JHU/APL
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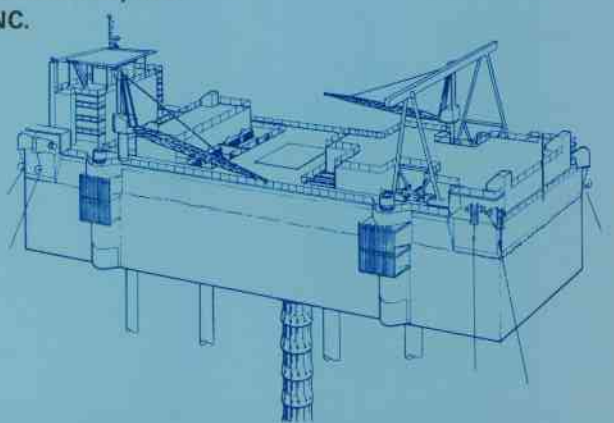
JUNE 1980

BASELINE DESIGNS OF MOORED AND GRAZING 40-MW OTEC PILOT PLANTS

VOLUME B: ENGINEERING DRAWINGS

ABAM ENGINEERS, INC.
L. R. GLOSTEN AND ASSOCIATES, INC.
TOKOLA OFFSHORE, INC.
SEWARD ASSOCIATES



THE JOHNS HOPKINS UNIVERSITY ■ APPLIED PHYSICS LABORATORY

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BASELINE DESIGNS OF MOORED AND GRAZING 40-MW OTEC PILOT PLANTS

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THE JOHNS HOPKINS UNIVERSITY ■ APPLIED PHYSICS LABORATORY
Johns Hopkins Road, Laurel, Maryland 20810
Operating under Contract N00024-78-C-5384 with the Department of the Navy

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ABSTRACT

Volume B is one part of a two-volume report that presents baseline design data for two types of floating Ocean Thermal Energy Conversion (OTEC) pilot plants: (a) a moored plant that uses underwater cables to transmit electric power to a shore-based utility company, and (b) a cruising plantship that uses the OTEC electric power to produce an energy-intensive product onboard, where it is stored for later transshipment to market. This volume provides the engineering drawings of the hull, cold-water pipe, ship outfitting and machinery, OTEC power system, electrical system, and folded-tube heat exchangers.

PREFACE

The Applied Physics Laboratory (APL) of the Johns Hopkins University has engineered two baseline designs of 40-MW_e(net) floating Ocean Thermal Energy Conversion (OTEC) pilot plants, one for moored operation near an island site with direct transmission of OTEC electric power to shore, and the other for cruising operation in the tropical oceans (where ΔT is the maximum) to use the OTEC power to synthesize an energy-intensive product (e.g., ammonia or aluminum). These designs, at the preliminary engineering level, are documented in a two-volume series and are designated Volume A: Detailed Report, and Volume B: Engineering Drawings. In addition to these reports, the design is supported by engineering calculations and computer analyses, all of which are available through APL to Government and industry to support future design efforts in the acquisition, construction, and deployment of OTEC pilot plants.

This work was sponsored by the Ocean Energy Systems Division of the U.S. Department of Energy.

The layout and structural design of the platform hull and cold-water pipe were performed by ABAM Engineers, Inc., under the technical direction of Mr. William Cichanski. Mr. Earl Fenstermacher of L. R. Glosten and Associates, Inc., developed the platform outfitting and machinery details. Tokola Offshore, Inv., developed the concepts for deploying the cold-water and seawater discharge pipes and selected the platform heavy-lift systems, under the direction of Mr. Ken James. Mr. Jerry Seward of Seward Associates prepared the design of the OTEC power utilization and electrical load distribution systems. The design of the OTEC power system and its integration with the platform structure and arrangement was under the direction of Mr. Dennis Richards of APL, who also developed the design of the ammonia product plant.

A more complete list of program participants is given in the Preface of Volume A.

DRAWINGS

HULL STRUCTURE

COLD WATER PIPE

MACHINERY AND OUTFITTING

POWER SYSTEM

ELECTRICAL

HEAT EXCHANGER

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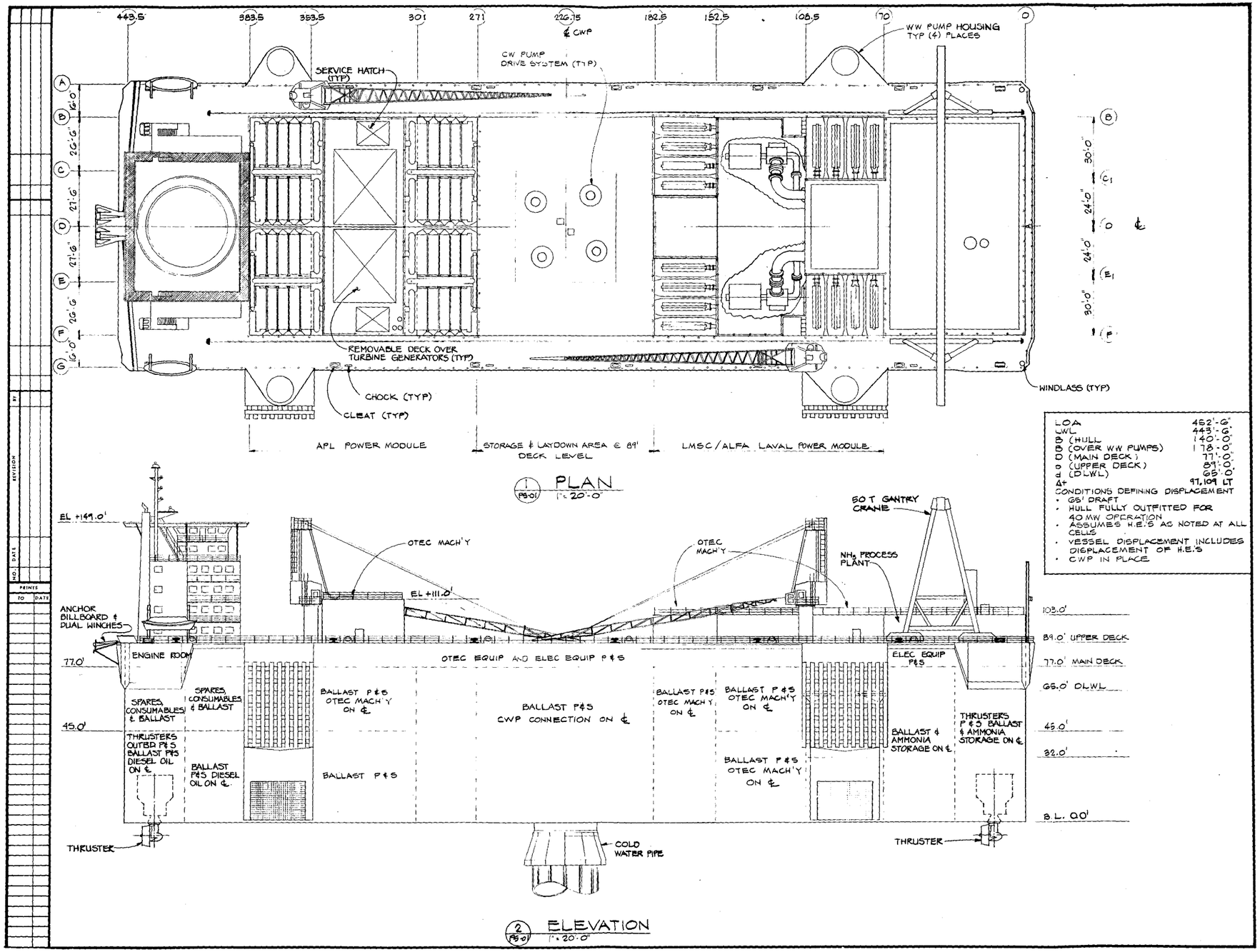
LAUREL, MARYLAND



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ABAM
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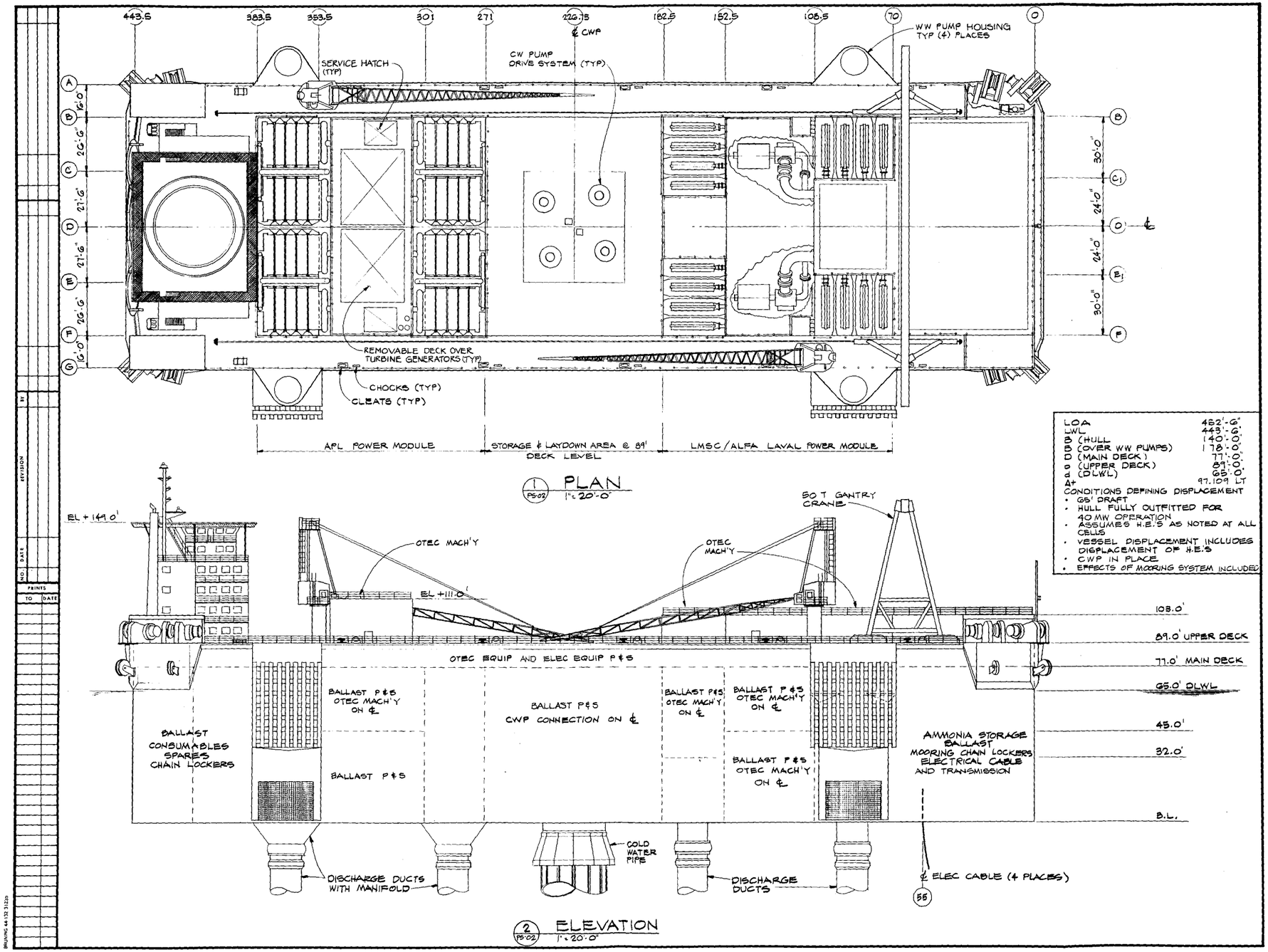
1121 PORT OF TACOMA ROAD TACOMA, WASH. (206) 383-3081

PROJECT TITLE
APL OTEC PLANTSHIP

SHEET TITLE
GENERAL ARRANGEMENT GRAZING MODE

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO: A79051
DRAWING NUMBER: PS-01

Fig. 1 General arrangement: grazing mode (PS-01).



LOA	482'-6"
LWL	443'-6"
B (HULL	140'-0"
B (OVER WW PUMPS)	178'-0"
D (MAIN DECK)	77'-0"
g (UPPER DECK)	89'-0"
Δ (DLWL)	65'-0"
Δ	97,109 LT

CONDITIONS DEFINING DISPLACEMENT
- 65' DRAFT
- HULL FULLY OUTFITTED FOR 40 MW OPERATION
- ASSUMES H.E.'S AS NOTED AT ALL CELLS
- VESSEL DISPLACEMENT INCLUDES DISPLACEMENT OF H.E.'S
- C.W.P. IN PLACE
- EFFECTS OF MOORING SYSTEM INCLUDED

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PROJECT TITLE
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SHEET TITLE
GENERAL ARRANGEMENT MOORED MODE

DESIGN BY W. CICHANSKI
DRAWN BY R. MOHN
DATE 21 DEC 1979
FILE NO. A79051
DRAWING NUMBER PS-02

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Fig. 2 General arrangement: moored mode (PS-02).

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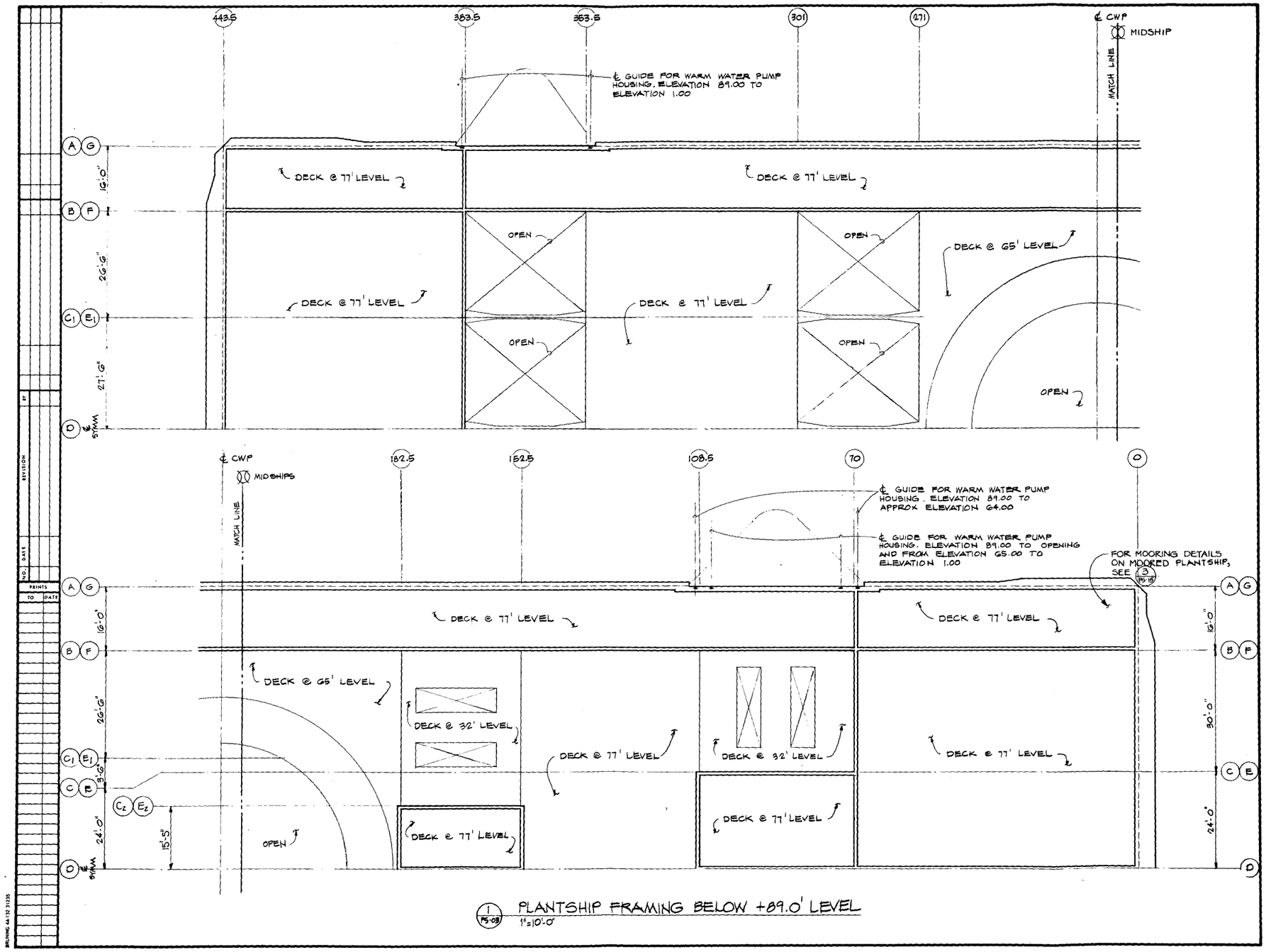

Fig. 3 Framing plan below 89-ft level (PS-03).

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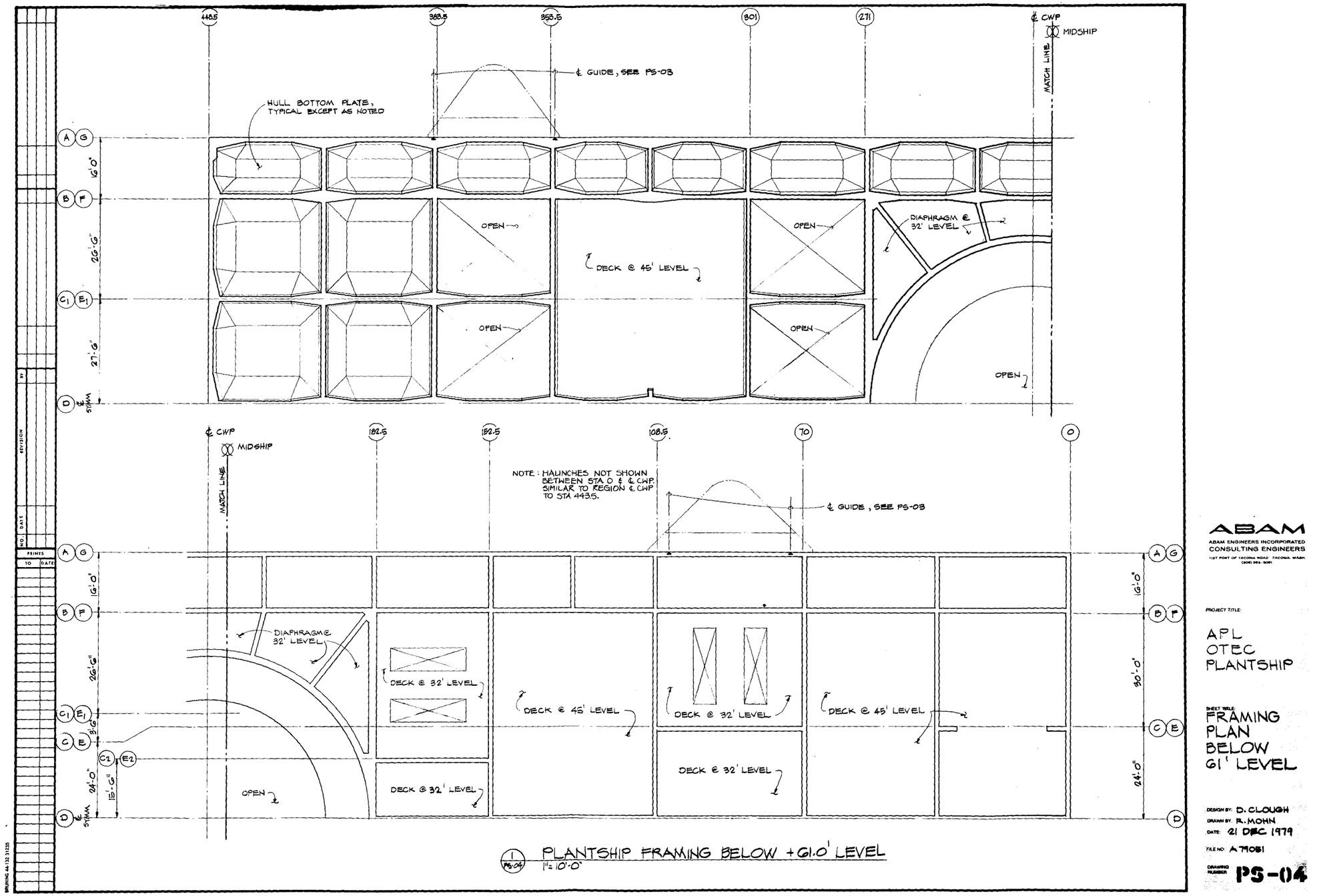

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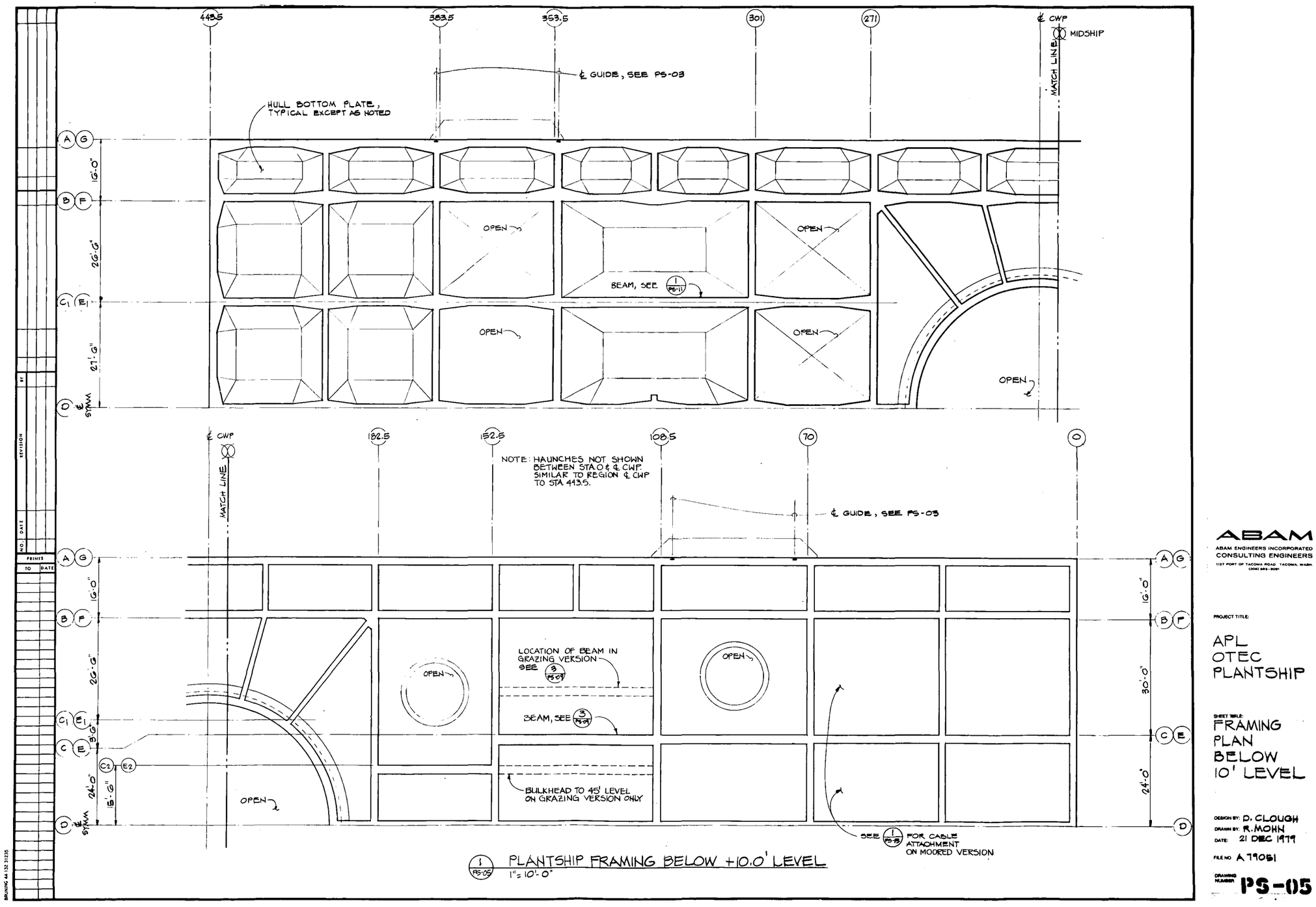
PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE
FRAMING PLAN BELOW 61' LEVEL

DESIGN BY: D. CLOUGH
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO: A-79081
DRAWING NUMBER: PS-04

Fig. 4 Framing plan below 61-ft level (PS-04).



