over the plastic sheets by 82 shelterees. The plastic sheets were preferred by 13 shelterees. The principal objection to the plastic sheets was that they were uncomfortable in the warm environment, sticking to the perspiring skin of the shelterees because of the lack of air circulation through the nonporous plastic.

Only 18 of the shelterees remarked that the canvas bunks were longer than the plastic bunks. One reason for this observation was that the canvas bunk sheets, not being restricted at their extremities, tended to creep along the bunk poles when occupied. This action put more sag in the bunks than had been anticipated and negated the attempt to provide a tent head end in lieu of a pillow.

The continuous canvas bunk sheets were very well, but some tearing of stitches connecting the tieflaps to the sheets was observed near the ends of the flaps. These failures were the result of stresses caused by the shelterees sitting upright on the ends of the bunks. Some tearing of the canvas in the tieflaps was also observed.

The U-shaped cup connectors were quite satisfactory as receptacles for supporting the horizontal bunk poles and enabled easy and quick connections. None of the other three connectors were considered satisfactory. Many of the stirrup connectors would flatten next to the bunk poles to slip from the stirrup loop and become a safety problem. The hook connectors would bend or drop loose during the storage of uprights. If the holes in the poles (vertical and horizontal) did not exactly match the curve of the hooks, the assembly of the bunks became a difficult and tiring task. The slot connectors had the advantage of holding the entire bunk framework rigidly, but were very difficult to assemble. All slots and notched bars had to be within a close tolerance to be effective and would require better quality control in manufacture with consequent increased cost.

C.6 MODIFICATIONS MADE AFTER SECOND FULL-CAPACITY TEST

The defects described in C.5 have been satisfactorily overcome by improved design, shown in detail in Fig. A-10M.

C.7 THIRD FULL-CAPACITY TEST

The bunk system functioned adequately during this mixed population test. It is therefore concluded the bunk system has now been developed and tested to the point where it represents a reasonable compromise between cost and comfort.

APPENDIX 2

DISCUSSION OF AIR-HANDLING ASPECTS TO ILLUSTRATE NEED FOR FUNDAMENTAL PERFORMANCE SPECIFICATIONS

D.1 GENERAL

The most important shelter auxiliary system is the air-handling system. This system should be designed to protect the occupants from the radiological, chemical, and biological-warfare threat resulting from ingress via the air supply. Prior to World War II, the wartime danger from breathing air was mainly derived from chemical agents. Precautions and protective-equipment design were based on the assumption that the chemical agents would be employed as gases, vapors, and/or particulate matter. Weapons developed for and used in World War I resulted in destruction by explosion and fire. These effects made necessary air-handling equipment that would prevent chemical agents, dust, and hot air from being drawn into the shelter. The nuclear weapon and the recent development in biological warfare have placed further requirements on the air-handling system in that radioactive particulate plus biological warfare agents may have to be kept from the shelter atmosphere.

Briefly then, the importance of the air-handling system cannot be over emphasized because it must provide an adequate human environment during shelter close up as well as during other shelter conditions. By current United States standards, a system for accomplishing this will be costly and complicated unless the design requirements are very closely controlled.

The author is of the opinion that the ventilation and air-conditioning systems specified in Ref. 1 are adequate to meet the requirements there stated, and, if properly applied, will ensure a suitable environment when the exterior air conditions are within the normal range of wet and dry bulb values found in the continental United States. The system as originally specified in Ref. 1 also provides for a shelter close-up period. The use of chemicals was resorted to for removal of CO₂, bottled oxygen was recommended as a means for oxygen replenishment, and the system has a marginal filter arrangement. When the firestorm package is added, the total system will enable operating the shelter completely sealed off for 24 hours. We have assumed that the air outside the shelter during all other periods of the 14-day stay will be suitable for human use if it is passed through the marginal filter. But the system is not designed to remove modern chemical and biological-warfare agents.

The author is of the opinion that design criteria for an effective air filtration system do not now exist; research and experimentation is needed to provide data for the design engineer to satisfactorily develop an adequate and mature shelter air-handling system. Specific information required is discussed below.