1/PS-05 PLANTSHIP FRAMING BELOW +10.0' LEVEL
1" = 10'-0"

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PROJECT TITLE:
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SHEET TITLE:
FRAMING PLAN BELOW 10' LEVEL

DESIGN BY: D. CLOUGH
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO. A79051
DRAWING NUMBER PS-05

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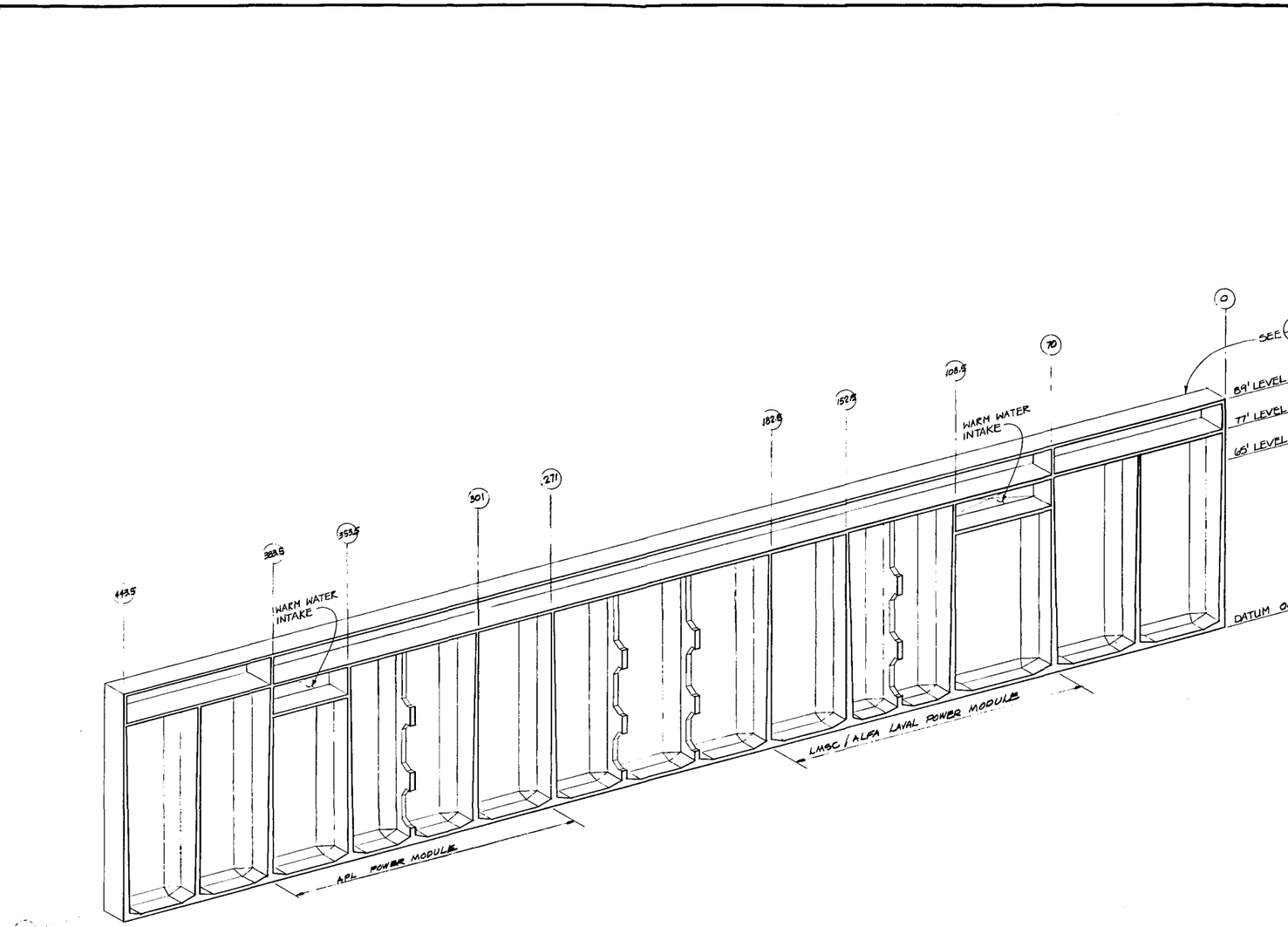
PRINTS TO DATE

Fig. 5 Framing plan below 10-ft level (PS-05).



(1/PS-06) LONGITUDINAL ISOMETRIC SECTION - PLANTSHIP FRAMING ℄ (A) TO ℄ (B)
NO SCALE

NOTE: SEE (18Z/PS-12) FOR HAUNCH DIMENSIONS & BULKHEAD THICKNESSES.

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PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
LONGITUDINAL ISOMETRIC SECTION BETWEEN ℄'A' & ℄'B'

DESIGN BY: D. CLOUGH
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO: A79051
DRAWING NUMBER: PS-06

Fig. 6 Longitudinal isometric section between grid lines A and B (PS-06).

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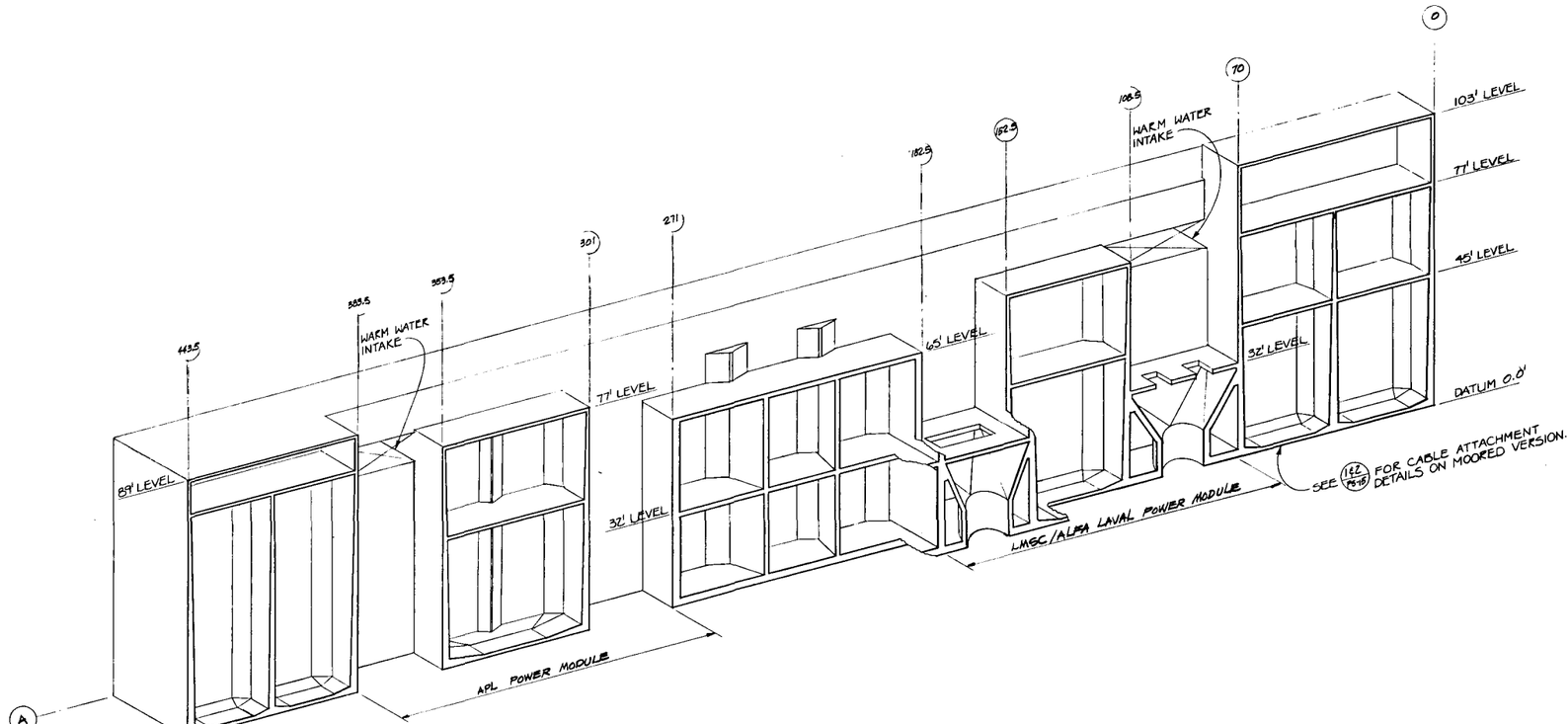

(1/PS-07) LONGITUDINAL ISOMETRIC SECTION - PLANTSHIP ℄ (B) TO ℄ (C)
NO SCALE

NOTES: 1. SEE (162/PS-12) FOR HAUNCH DIMENSIONS & BULKHEAD THICKNESSES.

2. HATCHES & OPENINGS IN DECKS & BULKHEADS OMITTED FOR CLARITY BULKHEAD ALONG ℄ B HAS MANY OPENINGS BETWEEN 77' & 89' LEVELS.

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PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
LONGITUDINAL ISOMETRIC SECTION BETWEEN ℄ 'B' & ℄ 'C'

DESIGN BY: D. CLOUGH
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO. A79051
DRAWING NUMBER PS-07

Fig. 7 Longitudinal isometric section between grid lines B and C (PS-07).

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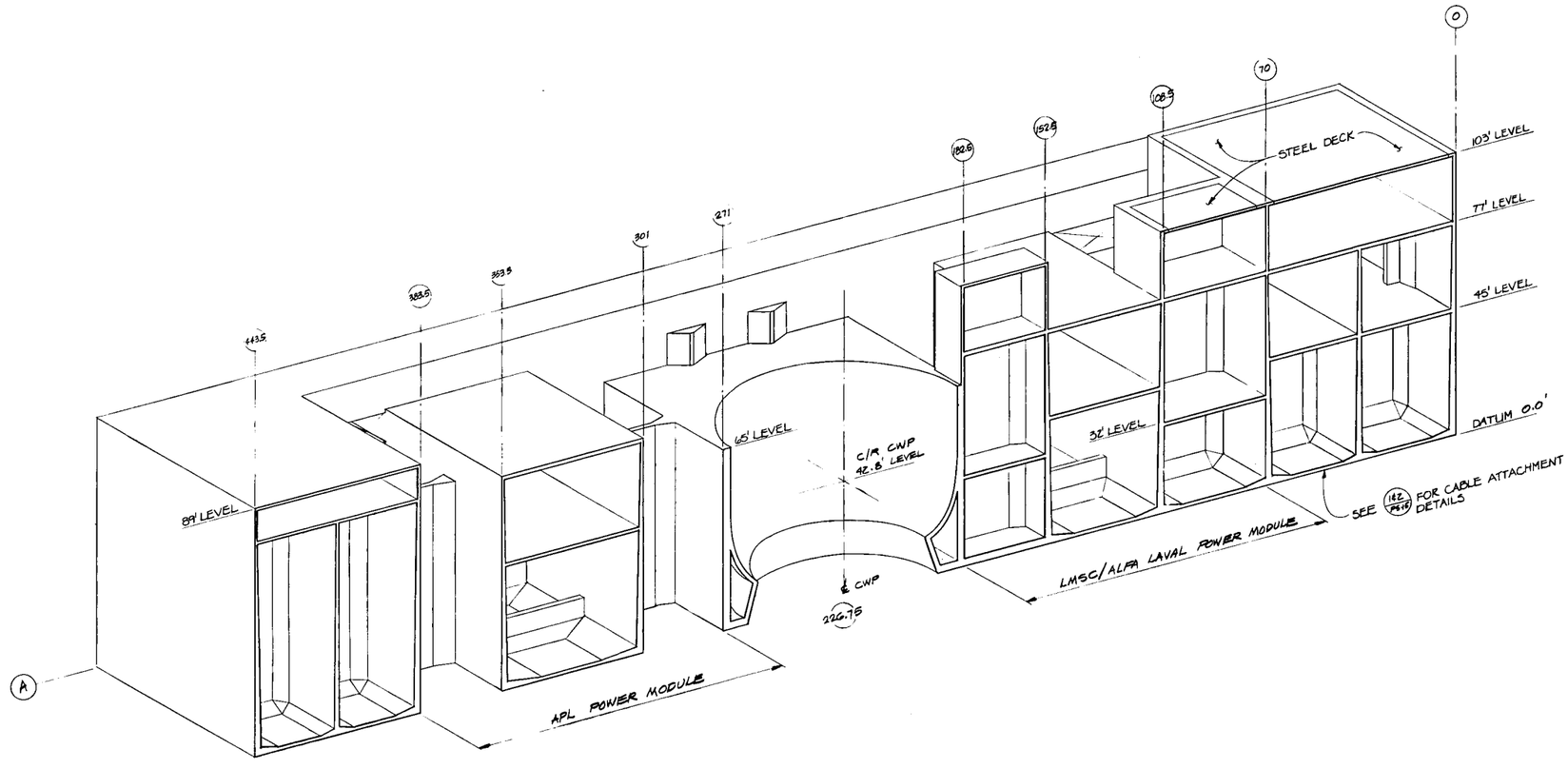

(1/PS-08) LONGITUDINAL ISOMETRIC SECTION - PLANTSHIP FRAMING ℄ Ⓒ TO ℄ Ⓓ
NO SCALE

NOTES: 1. SEE (182/PS-15) FOR HAUNCH DIMENSIONS & BULKHEAD THICKNESSES.

2. HATCHES & OPENINGS IN DECKS & BULKHEADS OMITTED FOR CLARITY BULKHEAD ALONG ℄ B HAS MANY OPENINGS BETWEEN 77' & 89' LEVELS.

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PROJECT TITLE:
APL
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PLANTSHIP

SHEET TITLE:
LONGITUDINAL ISOMETRIC SECTION BETWEEN ℄ 'C' & ℄ 'D'

DESIGN BY: D. CLOUGH
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO A79051
DRAWING NUMBER PS-08

Fig. 8 Longitudinal isometric section between grid lines C and D (PS-08).

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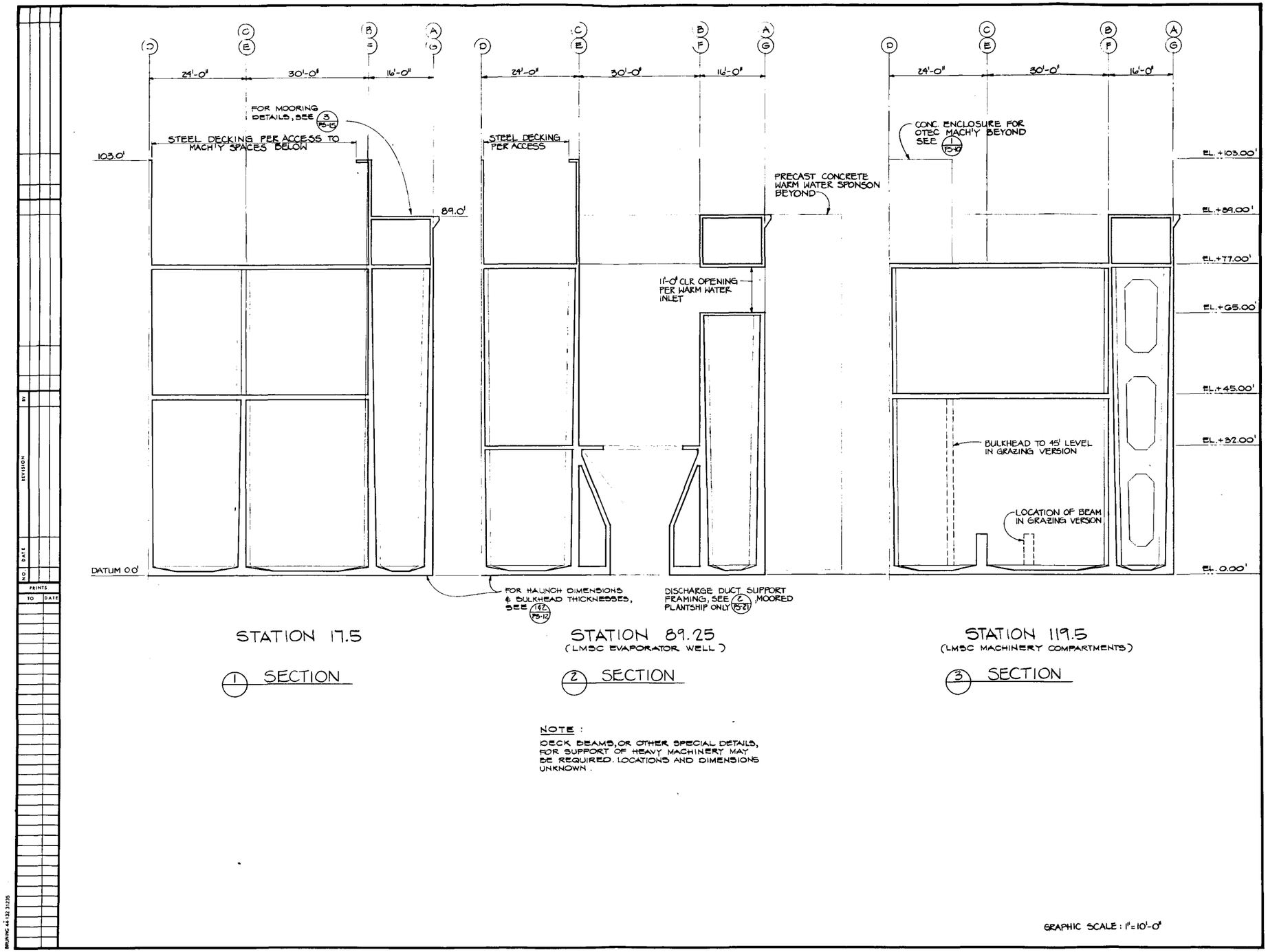

Fig. 9 Transverse sections at stations 17.5, 89.25, and 119.5 (PS-09).

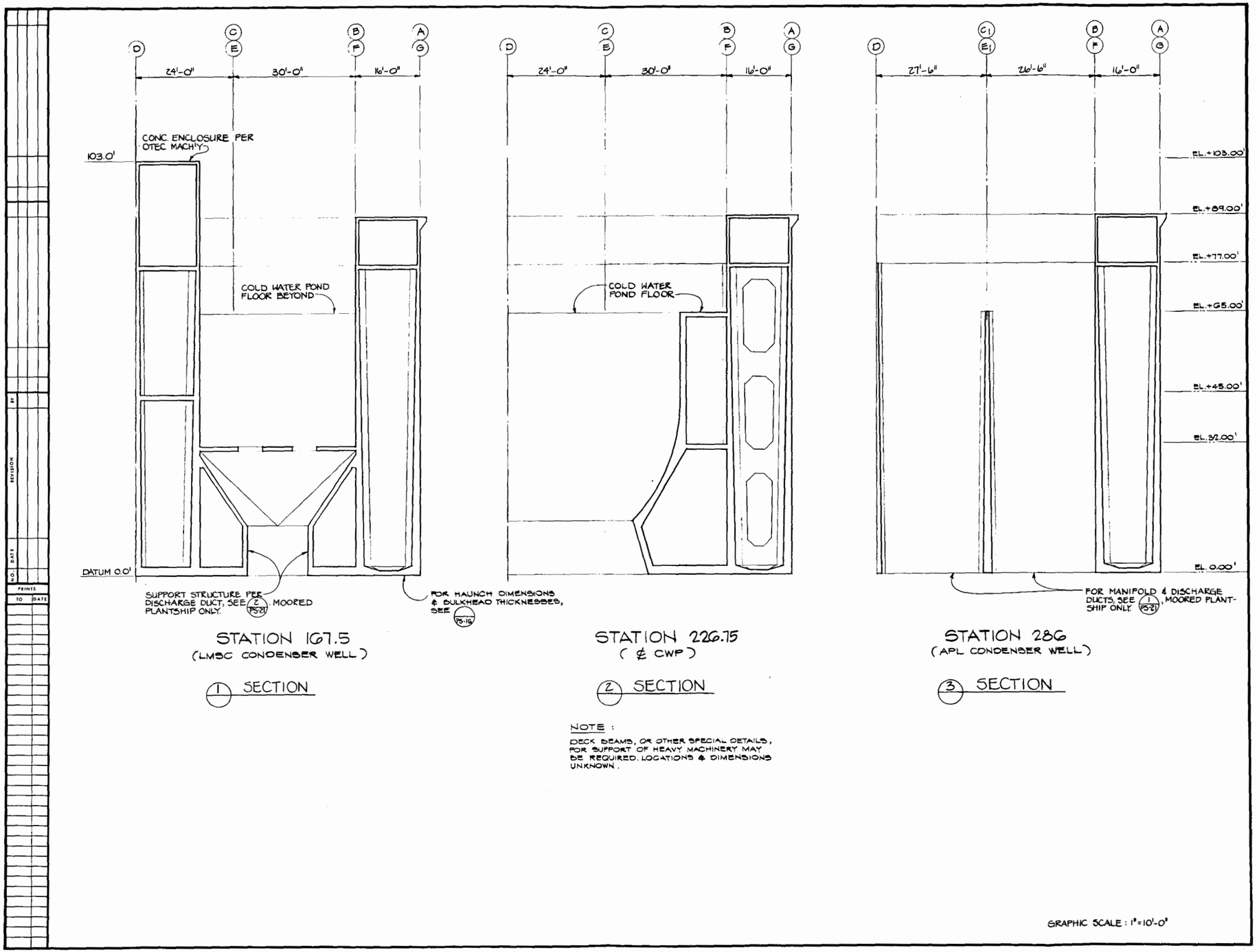

Fig. 10 Transverse sections at stations 167.5, 226.75, and 286 (PS-10).

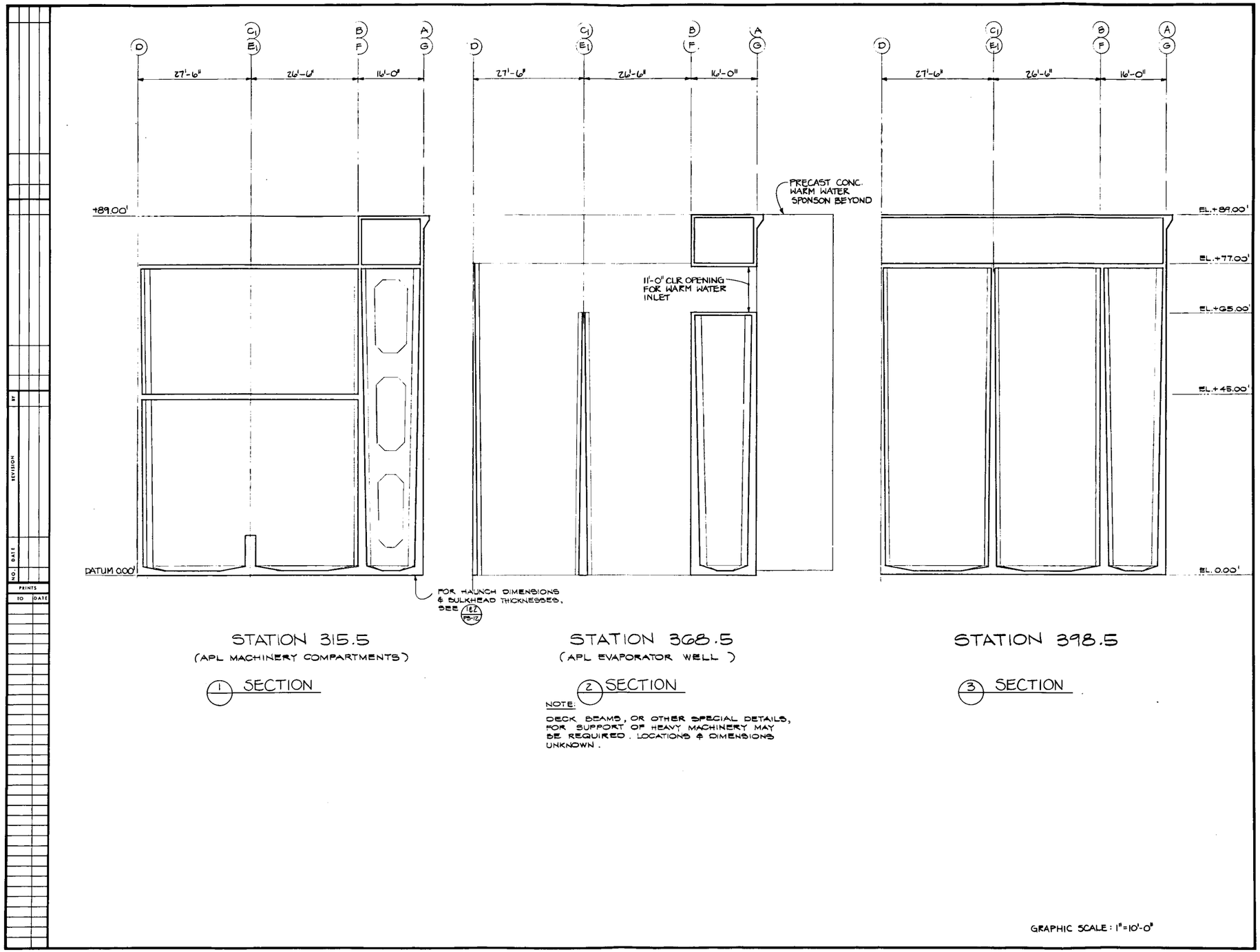

Fig. 11 Transverse sections at stations 315.5, 368.5, and 398.5 (PS-11).

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(1 PS-12) TRANSVERSE BULKHEAD DIMENSIONS

NOTE: TRANSVERSE BULKHEADS ARE 1'-9" THICK AT 2.17' LEVEL AND 9" THICK AT 77' LEVEL, EXCEPT AS NOTED BELOW. BULKHEADS ABOVE 77' LEVEL, 8" THICK.

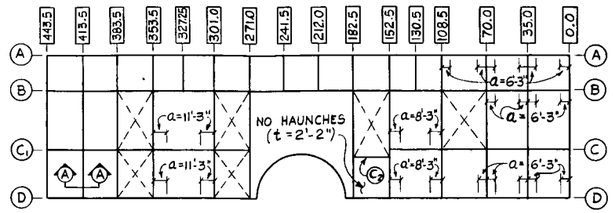
STATION	℄ TO ℄	THICKNESS AT 2.17' LEVEL	THICKNESS AT UPPER CONTROL POINT	ELEVATION OF UPPER CONTROL POINT
327.25	A TO B	1'-6"	1'-6"	77'
241.50	A TO B	1'-6"	1'-6"	77'
212.00	A TO B	1'-6"	1'-6"	77'
130.50	A TO B	1'-6"	1'-6"	77'
271.00	B TO D	2'-0"	2'-0"	65'
182.50	B TO D	2'-0"	2'-0"	65'
0.0	A TO G	1'-9"	1'-0"	65'
182.50	C_2 TO D	11½"@65'	9"	77'
443.50	A TO B	1'-9"	1'-0"	65'
RADIAL	WEBS SUPPORTING BOWL	1'-0"	1'-0"	65'

(4 PS-12) LONGITUDINAL BULKHEAD DIMENSIONS

NOTE: LONGITUDINAL BULKHEADS ARE 2'-0" THICK AT 2.17' LEVEL AND 9" THICK AT 77' LEVEL, EXCEPT AS NOTED BELOW. BULKHEADS ABOVE 77' LEVEL, 8" THICK

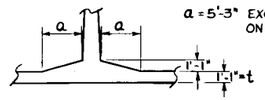
℄	STATION TO STATION	THICKNESS AT 2.17' LEVEL	THICKNESS AT UPPER CONTROL POINT	ELEVATION OF UPPER CONTROL POINT
A	383.5 TO 353.5	2'-1"	1'-0½"	65'
	108.5 TO 70.0	2'-1"	1'-0½"	65'
	70.0 TO 0.0	2'-1"	10"	77'
B	383.5 TO 353.5	2'-2"	1'-1½"	65'
	301.0 TO 271.0	2'-2"	11"	77'
	182.5 TO 152.5	2'-2"	11"	77'
	108.5 TO 70.0	2'-2"	1'-1½"	65'
C_1	383.5 TO 353.5	2'-0"@0.0	11"	65'
	301.0 TO 271	2'-0"@0.0	11"	65'
C	108.5 TO 70.0	2'-2"	11"	77'
C_2	182.5 TO 152.5	2'-2"	11"	77'
D	383.5 TO 353.5	2'-0"@0.0	9"	77'
	353.5 TO 301.0	2'-0"	1'-6"	77'
	301.0 TO 271.0	2'-0"@0.0	9"	77'
	152.5 TO 108.5	2'-0"	1'-6"	77'

(2 PS-12) BOTTOM ℄ TRANSVERSE HAUNCH DIMENSIONS



NOTE: HULL SYMMETRIC ABOUT LONGITUDINAL CENTERLINE (℄ D)

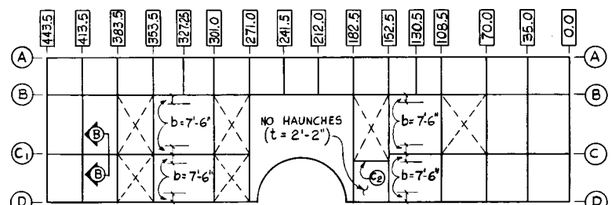
a = 5'-3" EXCEPT AS NOTED ON PLAN ABOVE



(A) SECTION

KEY PLAN

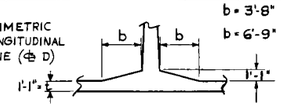
(5 PS-12) BOTTOM ℄ LONGITUDINAL HAUNCH DIMENSIONS



b = 3'-8" BETWEEN ℄A & ℄B

b = 6'-9" BETWEEN ℄B & ℄D, EXCEPT AS NOTED ON PLAN ABOVE

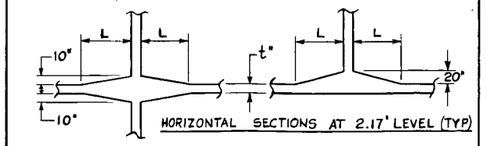
NOTE: HULL SYMMETRIC ABOUT LONGITUDINAL CENTERLINE (℄ D)



(B) SECTION

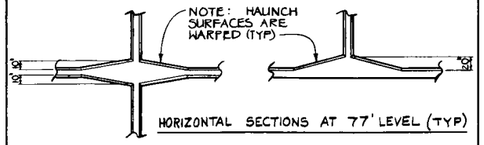
KEY PLAN

(3 PS-12) VERTICAL HAUNCH DETAILS



HORIZONTAL SECTIONS AT 2.17' LEVEL (TYP)

NOTE: HAUNCH LENGTH L MEASURED FROM FACE OF INTERSECTING BULKHEAD AT 2.17' LEVEL



HORIZONTAL SECTIONS AT 77' LEVEL (TYP)

HAUNCHES IN LONGITUDINAL BULKHEADS

STATION TO STATION	L
0.0 TO 108.5	11'
108.5 TO 443.5	8'

HAUNCHES IN TRANSVERSE BULKHEADS

L = 7', EXCEPT 4' BETWEEN ℄ A & ℄ B

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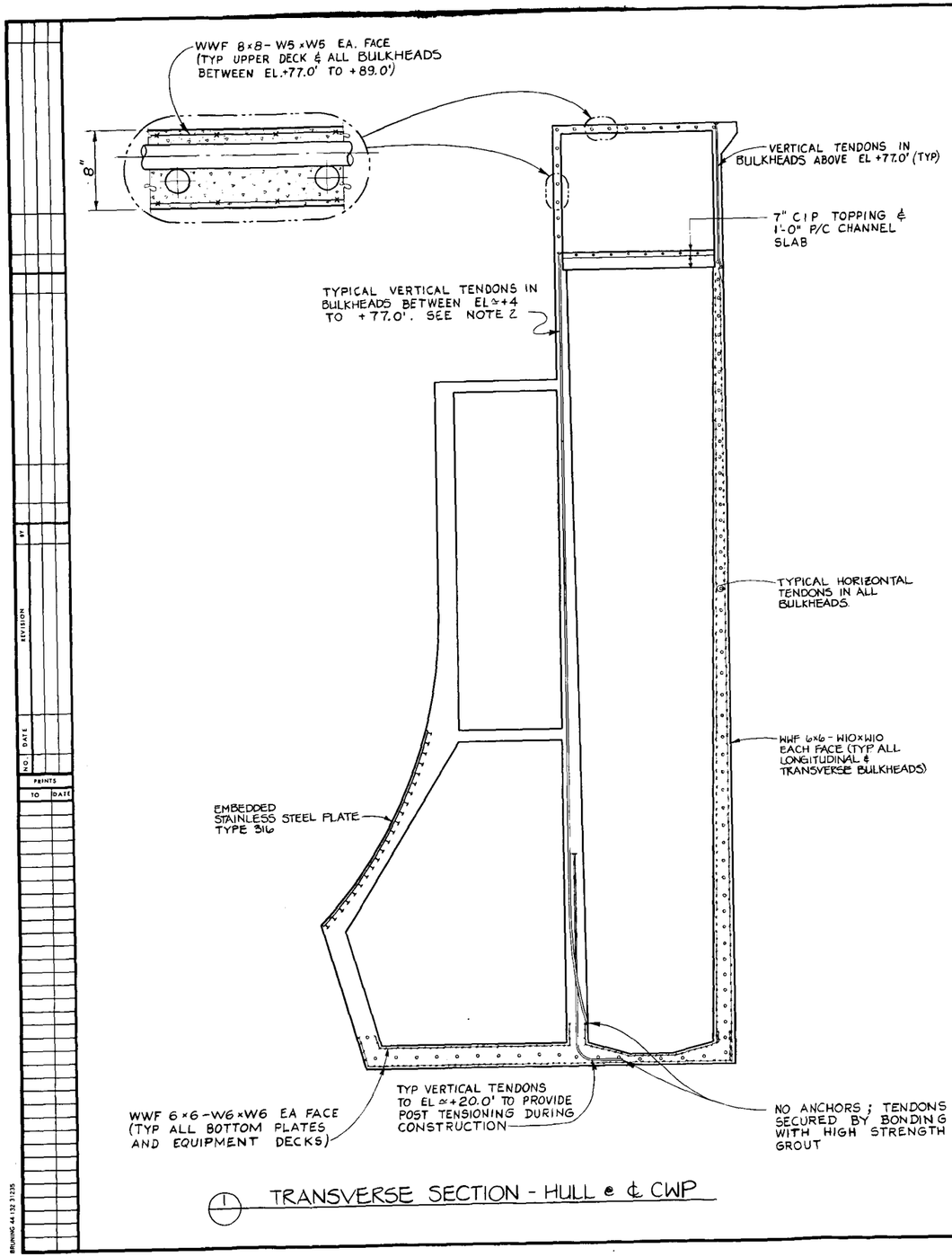
(206) 922-9001

PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
DIMENSIONS-
PRIMARY
STRUCTURE

DESIGN BY: D. CLOUGH
DRAWN BY: MVA
DATE: 21 DEC. 1979
FILE NO: A77051
DRAWING NUMBER: PS-12

Fig. 12 Dimensions: primary structure I (PS-12).



1 TRANSVERSE SECTION - HULL ℄ CWP

NOTES:

1. DETAILS SHOWN ON LONGITUDINAL BULKHEADS. SIMILAR FOR TRANSVERSE BULKHEADS.
2. TENDONS ARE 6,12, & 19 STRAND.
3. STRANDS ARE ½"Φ 7-WIRE, 270 K GRADE.
4. FOR PRESTRESSING SCHEDULES, SEE SHT PS-14.

GRAPHIC SCALE: 1"=5'-0"

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PROJECT TITLE:
APL
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PLANTSHIP

SHEET TITLE:
CONCRETE
STRUCTURE
REINFORCEMENT
DETAILS

DESIGN BY: D. CLOUGH
DRAWN BY: MVA
DATE: 21 DEC. 1979
FILE NO A79051
DRAWING NUMBER PS-13

Fig. 13 Concrete structure: reinforcement details (PS-13).

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1 PS-14 LONGITUDINAL BULKHEADS POST-TENSIONING SCHEDULE

Grid Line (℄)	Elevation (Ft.)	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
A & G	2.50 to 20.00	19	14	28	443.5 Ft.	6,209 Ft.
	21.38 to 33.75	19	10	20	443.5 Ft.	4,435 Ft.
	35.50 to 47.75	19	9	18	443.5 Ft.	3,992 Ft.
	49.04 to 63.63	12	10	20	443.5 Ft.	4,435 Ft.
	65.29 to 75.29	12	9	54	375.0 Ft.	3,375 Ft.
	77.96 to 87.54	12	6	12	443.5 Ft.	2,661 Ft.
B & F	2.19 to 20.0	19	12	24	443.5 Ft.	5,322 Ft.
	21.25 to 33.75	19	8	16	443.5 Ft.	3,548 Ft.
	35.25 to 47.25	12	10	20	443.5 Ft.	4,435 Ft.
	49.04 to 63.88	12	9	18	443.5 Ft.	3,992 Ft.
	66.17 to 75.33	12	7	42	375.0 Ft.	2,625 Ft.
	78.0 to 87.54	6	6	12	443.5 Ft.	2,661 Ft.
	89.0 to 102.00	6	8	16	70.0 Ft.	560 Ft.
C_1 & E_1	1.00 to 16.00	19	11	44	120 Ft.	1,320 Ft.
	17.67 to 31.00	19	9	36	120 Ft.	1,080 Ft.
	33.00 to 43.00	19	6	24	120 Ft.	720 Ft.
	45.00 to 47.00	19	2	8	120 Ft.	240 Ft.
	48.50 to 62.00	12	10	40	120 Ft.	1,200 Ft.
	63.75 to 76.00	12	8	2	60 Ft.	480 Ft.
C & E	1.00 to 76.00	Same as ℄ C_1 & E_1		92	38.5 Ft.	1,771 Ft.
	78.00 to 102.00	Same as ℄ B & F		28	38.5 Ft.	539 Ft.
C_2 & E_2	1.00 to 76.00	Same as ℄ C_1 & E_1		92	30.0 Ft.	1,380 Ft.
	78.00 to 102.00	Same as ℄ B & F		28	30.0 Ft.	420 Ft.
D	1.00 to 16.00	19	11	44	379.0 (Ave.)	4,169 Ft.
	17.67 to 31.00	19	9	36	369.0 (Ave.)	3,321 Ft.
	33.00 to 47.00	19	8	32	359.0 Ft.	2,872 Ft.
	48.50 to 62.00	12	10	40	359.0 Ft.	3,590 Ft.
	63.75 to 76.00	12	8	48	295.0 Ft.	2,360 Ft.
	78.00 to 102.00	Same as ℄ B & F		56	235.0 Ft.	3,290 Ft.

2 PS-14 TRANSVERSE BULKHEADS--POST-TENSIONING SCHEDULE

Station (Ft.)	Elevation (Ft.)	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
0.0	1.00 to 20.00	19	13	26	140.0 Ft.	1,820 Ft.
	21.75 to 39.25	19	11	22	140.0 Ft.	1,540 Ft.
	41.33 to 55.92	19	8	16	140.0 Ft.	1,120 Ft.
	57.75 to 76.08	12	11	22	140.0 Ft.	1,540 Ft.
	78.17 to 87.75	6	6	12	140.0 Ft.	840 Ft.
	89.33 to 101.40	6	8	16	108.0 Ft.	864 Ft.
35.0	1.00 to 21.00	12	13	26	140.0 Ft.	1,820 Ft.
	23.00 to 41.00	12	10	20	140.0 Ft.	1,400 Ft.
	43.42 to 60.33	12	8	16	140.0 Ft.	1,120 Ft.
	61.92 to 76.17	6	10	20	140.0 Ft.	1,400 Ft.
70.0	1.00 to 76.17		Same as Station 35.0			
	78.17 to 101.40		Same as Station 0.0			
108.5	1.00 to 76.17		Same as Station 35.0			
	78.17 to 101.40		Same as Station 0.0		48.0 Ft.	672 Ft.
152.5	1.00 to 76.17		Same as Station 35.0			
	78.17 to 101.40		Same as Station 0.0		31.0 Ft.	434 Ft.
182.5	1.00 to 21.00	12	13	26	140.0 Ft.	1,820 Ft.
	23.00 to 41.00	12	10	20	140.0 Ft.	1,400 Ft.
	31.00 to 63.50	12	16	32	108.0 Ft.	1,728 Ft.
	43.42 to 60.33	12	8	16	140.0 Ft.	1,120 Ft.
	61.92 to 63.50	6	2	4	140.0 Ft.	280 Ft.
271.0	1.00 to 63.50		Same as Station 182.5			
301.0	1.00 to 76.17		Same as Station 35.0			
353.5	1.00 to 76.17		Same as Station 35.0			
383.5	1.00 to 76.17		Same as Station 35.0			
	78.17 to 87.75		Same as Station 0.0			
443.5	1.00 to 87.75		Same as Station 0.0			

3 PS-14 DECKS & BOTTOM PLATES--LONGITUDINAL POST-TENSIONING SCHEDULE

Item	℄ to ℄	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
Bottom Plate	A to B	12	7	14	443.5 Ft.	3,105 Ft.
	B to F	12	44	312	Varies	11,126 Ft.
	B to F @ CWP	12	16	40	Varies	900 Ft.
	F to G	12	7	14	443.5 Ft.	3,105 Ft.
Deck @ 77' Level	Same as Bottom Plate, except No Tendons at CWP					
Deck @ 89' Level	A to B	6	9	18	443.5 Ft.	3,992 Ft.
	B to F	6	62	124	60.0 Ft.	3,720 Ft.
	F to G	6	9	18	443.5 Ft.	3,992 Ft.
Deck @ 103' Level	C_2 to E_2	6	17	34	182.5 Ft.	3,102 Ft.
	C to E	6	10	20	152.5 Ft.	1,525 Ft.
	B to F	6	34	68	70.0 Ft.	2,380 Ft.