D.2 SPECIFIC INFORMATION REQUIRED

1. A specific particulate size (and density) below which penetrating filter can then be designed to have a particulate "cut off" at this point. This criterion is important, since many shelter designers at present are specifying filters that have an "American Filter Institute efficiency value of 50% with particulate size of 0.3 micron." This type of filter is of necessity a high-resistance filter having about 0.9 inch of water drop at normal air flow. Such a filter in itself is costly and also will completely govern the design characteristics of the air-handling blower and motor-dust system. Prefiltering for this filter will no doubt be required.
2. The total time during the 14-day stay in the shelter that airborne radioactive material must be filtered from the incoming air, and the approximate amount of such material that will accumulate in the filter during this time. With this information in hand, the designer can then determine the type of filter he must furnish and whether the filter must be installed inside a radiation shield. If a shield is necessary, this information will be adequate to provide for its design. (The present trend in West Germany is to provide a radiological filtration capacity of approximately 1/2 hours.¹⁰)

3. The time that each specific class of shelter will be closed off from the outside in the event of a firestorm. For example, compared to the 24-hour period specified in Ref. 1, Sweden has specified that their class 1 shelter shall have an air-handling system capable of complete shut off from the outside for a period of 10 hours.¹¹

4. The number of people that will be assigned to the shelter and the maximum effective temperature that will be allowable. High-perfor-mance, class-1 shelters in Sweden are provided with temperature control and ventilation devices, as well as gas and aerosol filters, for a population density of 5.4 sq ft per person.¹¹ The current QGD recommendation is 12.5 sq ft per person. The former density is reasonable when one considers the high cost for the basic class-1-type shelter vs the additional cost of air-handling plus miscellaneous other hotel-type requirements necessary to accommodate the former density.

5. The heat-absorbing capability of the air-handling equipment. This design requirement will necessitate research that is directed at determining the conditions that will exist as the result of a fire caused by a nuclear weapon detonation at a specified location. Basically, this research should provide shelter air-inlet temperatures vs time data with the air inlet installed in a specific environment. The temperature vs time environment of the air inlet will be dependent on:

Weapon yield range being considered.

Distance from ground zero of the specified class of shelter.

Percent buildup of contamination in the vicinity.

General features of terrain surrounding the inlet location relative to hills and amount of combustibles.

6. The optimum internal pressuring of the shelter to ensure minimum ingress of contaminants when the shelter is exposed to outside winds of varying velocities.

7. The duration that chemical and biological agents will persist, the types of such agents, and the amount of such agents a filter must remove from inlet air. This feature is an extremely important feature of a shelter's air-handling system. Research should establish the type and possible concentration of chemical and biological agents that must be removed. Then, research regarding the filter's required capacity for this air-cleaning problem is necessary. Currently German research is based on the assumption that these war gases will persist for approximately 96 hours.¹²

8. The design of the shelter air inlet. Results of the Camp Parks firestorm test indicate that the air inlet must protrude above the rubble after the detonation in order to minimize the entry of hot air, oxygen-depleted air, carbon monoxide, carbon dioxide, into the shelter. Research must determine for the designer the correlation between buildings in the proposed shelter location and the possible rubble height.

D.3 PROPOSED SHELTER AIR-HANDLING SYSTEM

The most satisfactory air-handling system for minimum cost will no doubt result when the designer has been furnished the information discussed above. This system will then operate as follows:

At the time of detonation, the shelter will have been manually or automatically closed off from the exterior by means of blast shields.

The system will not be used when the outside air is above 1000°F, depleted of oxygen, or has lethal concentrations of carbon monoxide or carbon dioxide.

The system will be used when the outside air presents a radiological, chemical, or biological hazard to the shelter; it will have an air valve for bypassing the filter when these threats disappear.

When an airborne-activity hazard exists, the shelter air supply will be reduced to a minimum and passed through the filter. Under this operating condition, the air supply can be reduced to approximately 2.5 cfm per person. This reduction during thermal, chemical, radiological, or biological conditions will aid in designing an adequate filter at minimum cost.

It is of interest to note that West Germany and Sweden have developed over the past 15 years a simplified sand filter that will function as a filter for chemical, biological, and radiological-warfare agents and also as an air cooler.¹²

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