4 PS-14 DECKS & BOTTOM PLATES TRANSVERSE POST-TENSIONING SCHEDULE

Item	Station to Station	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
Bottom Plates	0 to 70	12	17	34	140 Ft.	1,680 Ft.
	70 to 108.5	12	14	84	80 Ft.	1,120 Ft.
	108.5 to 152.5	12	11	22	140 Ft.	1,540 Ft.
	152.5 to 182.5	12	11	66	63 Ft.	693 Ft.
	182.5 to 271.0	12	32	110	Varies	2,940 Ft.
	271 to 301	12	11	44	32 Ft.	352 Ft.
	301 to 353.5	12	13	26	140 Ft.	1,820 Ft.
	353.5 to 383.5	12	11	44	32 Ft.	352 Ft.
	383.5 to 443.5	12	14	28	140 Ft.	1,960 Ft.
Deck @ 89' Level	0 to 383.5	6	256	1,023	32 Ft.	8,192 Ft.
	383.5 to 443.5	6	25	50	140 Ft.	3,500 Ft.
Deck @ 103' Level	0 to 70	6	35	70	108 Ft.	3,780 Ft.
	70 to 108.5	6	26	52	48 Ft.	1,248 Ft.
	152.5 to 182.5	6	20	40	31 Ft.	620 Ft.
Interior Decks	Composite, Precast prestressed channel slab with 7" CIP topping *See Pretensioning Schedule*					

5 PS-14 VERTICAL POST-TENSIONING SCHEDULE

Item	Location	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
Longitudinal	℄ A & G	12	126	126	77	9,702 Ft.
Bkhds. to 77' Level		12	23	23	65	1,495 Ft.
		12	149	149	25	3,725 Ft.
	℄ B & F	Same as ℄ A, except No 25-Foot Long Tendons				
	℄ C_1 & E_1	12	20	20	77	1,540 Ft.
		12	20	20	65	1,300 Ft.
	℄ C & E	12	13	13	77	1,001 Ft.
	℄ C_2 & E_2	12	10	10	77	770 Ft.
	℄ D	12	98	98	77	7,546 Ft.
		12	20	20	65	1,300 Ft.
Transverse Bkhds. to 77' Level	Stations 0.0 & 443.5	12	43	43	77	3,311 Ft.
		12	43	43	25	1,075 Ft.
	Stations 35.0, 70.0, 108.5, 152.5, 301.0, 353.5, 383.5 & 413.5	Same as Station 0.0, except No 25-Foot Long Tendons				
Transverse Bkhds to 77' Level	Stations 182.5 & 271.0	12	10	10	77 Ft.	770 Ft.
		12	33	33	65 Ft.	2,145 Ft.
Long & Transv. Bkhds Above 77' Level	℄ A, B, C, C_2, D, E_2, E, F, & G Stations 0.0, 70.0 108.5, 152.5, 182.5, 383.5 & 443.5	6	1,400	2,800	Varies 12 & 26	22,400 Ft.
Web Frames	Various Locations	12	32	32	77 Ft.	2,464 Ft.

6 PS-14 DECK PRETENSIONING SCHEDULE

Item	Station to Station	No. of Strands	Length Each Strand	Total Strand Length
Deck @ 77' Level	0.0 to 70.0	43	140 Ft.	6,020 Ft.
	70.0 to 108.5	24	80 Ft.	1,920 Ft.
	108.5 to 152.5	27	140 Ft.	3,780 Ft.
	152.5 to 182.5	19	63 Ft.	1,197 Ft.
	182.5 to 301.0	73	32 Ft.	2,336 Ft.
	301.0 to 353.5	33	140 Ft.	4,620 Ft.
	353.5 to 383.5	19	32 Ft.	608 Ft.
	383.5 to 443.5	37	140 Ft.	5,180 Ft.
Deck @ 65' Level	70.0 to 108.5	24	32 Ft.	768 Ft.
	353.5 to 383.5	19	32 Ft.	608 Ft.
Deck @ 45' Level	0.0 to 70.0	43	108 Ft.	4,644 Ft.
	108.5 to 152.5	27	108 Ft.	2,916 Ft.
	301.0 to 353.5	33	108 Ft.	3,564 Ft.
Deck @ 32' Level	70.0 to 108.5	24	48 Ft.	1,152 Ft.
	152.5 to 182.5	19	31 Ft.	589 Ft.

*Each strand is 1/2" ϕ with 7 wires, 270 KSI grade.

7 PS-14 MISCELLANEOUS POST-TENSIONING SCHEDULE

Item	Location	No. of Strands Per Tendon	No. of Tendons	No. of Anchors	Length Each Tendon	Total Tendon Length
Bottom Plate Beams	℄ C & E C_1 & E_1	12	6	36	167 Ft.	1,000 Ft.
Web Frames	Various Location & Elevations	12	48	96	16 Ft.	768 Ft.
CWP Support:	Elevation					
Cone	0.75 to 13.50	19	10	80	176.0 Ft. (Ave)	1,760 Ft.
Socket	14.75 to 40.75	12	22	176	202.0 Ft. (Ave)	4,444 Ft.
Cylinder	42.00 to 64.00	12	12	96	238.0 Ft.	2,856 Ft.

*Each strand is 1/2" ϕ with 7 wires, 270 KSI grade.

8 PS-14 PRESTRESS MATERIALS SUMMARY

Post-Tensioning		
Tendon Type	Tendon Length	Number of Anchors
6-Strand	79,100 Ft.	4800
12-Strand	227,500 Ft.	4700
19-Strand	53,000 Ft.	700
PreTensioning		
1/2" ϕ, 7-Wire Strand: 44,500 Ft.		

NOTES:

1. Each strand is 1/2" ϕ with seven wires, 270 KSI grade.
2. All lengths are net and do not include additional length for tensioning operation.
3. Miscellaneous openings in hull for hatches, thrusters, pipe penetrations, etc. have been neglected in computing tendon lengths and number of anchorages.

REVISIONS | NO. | DATE | PRINTS TO | DATE

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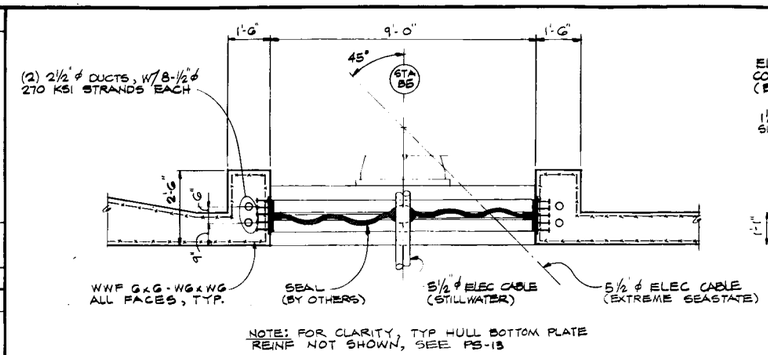
PROJECT TITLE
APL
OTEC
PLANTSHIP

SHEET TITLE
CONCRETE STRUCTURE PRE-STRESSIN SCHEDULES

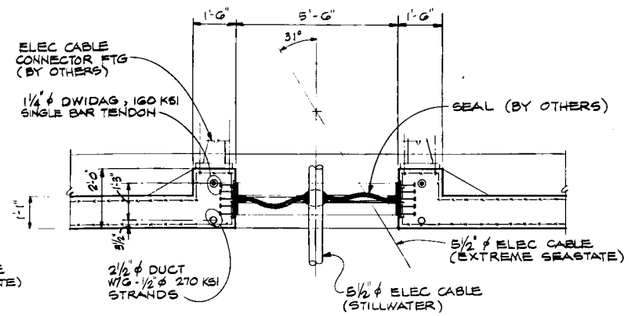
DESIGN BY D. CLOUGH
DRAWN BY R. MOHN
DATE 21 DEC. 1979
FILE NO A 79081
DRAWING NUMBER PS-14

Fig. 14 Concrete structure: pre-stressing schedules (PS-14).

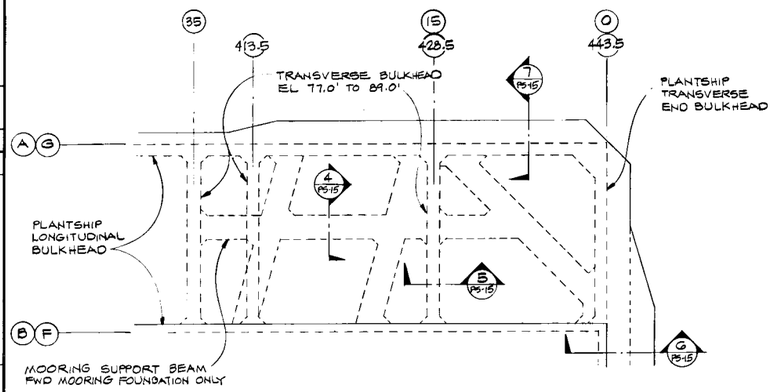


NOTE: FOR CLARITY, TYP HULL BOTTOM PLATE REINF NOT SHOWN, SEE PS-13

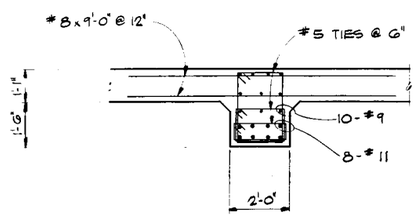
(1) PS-05 LONGITUDINAL SECTION - ELEC CONNECTION
1" = 2'-0" (SEE DWG PS-05 FOR LOCATION)



(2) PS-05 TRANSVERSE SECTION - ELEC CONNECTION
1" = 2'-0"

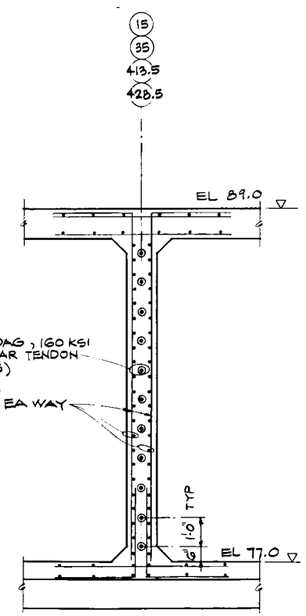


(3) PS-03 PLAN - MOORING FOUNDATION FWD & AFT @ EL 89.0
1" = 5'-0"



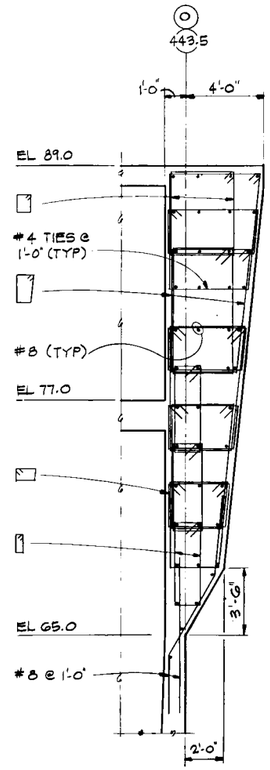
NOTE: FOR CLARITY, TYP DECK REINF NOT SHOWN, SEE PS-13

(4) PS-15 SECTION
1" = 2'-0"



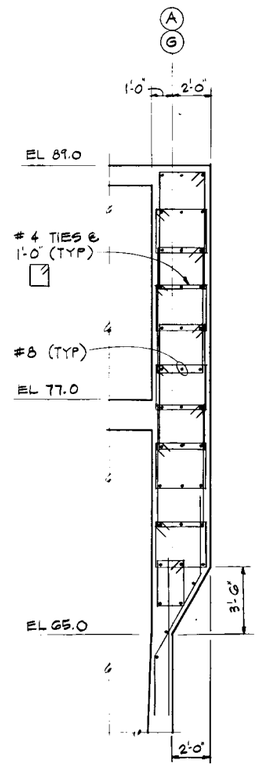
NOTE: FOR CLARITY, TYP DECK REINF NOT SHOWN, SEE PS-13

(5) PS-15 SECTION - PARTIAL BULKHEAD
1" = 2'-0"



NOTE: FOR CLARITY, TYP BULKHEAD REINF NOT SHOWN; SEE PS-15

(6) PS-15 SECTION
1" = 3'-0"
SECTION THRU FWD/AFT WAVE DEFLECTORS



(7) PS-15 SECTION
1" = 3'-0"
SECTION THRU PORT/STBD WAVE DEFLECTORS

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DRAWING 44 132 3120

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PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
MISCELLANEOUS CONCRETE DETAILS

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO. A79061
DRAWING NUMBER: PS-15

Fig. 15 Miscellaneous concrete details (PS-15).

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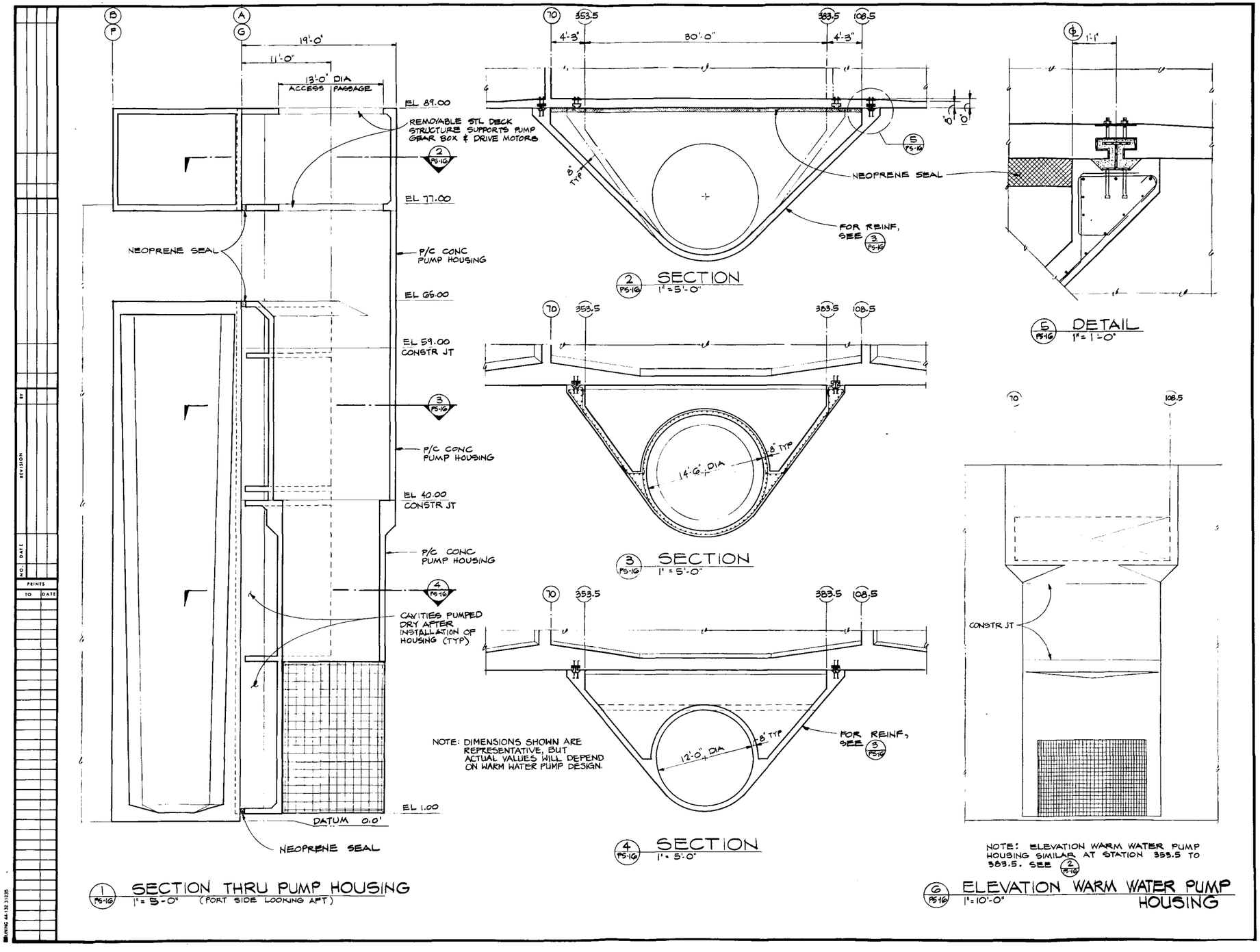
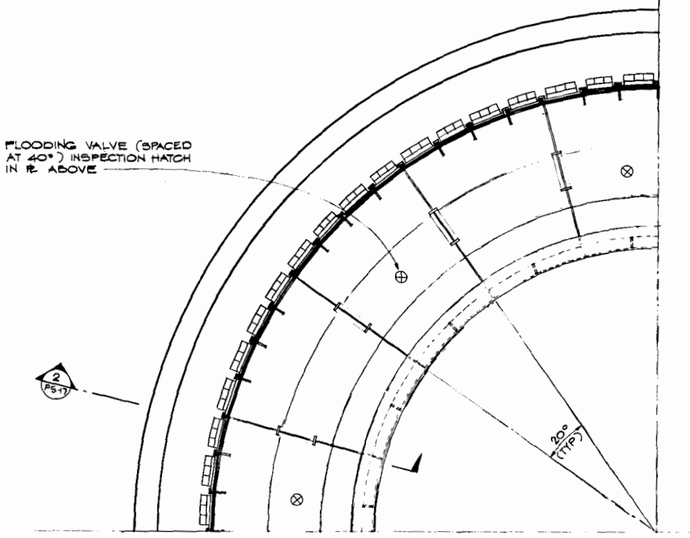
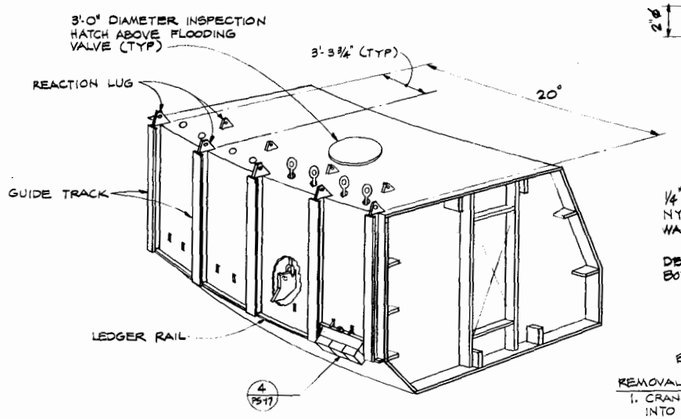


Fig. 16 Housing: warm water pump (PS-16).

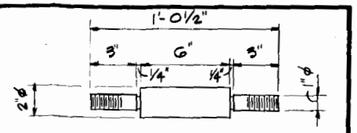


1 PS-17 PLAN
1" = 5'-0"

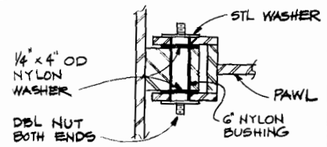


3 PS-17 PERSPECTIVE
NO SCALE

NOTES:
- A36 STEEL
- GALVANIZE ALL COMPONENTS PRIOR TO ASSEMBLY. GALVANIZE ALL WELDS AFTER JOINING



6 PS-17 DETAIL
NO SCALE

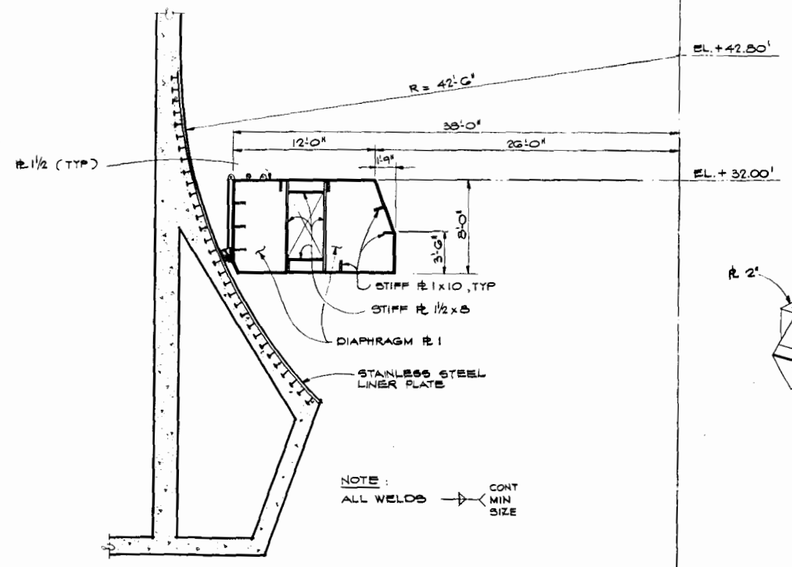


7 PS-17 DETAIL
NO SCALE

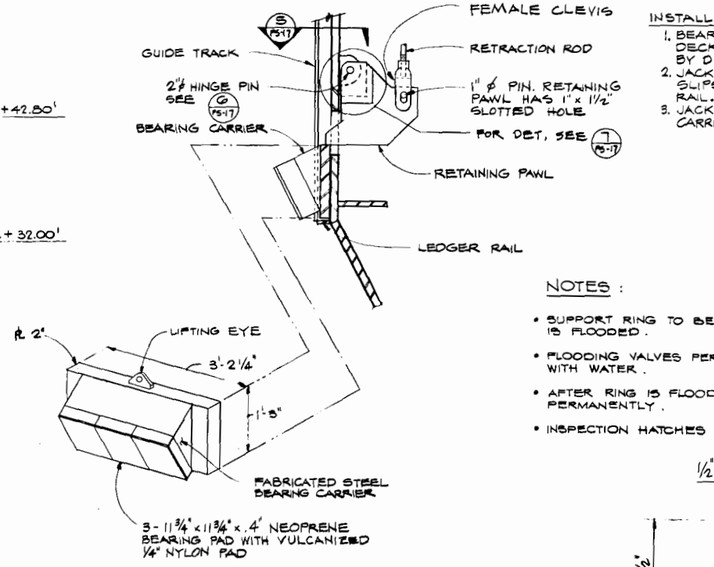
BEARING REPLACEMENT PROCEDURE

REMOVAL:
1. CRANE LOWERS JACKING FRAME (NOT SHOWN) INTO POSITION; DIVER INSERTS PINS THROUGH REACTION LUGS TO SECURE.
2. JACK IS EXTENDED AND EXERTS DOWNWARD FORCE ON BEARING CARRIER TO RELEASE PAWLS.
3. DIVER DRAWS RETRACTION RODS UP, PAWLS RETREAT THROUGH SIDE OF RING.
4. JACK IS WITHDRAWN; DIVER ATTACHES CABLE TO LIFTING EYE.
5. BEARING CARRIER IS RAISED THROUGH GUIDE TRACKS AND UP TO DECK.
6. RETRACTION RODS ARE RELEASED, PAWLS SWING FREELY TO ORIGINAL POSITION.

INSTALLATION:
1. BEARING CARRIER IS LOWERED FROM DECK AND PLACED IN GUIDE TRACKS BY DIVER.
2. JACK IS EXTENDED; BEARING CARRIER SLIPS PAST PAWLS AND DOWN TO LEDGER RAIL.
3. JACK IS WITHDRAWN, PAWLS HOLD BEARING CARRIER IN POSITION.

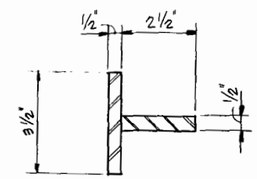


2 PS-17 SECTION - SUPPORT RING
1" = 5'-0"



4 PS-17 DETAIL - BEARING ASSEMBLY
NO SCALE

NOTES:
- SUPPORT RING TO BE INSTALLED BEFORE DRYDOCK IS FLOODED.
- FLOODING VALVES PERMIT SUPPORT RING TO FILL WITH WATER.
- AFTER RING IS FLOODED, VALVES ARE CLOSED PERMANENTLY.
- INSPECTION HATCHES NOT WATERTIGHT.



5 PS-17 SECTION - GUIDE TRACK
NO SCALE

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PROJECT TITLE
APL
OTEC
PLANTSHIP

SHEET TITLE
STEEL
SUPPORT
RING

DESIGN BY: D. CLOUGH
DRAWN BY: D. HUYNH
DATE: 21 DEC 1979
FILE NO: AT9051
DRAWING NUMBER: PS-17

NO.	DATE	REVISION

PRINTS TO	DATE

BRUNING 44-132-31235

Fig. 17 Steel-support ring (PS-17).

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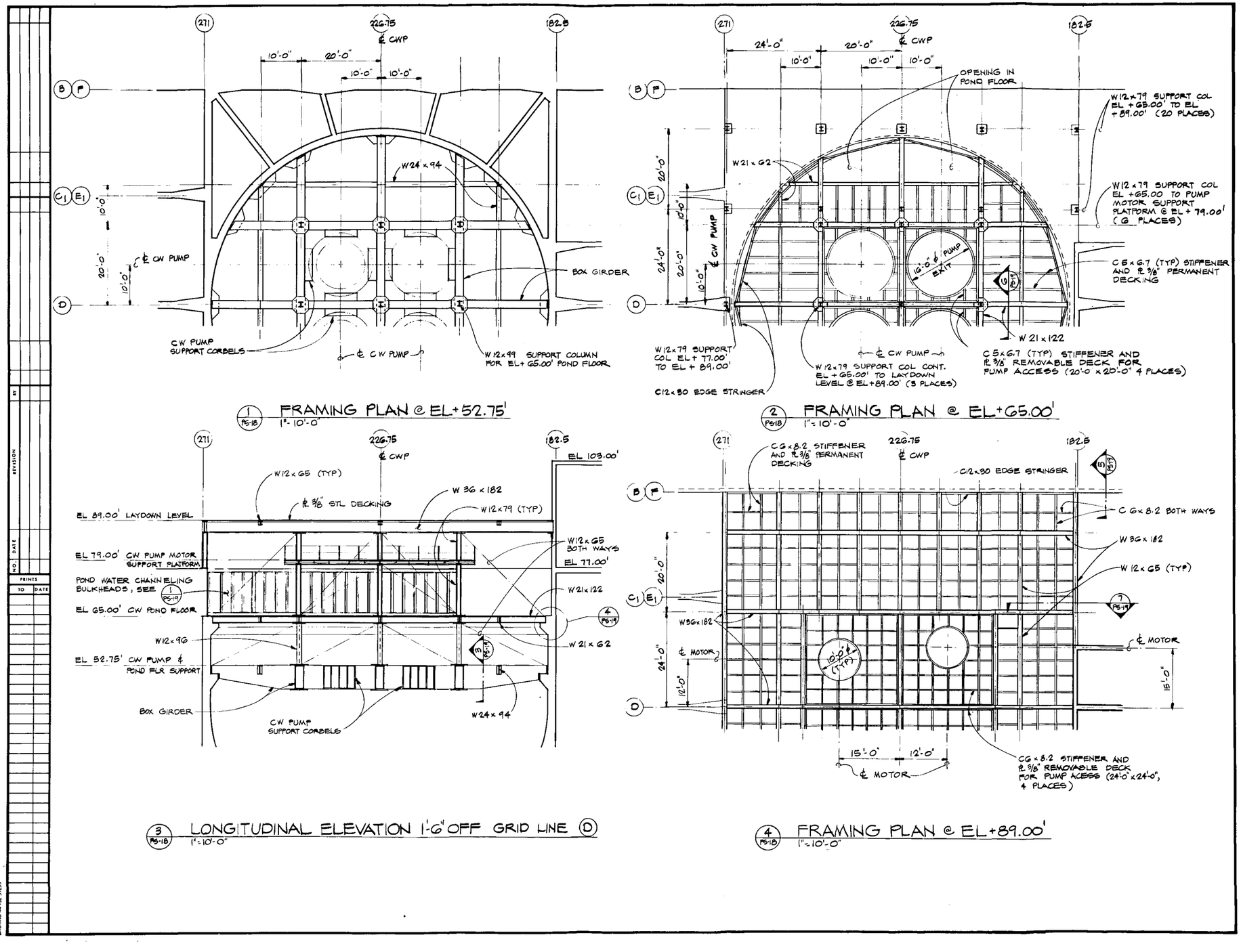

1 PS-18 FRAMING PLAN @ EL+52.75'
1"= 10'-0"

2 PS-18 FRAMING PLAN @ EL+65.00'
1"= 10'-0"

3 PS-18 LONGITUDINAL ELEVATION 1'-6" OFF GRID LINE (D)
1"=10'-0"

4 PS-18 FRAMING PLAN @ EL+89.00'
1"=10'-0"

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PRINTS	TO	DATE

BRUNING 44 132 3125

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PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
COLD WATER POND FLOOR SUPPORT FRAMING

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO A79051
DRAWING NUMBER PS-18

Fig. 18a Cold-water pond floor-support framing (PS-18).

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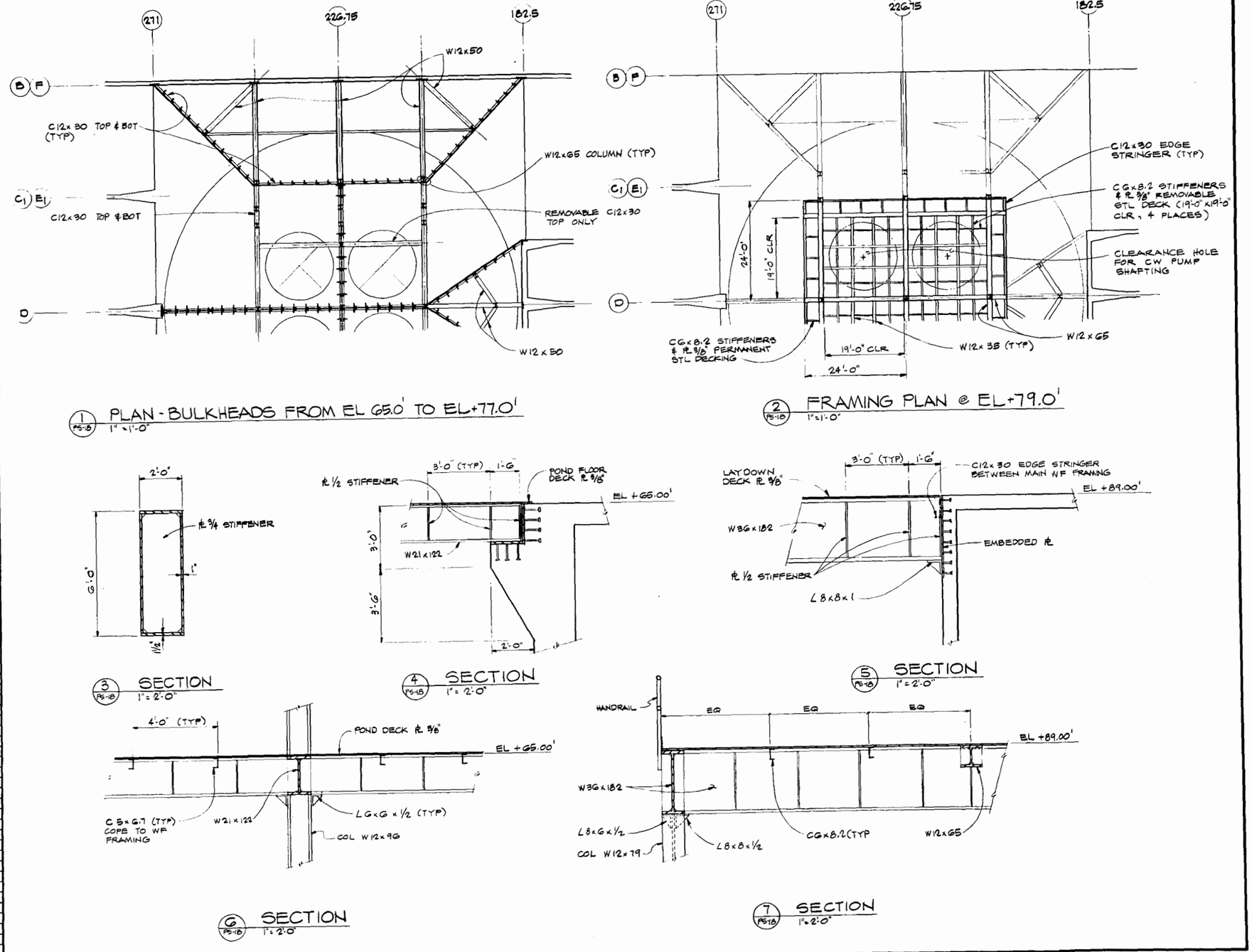

NO. DATE REVISION

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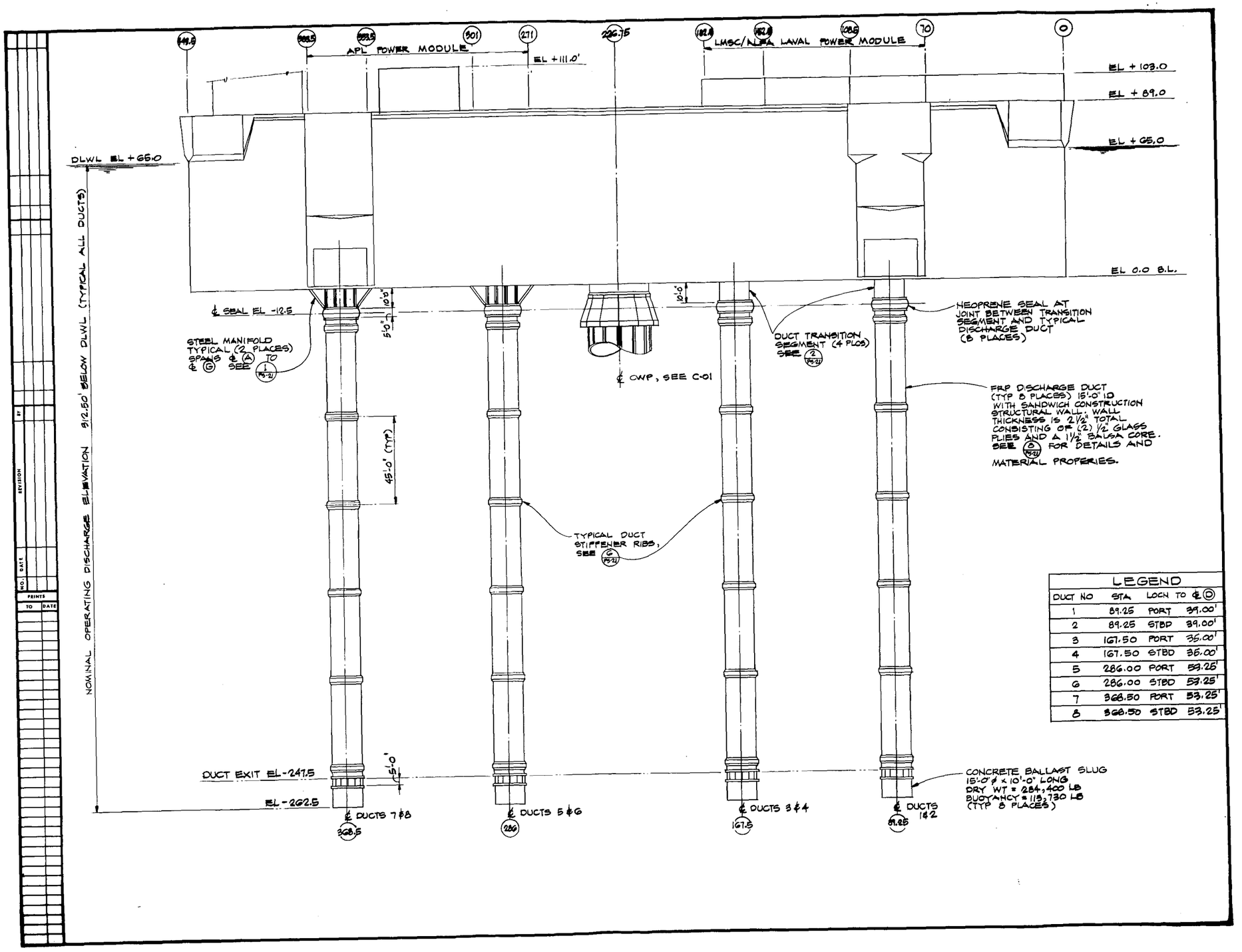
PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
COLD WATER POND FLOOR SUPPORT FRAMING

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO A79051
DRAWING NUMBER PS-19

Fig. 18b Cold-water pond floor-support framing (PS-19).



LEGEND			
DUCT NO	STA	LOCN TO ℄ (D)	
1	89.25	PORT	39.00'
2	89.25	STBD	39.00'
3	167.50	PORT	39.00'
4	167.50	STBD	39.00'
5	286.00	PORT	53.25'
6	286.00	STBD	53.25'
7	368.50	PORT	53.25'
8	368.50	STBD	53.25'

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PROJECT TITLE
APL OTEC PLANTSHIP

SHEET TITLE
GENERAL ARRANGEMENT DISCHARGE DUCTS

DESIGN BY W. CICHANSKI
DRAWN BY R. MOHN
DATE 21 DEC 1979
FILE NO A79051
DRAWING NUMBER PS-20

Fig. 19 General arrangement: discharge ducts (PS-20).

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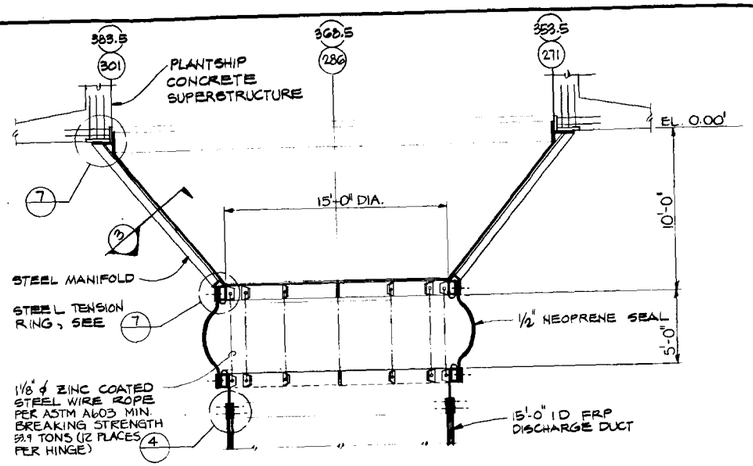
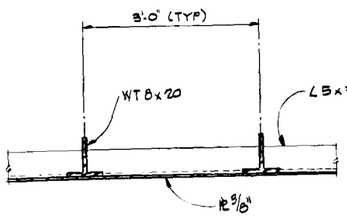
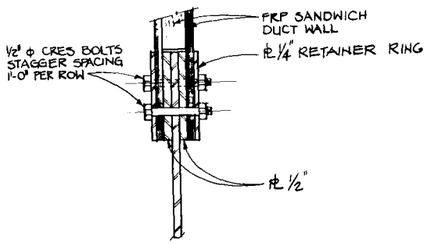


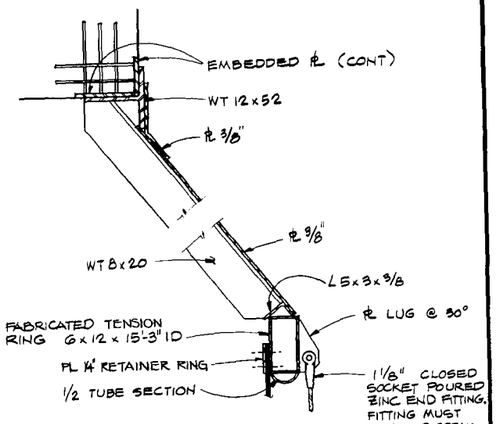
1 SECTION-APL DISCHARGE DUCT



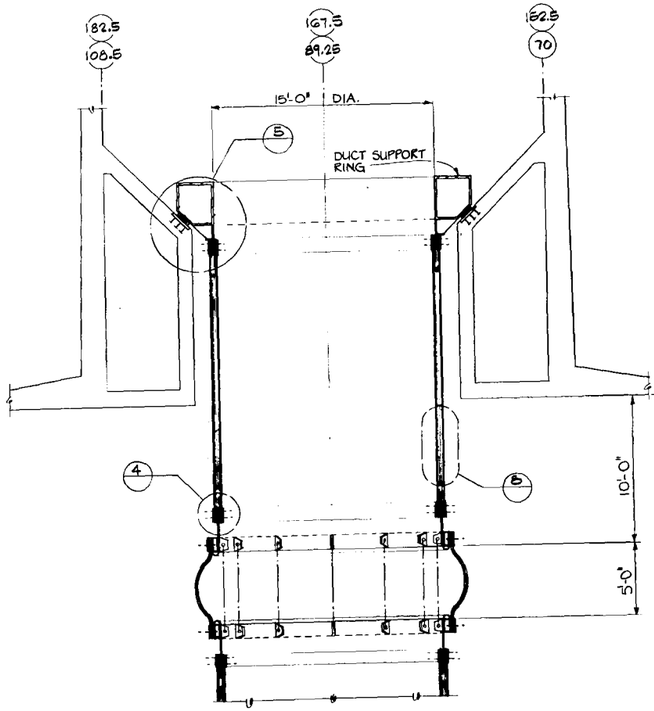
3 SECTION
1"=1'-0"



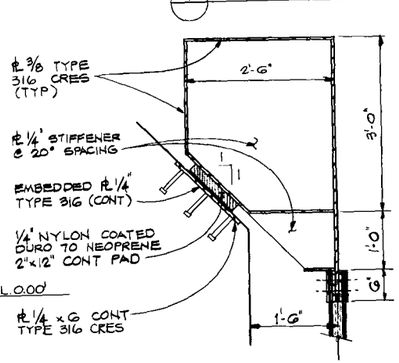
4 DETAIL



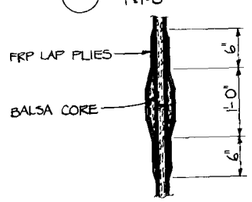
7 DETAIL
1"=1'-0"



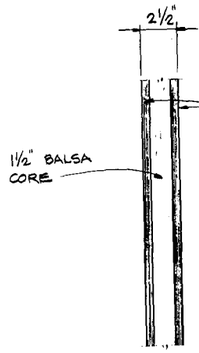
2 SECTION-LMSC/ALFA LAVAL TRANSITION DUCT



5 DETAIL
1"=1'-0"



6 DETAIL-DUCT STIFFENER



REINFORCED CLOTH FABRIC WITH RESIN/GLASS RATIO = .50, SEE TABLE 'A' FOR SHORT TERM STRUCTURAL PROPERTIES.

TABLE "A"

FRP STRUCTURAL PROPERTIES	
SPECIFIC GRAVITY	1.89
GLASS CONTENT	50%
FLEXURAL STRENGTH	40 KSI
FLEXURAL MODULUS	1.9×10^6 PSI
TENSILE STRENGTH	34 KSI
COMPRESSIVE STRENGTH	50 KSI
SHEAR STRENGTH	20 KSI

8 DETAIL-FRP SANDWICH DUCT WALL

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CONSULTING ENGINEERS
1107 PORT OF TACOMA ROAD TACOMA, WASH. (206) 383-1091

PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
DISCHARGE DUCT DETAILS

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO: A79051
DRAWING NUMBER: PS-21

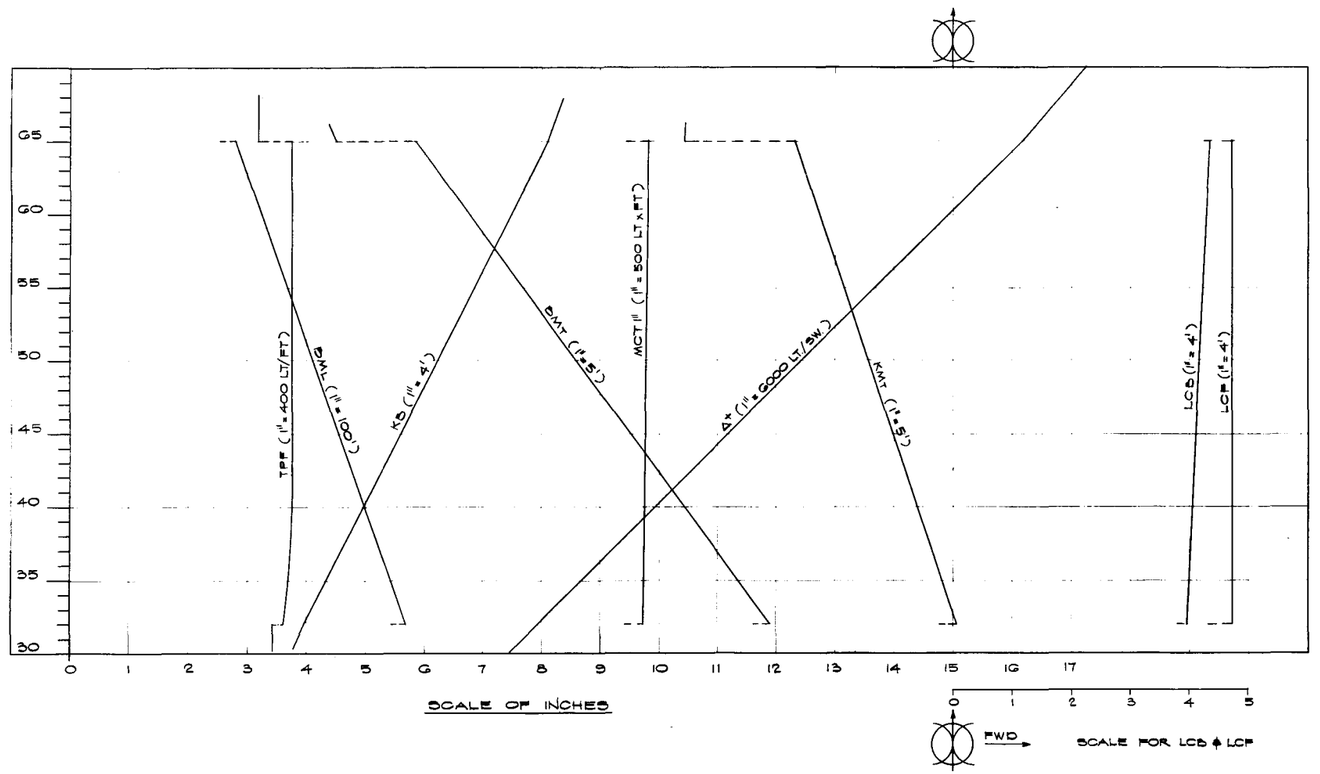
REVISION | NO. | DATE | PRINTS TO | DATE

BRUNING 44-132-31235

Fig. 20 Details of the discharge ducts (PS-21).

NOTES :

1. TONS ARE 2240 LBS.
2. SALT WATER IS 35 CUBIC FEET / LONG TON.
3. PROPERTIES ARE TO OUTSIDE OF STRUCTURE.
4. EFFECT OF THRUSTERS, WARM WATER PUMPS AND SEACHESTS HAS BEEN NEGLECTED.
5. EFFECT OF 20 MW APL HEAT EXCHANGERS HAS BEEN INCLUDED, WITH A TOTAL BUOYANCY OF 2056 LT, EVENLY DISTRIBUTED BETWEEN BASELINE AND 65' WL. LMSC HEAT EXCHANGER COMPARTMENTS ARE CONSIDERED INTACT.
6. KG = 42 FEET HAS BEEN USED IN CALCULATION OF MCT 1".
7. PROPERTIES INCLUDE EFFECT OF WARM WATER PUMP HOUSING, ASSUMING VOLUME CONTAINED BETWEEN HULL AND WARM WATER DUCT IS DRY.



NO.	DATE	BY	REVISION

PRINTS TO DATE

ABAM
ABAM ENGINEERS INCORPORATED
CONSULTING ENGINEERS
1121 PORT OF TACOMA ROAD TACOMA, WASH. (206) 383-3091

PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
HYDROSTATIC CURVES

DESIGN BY: O. SANDER
DRAWN BY: O.S. / SH
DATE: 21 DEC 1979
FILE NO. A79051
DRAWING NUMBER PS-22

BRUNING 44-132 31235

Fig. 21 Hydrostatic curves (PS-22).

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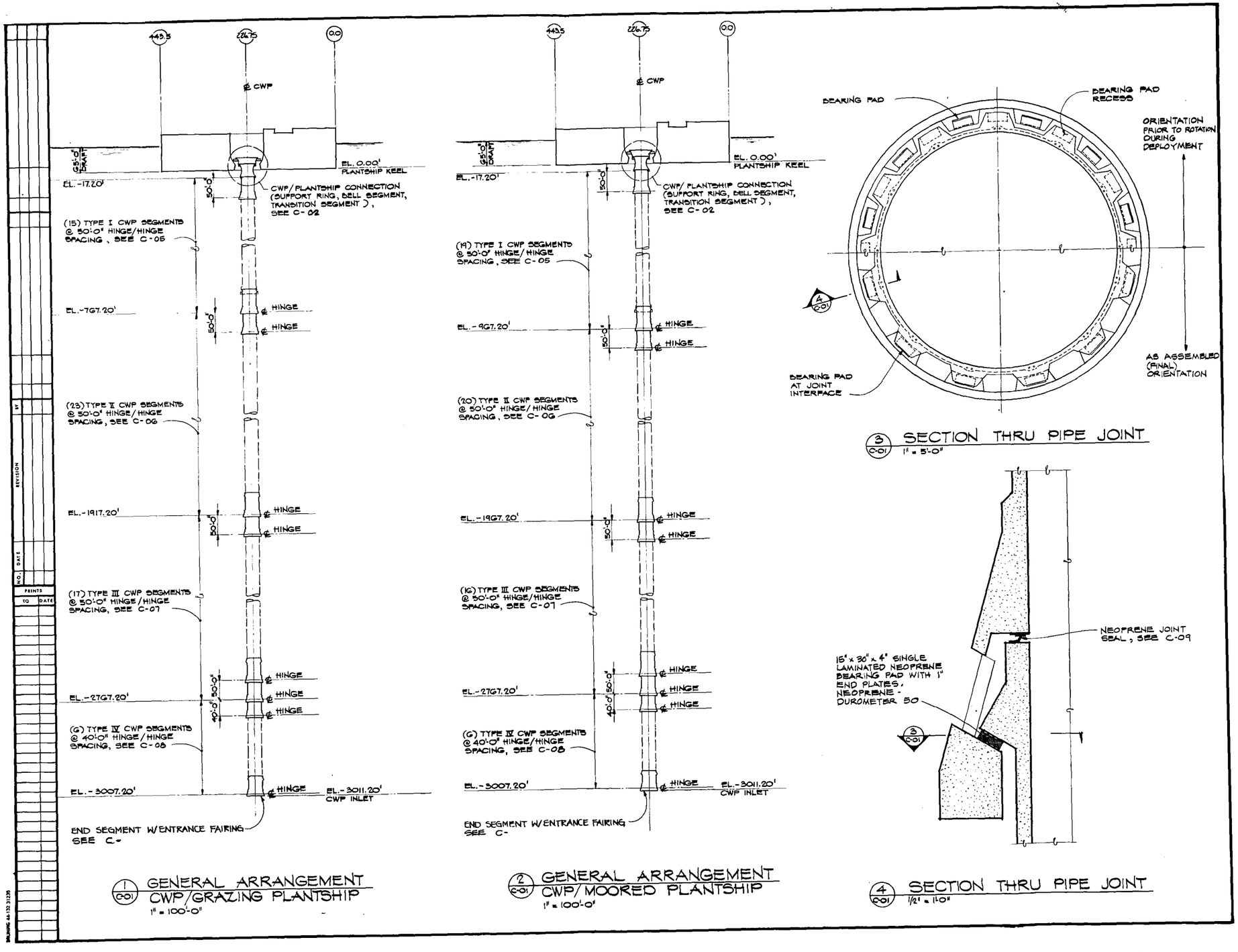
APPLIED PHYSICS LABORATORY
LAUREL, MARYLAND



1 0-01 GENERAL ARRANGEMENT CWP/GRAZING PLANTSHIP
1" = 100'-0"

2 0-01 GENERAL ARRANGEMENT CWP/MOORED PLANTSHIP
1" = 100'-0"

3 0-01 SECTION THRU PIPE JOINT
1" = 5'-0"

4 0-01 SECTION THRU PIPE JOINT
1/2" = 1'-0"

REVISION | NO. | DATE | PRINTS TO | DATE

ABAM
ABAM ENGINEERS INCORPORATED
CONSULTING ENGINEERS
1127 PORT OF TACOMA ROAD TACOMA, WASH. (206) 383-8091

PROJECT TITLE
APL OTEC PLANTSHIP

SHEET TITLE
CWP GENERAL ARRANGEMENT

DESIGN BY: W. CICHANOWICZ
DRAWN BY: D. HUYNH
DATE: 21 DEC 1979
FILE NO. A79051
DRAWING NUMBER C-01

Fig. 22 General arrangement of the CWP (C-01).

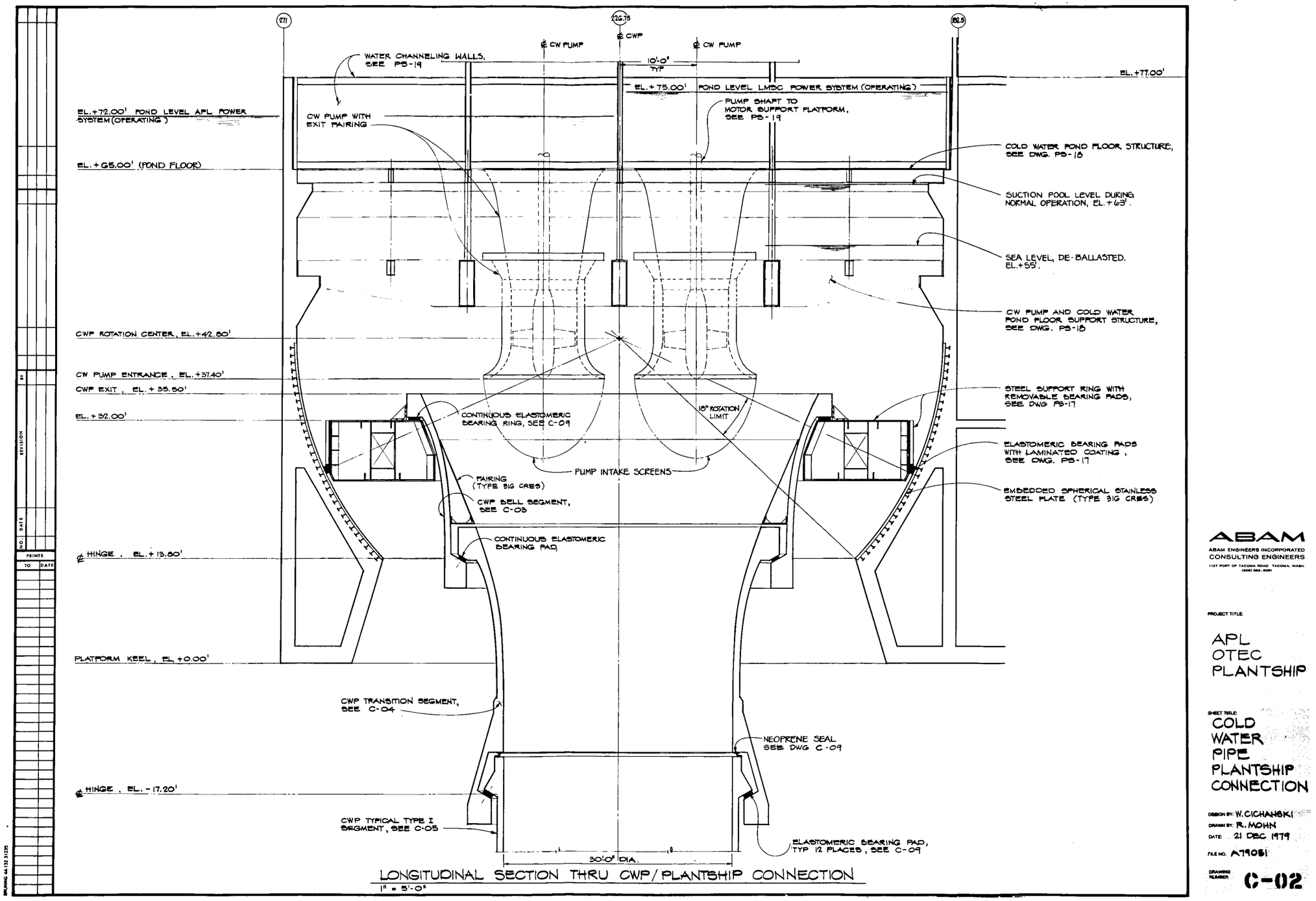


Fig. 23 Cold-water pipe/plantship connection (C-02).

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LAUREL, MARYLAND

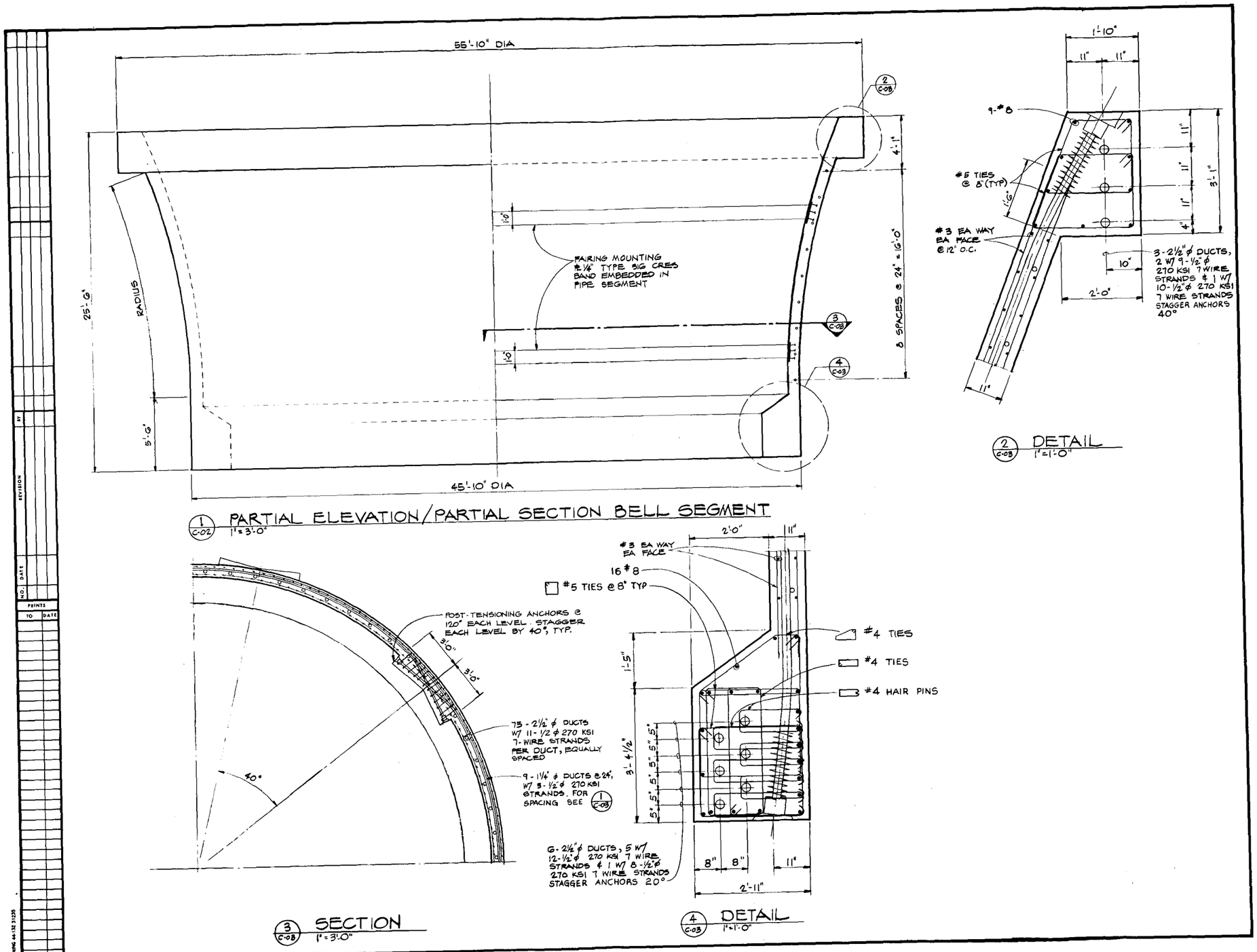

Fig. 24 Details of the upper bell segment (C-03).

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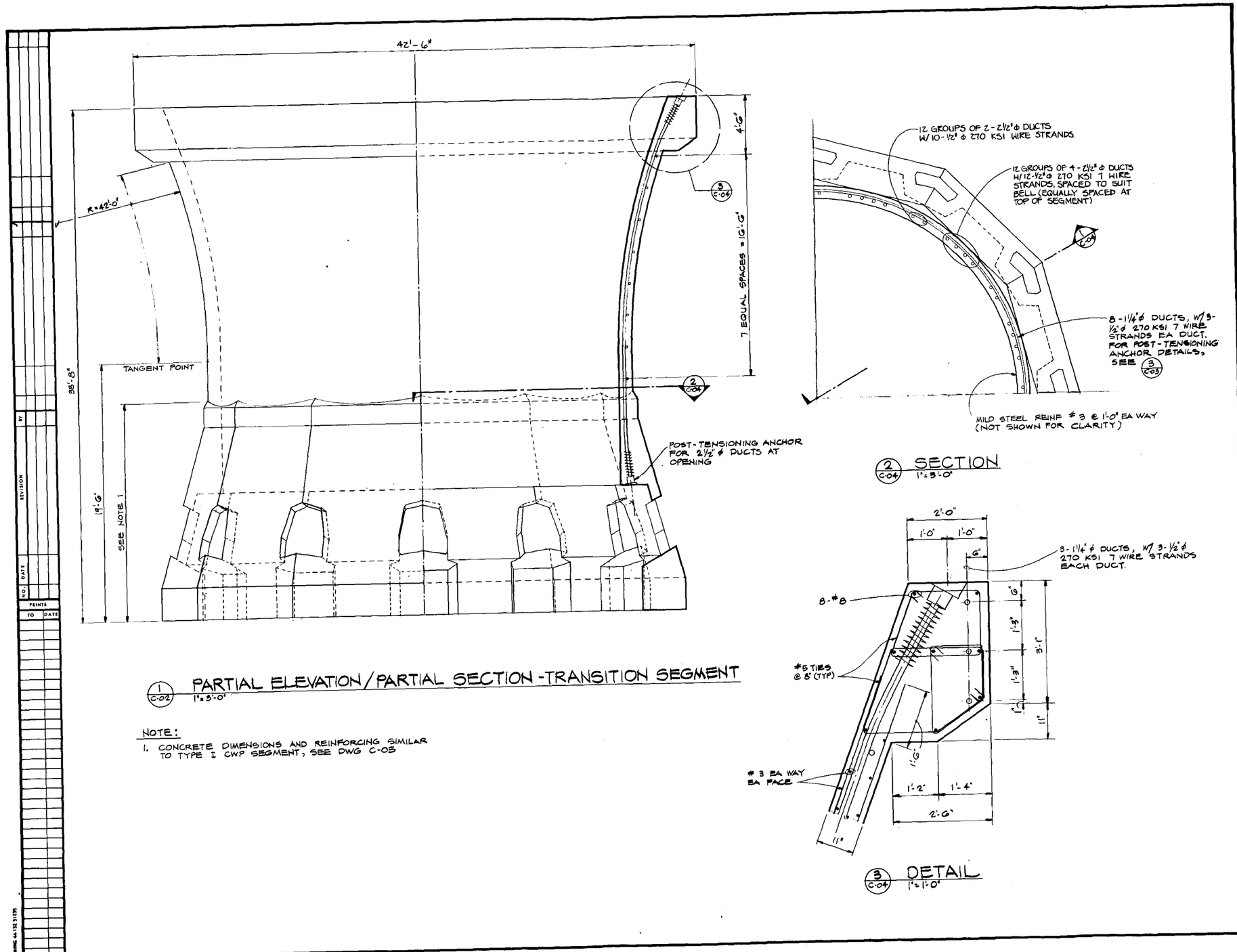
APPLIED PHYSICS LABORATORY
LAUREL, MARYLAND



1 C-02 PARTIAL ELEVATION / PARTIAL SECTION - TRANSITION SEGMENT
1" = 5'-0"

2 C-04 SECTION
1" = 5'-0"

3 C-04 DETAIL
1" = 1'-0"

NOTE:
1. CONCRETE DIMENSIONS AND REINFORCING SIMILAR TO TYPE I CWP SEGMENT, SEE DWG C-05

NO.	DATE	BY	REVISION

PRINTS

TO	DATE

BRUNING 44-132-31235

ABAM
ABAM ENGINEERS INCORPORATED
CONSULTING ENGINEERS
1191 POINT OF TACOMA ROAD, TACOMA, WASH. (206) 383-5091

PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
TRANSITION SEGMENT DETAILS

DESIGN BY: O. SANDER
DRAWN BY: R. MOHN
DATE: 21 DEC 1979
FILE NO: A79051
DRAWING NUMBER: C-04

Fig. 25 Details of the transition segment (C-04).

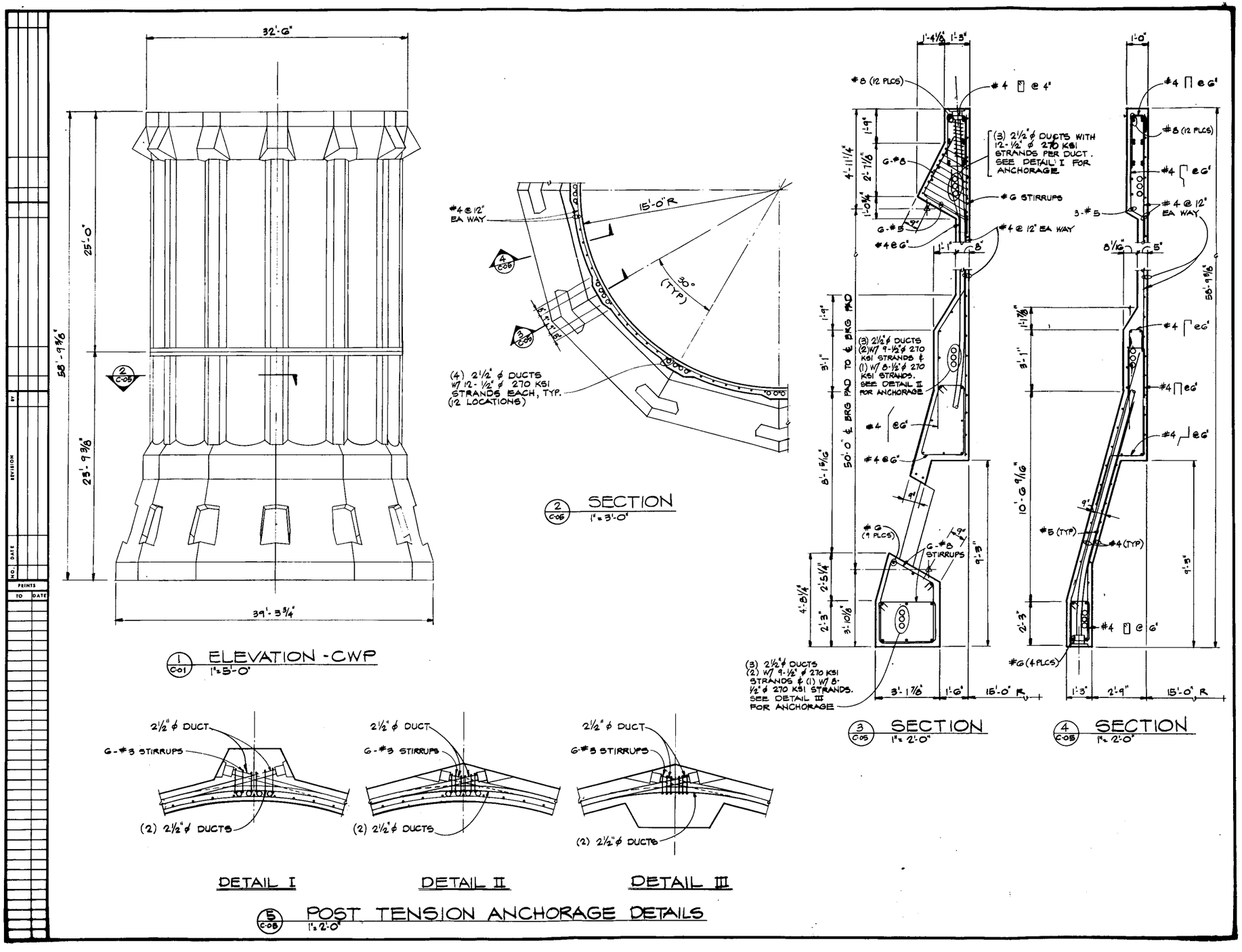
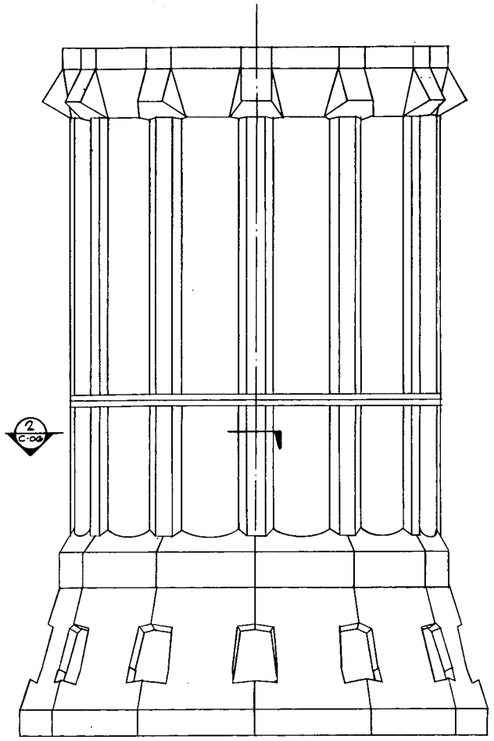
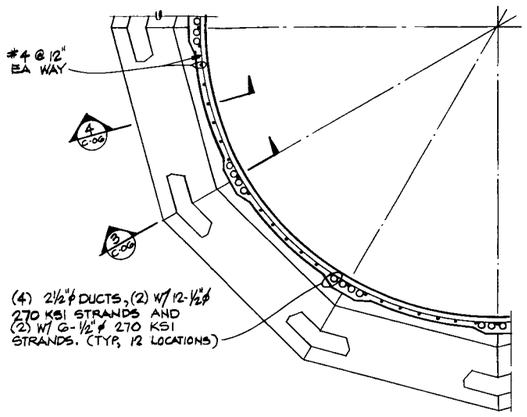


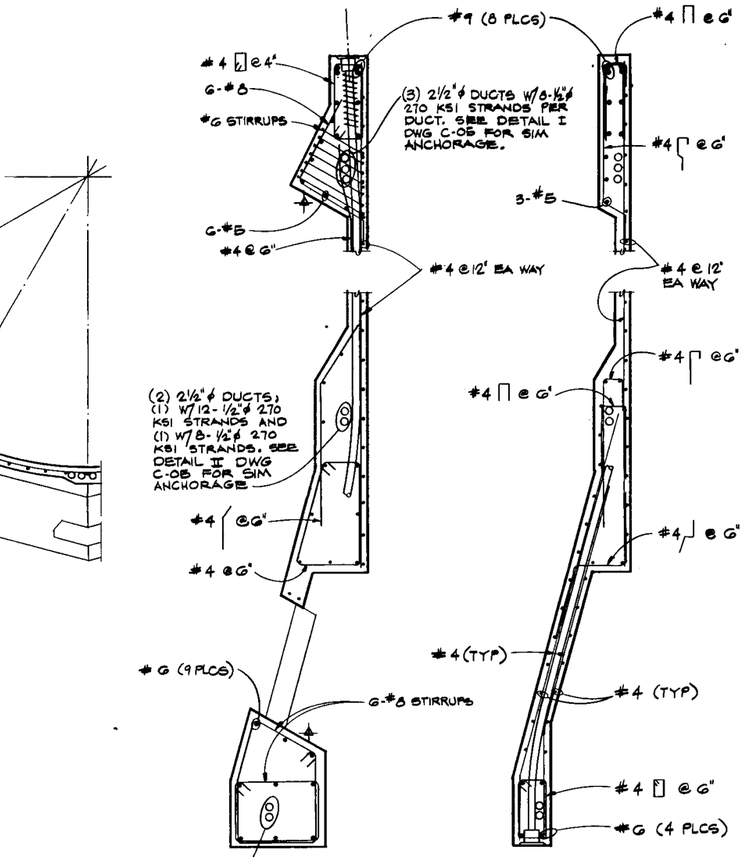
Fig. 26 Details of the CWP Type I segment (C-05).



(1) C-01 ELEVATION - CWP
1"=5'-0"



(2) C-06 SECTION
1"=3'-0"



(3) C-06 SECTION
1"=2'-0"

(4) C-06 SECTION
1"=2'-0"

NOTE:
DIMENSIONS NOT SHOWN ARE THE SAME AS CWP TYPE I, DWG C-05

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PRINTS TO	DATE

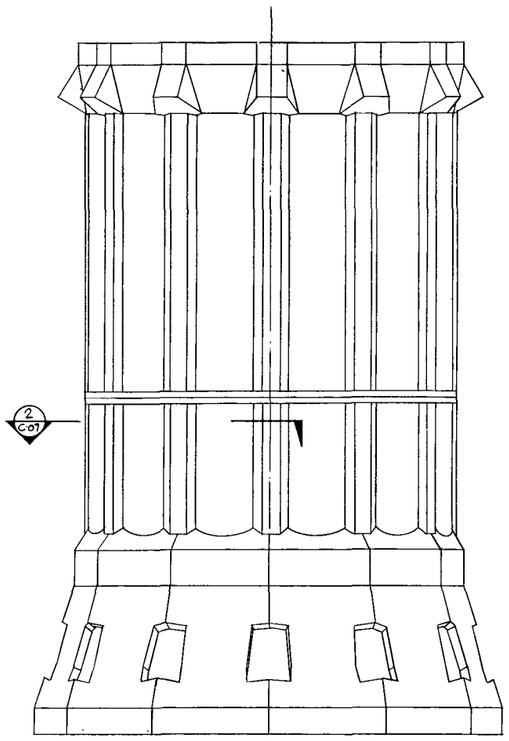
ABAM
ABAM ENGINEERS INCORPORATED
CONSULTING ENGINEERS
1197 PORT OF TACOMA ROAD, TACOMA, WASH. (206) 383-3081

PROJECT TITLE
APL
OTEC
PLANTSHIP

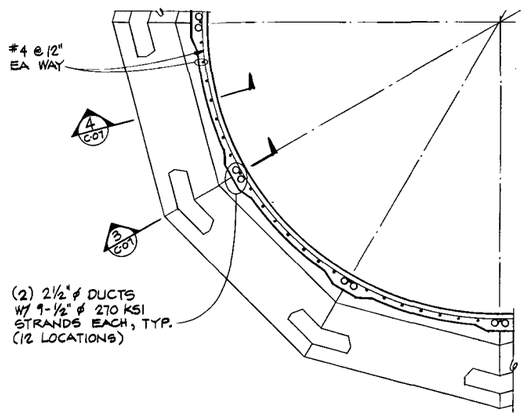
SHEET TITLE
CWP
TYPE II
SEGMENT
DETAILS

DESIGN BY W. CICHANSKI
DRAWN BY R. MOHN
DATE 21 DEC 1979
FILE NO A79051
DRAWING NUMBER C-06

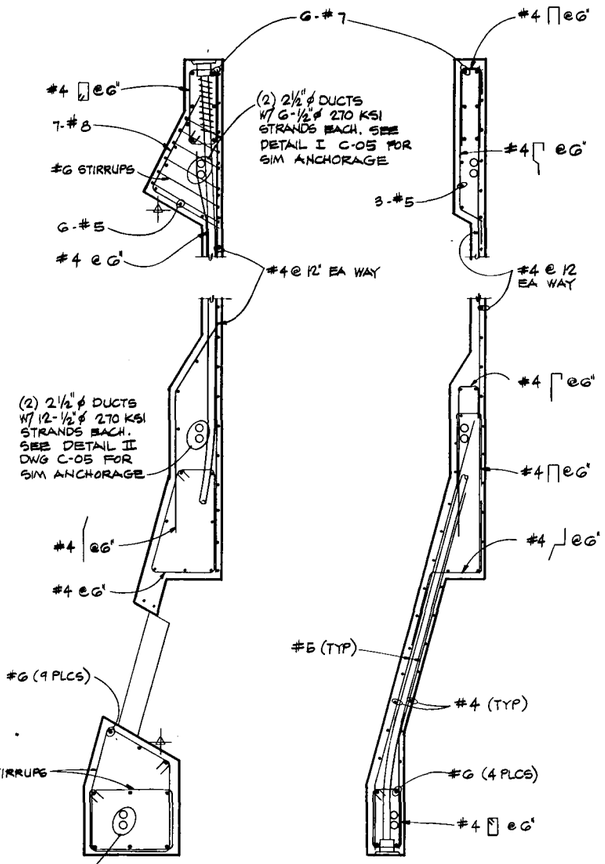
Fig. 27 Details of the CWP Type II segment (C-06).



(1) C-01 ELEVATION - CWP
1"=5'-0"



(2) C-07 SECTION
1"=3'-0"



(3) C-07 SECTION
1"=2'-0"

(4) C-07 SECTION
1"=2'-0"

NOTE:
DIMENSIONS NOT SHOWN ARE THE SAME AS CWP TYPE, I DWG C-05

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CONSULTING ENGINEERS
1191 PORT OF TACOMA ROAD, TACOMA, WASH.
(206) 383 - 8091

PROJECT TITLE:
APL
OTEC
PLANTSHIP

SHEET TITLE:
CWP
TYPE III
SEGMENT
DETAILS

DESIGN BY: W. CICHANSKI
DRAWN BY: R. MOHN
DATE: 21 DEC. 1979
FILE NO. A79051
DRAWING NUMBER C-07

REVISION | NO. | DATE
PRINTS TO | DATE

DRAWING 44-132 31235

Fig. 28 Details of the CWP Type III segment (C-07).

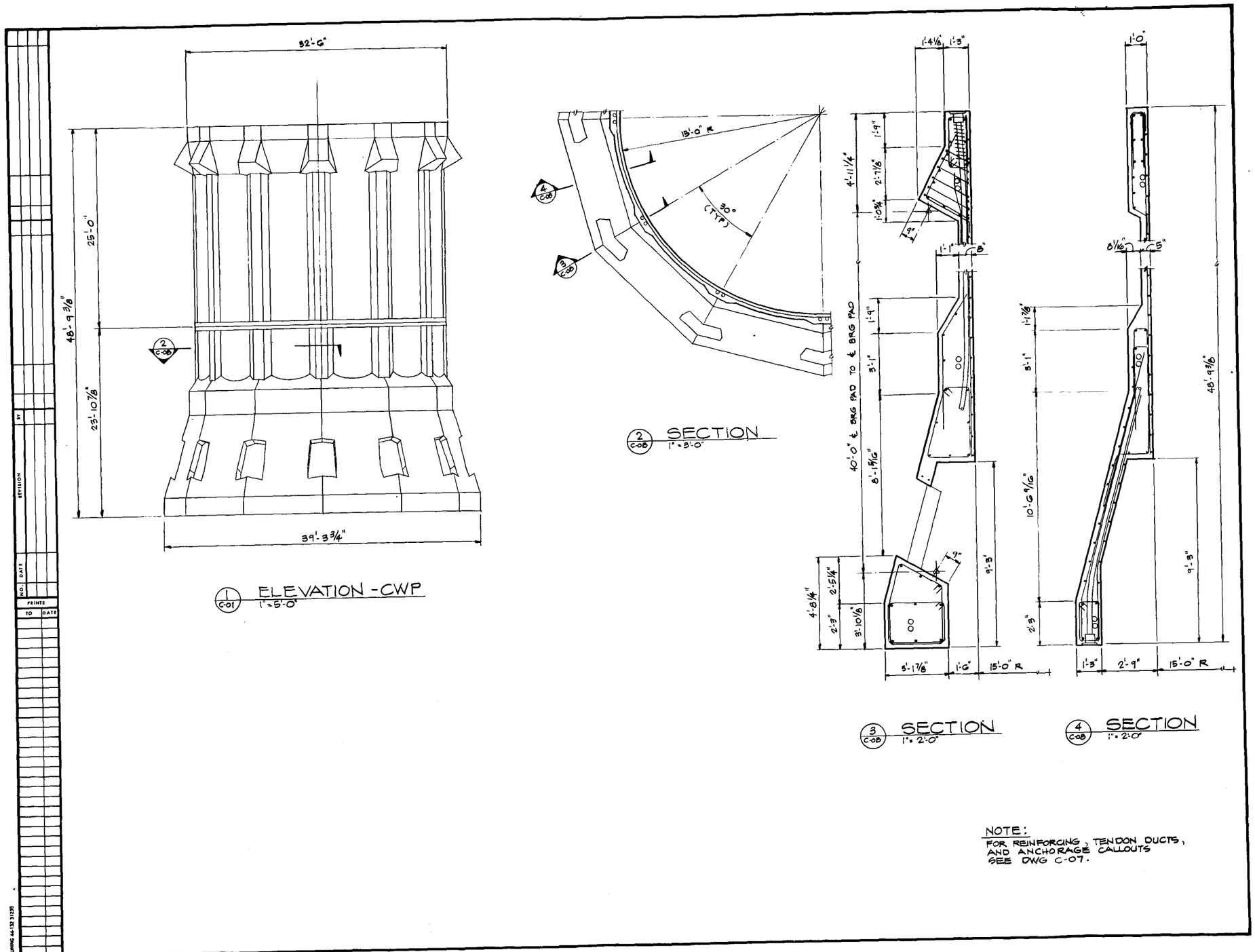
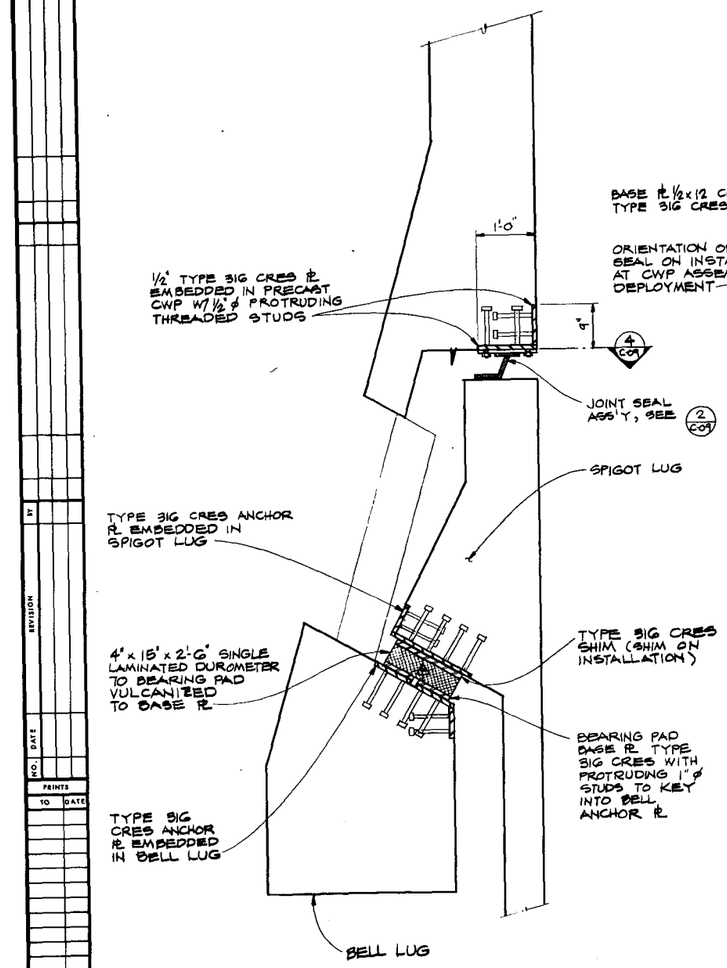
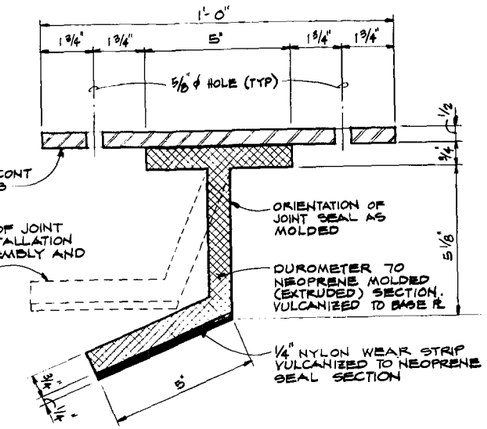


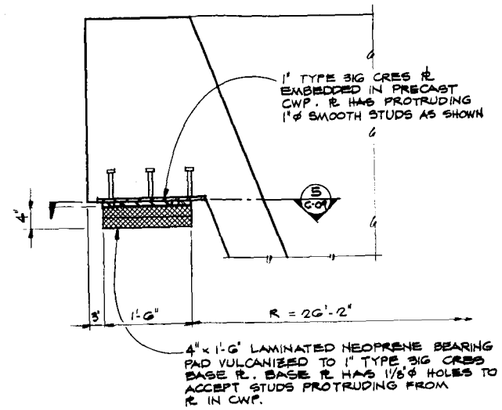
Fig. 29 Details of the CWP Type IV segment (C-08)



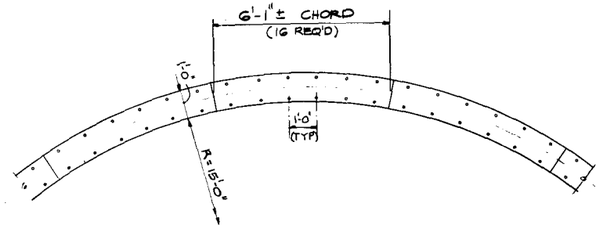
1 C-01 SECTION THRU TYP CWP JOINT
1"=1'-0"



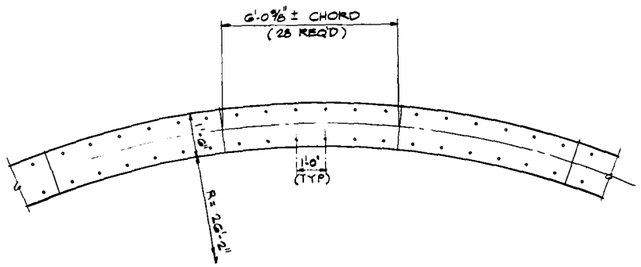
2 C-09 JOINT SEAL ASSEMBLY
HALF SIZE



3 C-09 SECTION THRU UPPER BELL SEGMENT TOP RING
1"=1'-0"



4 C-09 PARTIAL PLAN - TYPICAL JOINT SEAL ASS'Y
1"=2'-0"



5 C-09 PARTIAL PLAN - UPPER BELL SEGMENT BRG PAD ASS'Y
1"=2'-0"

REVISION | NO. | DATE | PRINTS TO | DATE

ABAM
ABAM ENGINEERS INCORPORATED
CONSULTING ENGINEERS
1121 PORT OF TACOMA ROAD TACOMA, WASH. (206) 383-3081

PROJECT TITLE
APL
OTEC
PLANTSHIP

SHEET TITLE
MISCELLANEOUS CWP DETAILS

DESIGN BY W. CICHANSKI
DRAWN BY R. MOHN
DATE 21 DEC 1979
FILE NO A79081
DRAWING NUMBER C-09

Fig. 30 Miscellaneous details of the CWP (C-09).

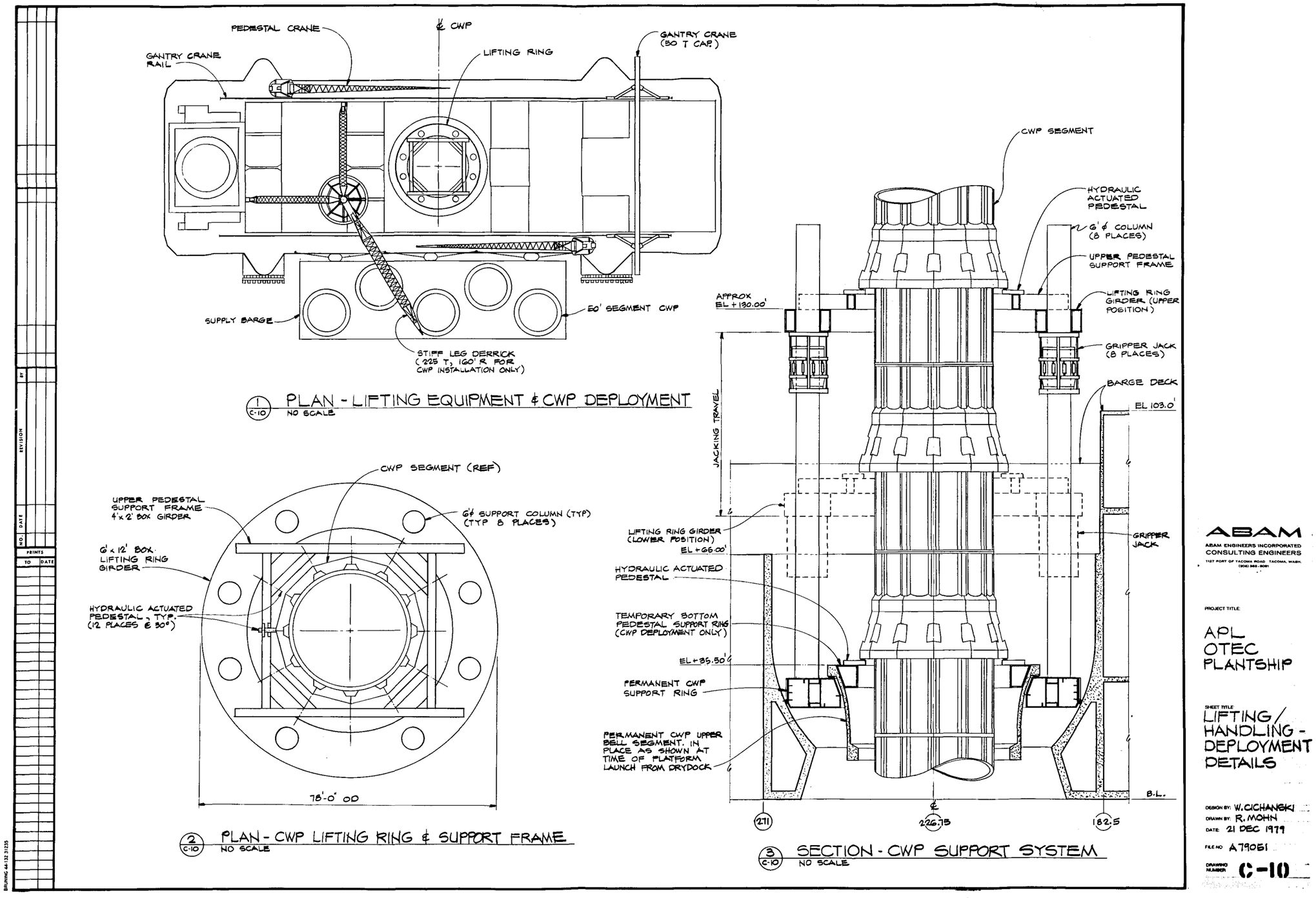


Fig. 31 Details of lifting/handling-deployment (C-10).

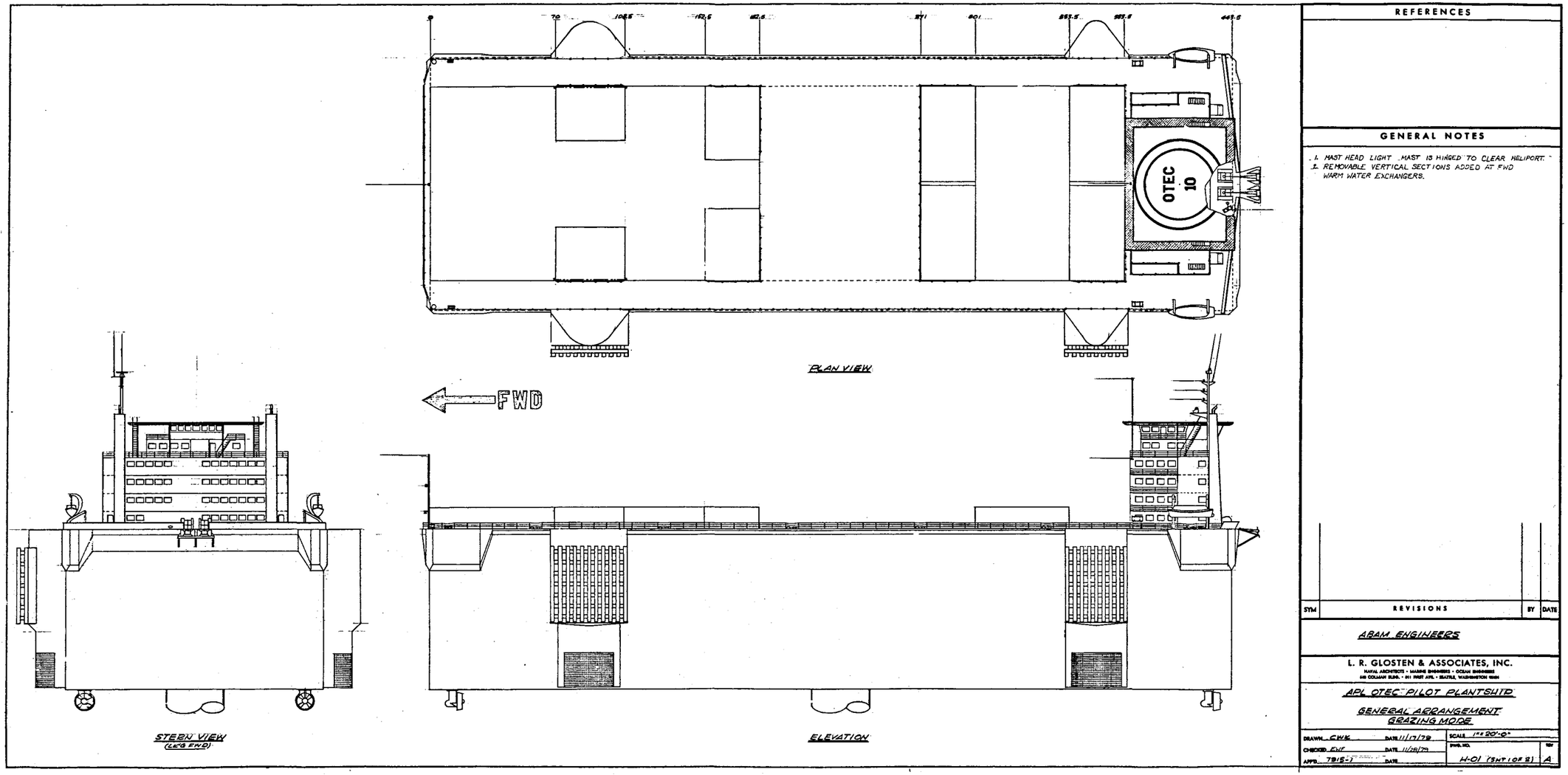
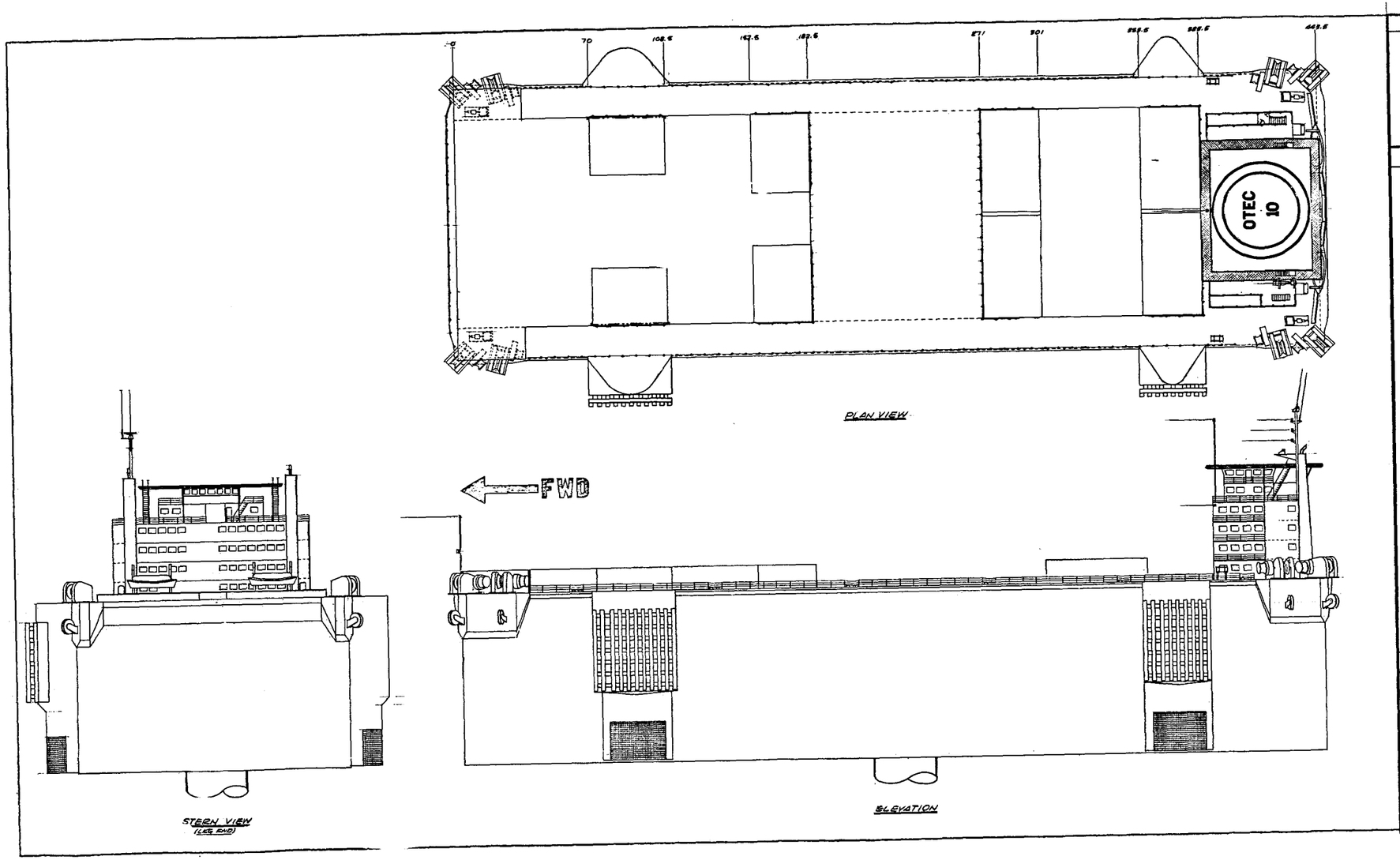


Fig. 32 General arrangement: grazing mode (H-01, sheet 1 of 2).



REFERENCES

GENERAL NOTES

1. MASTHEAD LIGHT MAST IS HINGED TO CLEAR HELIPORT.
2. REMOVABLE VERTICAL SECTIONS ADDED AT FOR WARD WARM WATER EXCHANGERS.

SYM	REVISIONS	BY	DATE

ABAM ENGINEERS

L. R. GLOSTEN & ASSOCIATES, INC.
NAVAL ARCHITECTS • MARINE ENGINEERS • OCEAN ENGINEERS
600 COLMAN BLDG. • 811 FIRST AVE. • SEATTLE, WASHINGTON 98104

APL OTEC PILOT PLANTSHIP

GENERAL ARRANGEMENT
MOORED MODE

DRAWN CWK	DATE 11/27/78	SCALE 1"=20'-0"	
CHECKED RHF	DATE 11/28/78	DWG. NO.	REV
APP'D 7815-1	DATE	H-01 (SHT 2 OF 2)	A

Fig. 33 General arrangement: moored mode (H-01, sheet 2 of 2).

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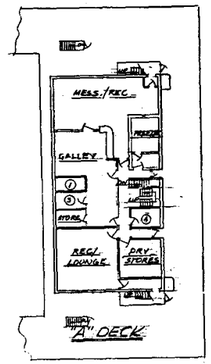
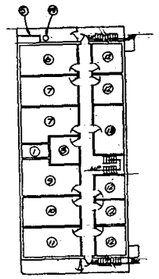
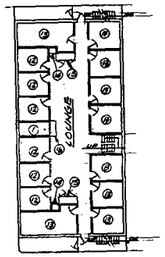
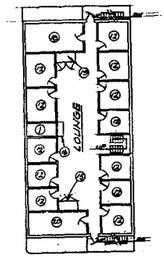
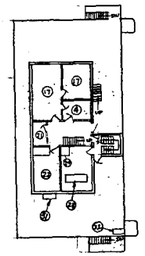
APPLIED PHYSICS LABORATORY
LAUREL, MARYLAND

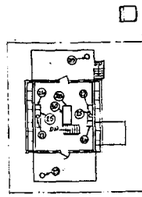



"B" DECK






BRIDGE DECK


PILOT HSE.

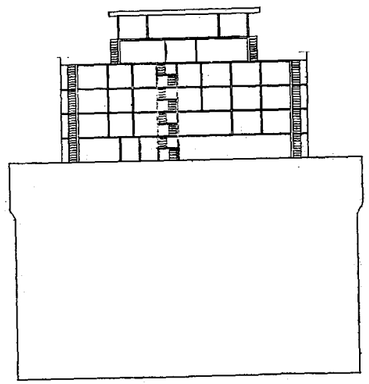
LEGEND
(FOR DECKS "A" - "D")

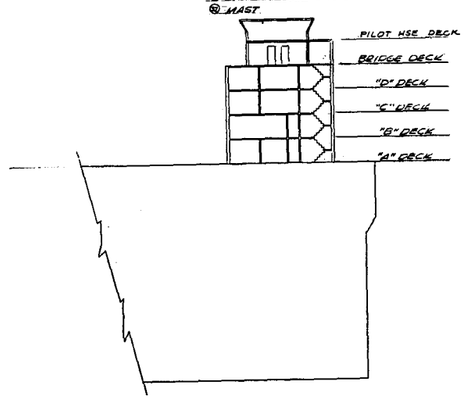
1. SERVICE SPACE
2. DRESSER SERVER
3. GARBAGE COMPACTOR ROOM
4. SHIP'S OFFICE
5. PAINT LOCKER
6. HOSPITAL
7. GYM & REC. ROOM
8. GENERAL STORES
9. LAUNDRY
10. LINEN LOCKERS & STORES
11. COMPUTER ROOM
12. ONE-MAN CABIN
13. TWO-MAN CABIN
14. LINEN LOCKER
15. LOCKER
16. COFFEE AREA
17. MASTER'S CABIN
18. CHIEF ENGINEER'S CABIN
19. CO_2

FWD

LEGEND
(FOR BRIDGE DK.)

1. TWO-MAN CABIN
2. HEAD
3. RADIO ROOM
4. EMERGENCY GENERATOR
5. D.O. TANK (1000 GAL.)
6. CONTROL CONSOLE
7. RADAR
8. GYRO
9. CHART TABLE
10. PELORUS
11. GYRO LOCKER (UNDER)
12. BATTERY BOX - RADIO
13. MAST


STERN VIEW (LK'G FWD)



ELEVATION @ ℄

20' 10' 0' 20' 40'
1"=20'-0"

REFERENCES

GENERAL NOTES

SYM	REVISIONS	BY	DATE

ABAM ENGINEERS

L. R. GLOSTEN & ASSOCIATES, INC.
NAVAL ARCHITECTS • MARINE ENGINEERS • OCEAN ENGINEERS
810 COLMAN BLDG. • 811 FIRST AVE. • SEATTLE, WASHINGTON 98104

APL OTEC PILOT PLANTSHIP

GEN'L ARRANGEMENT - LIVING QTRS.

DRAWN CWK	DATE 8/14/78	SCALE 1"=20'-0"	
CHECKED EMF	DATE 11/28/78	DWG. NO. MO-01	REV A
APP'D 7315:2	DATE		

Fig. 34 General arrangement: living quarters (MO-01).

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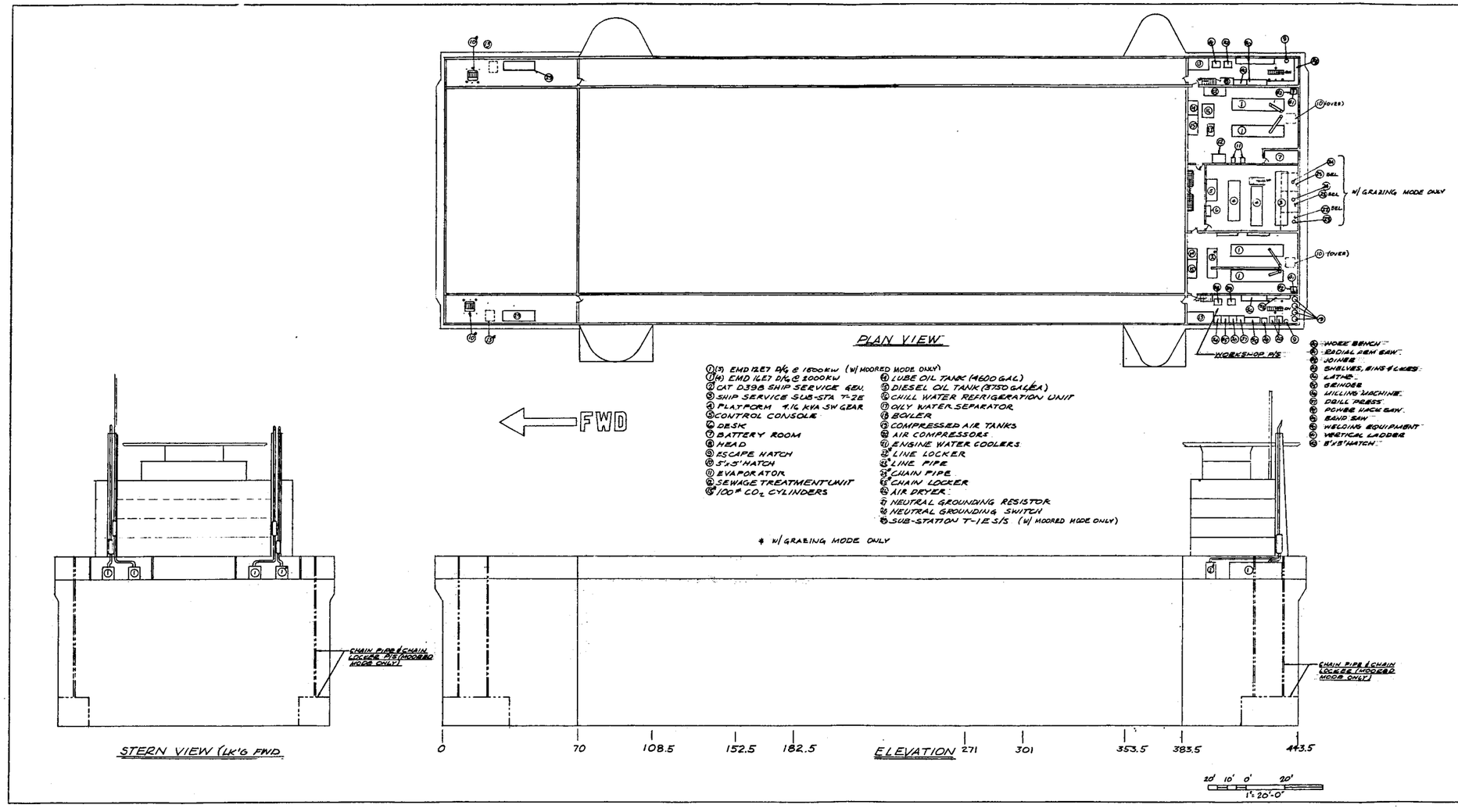

REFERENCES

GENERAL NOTES

1. ARRANGEMENTS FOR WORKSHOPS P/S AS E/R FOR GRAZING MODE. ARRANGEMENTS FOR MOORED MODE WILL BE SIMILAR BUT MAY VARY SLIGHTLY.

SYM	REVISIONS	BY	DATE

ABAM ENGINEERS
OCT. 31, 1978

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616 COLMAN BLDG. • 811 FIRST AVE. • SEATTLE, WASHINGTON 98104

APL OTEC PILOT PLANTSHIP

MACH'Y ARRANGEMENT @ 77' W.L.

DRAWN CWK	DATE 8/18/78	SCALE 1"=20'	
CHECKED GHF	DATE 11/28/78	DWG NO. MO-02	REV A
APP'D 7918-3	DATE		

Fig. 35 Machinery arrangement at 77-ft water level (MO-02).

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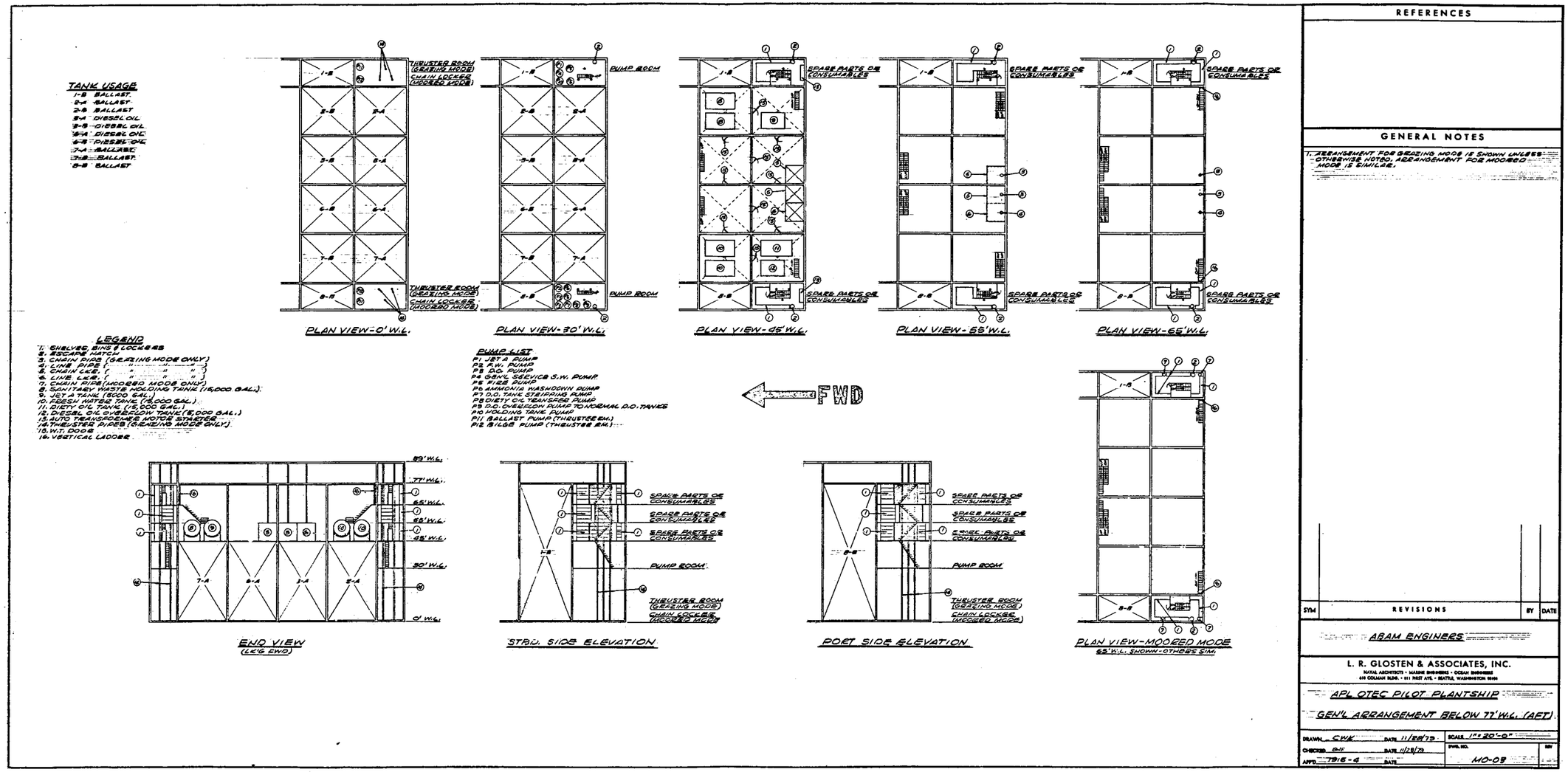

REFERENCES

GENERAL NOTES

1. ARRANGEMENT FOR GRAZING MODE IS SHOWN UNLESS OTHERWISE NOTED. ARRANGEMENT FOR MOORED MODE IS SIMILAR.

SYM	REVISIONS	BY	DATE

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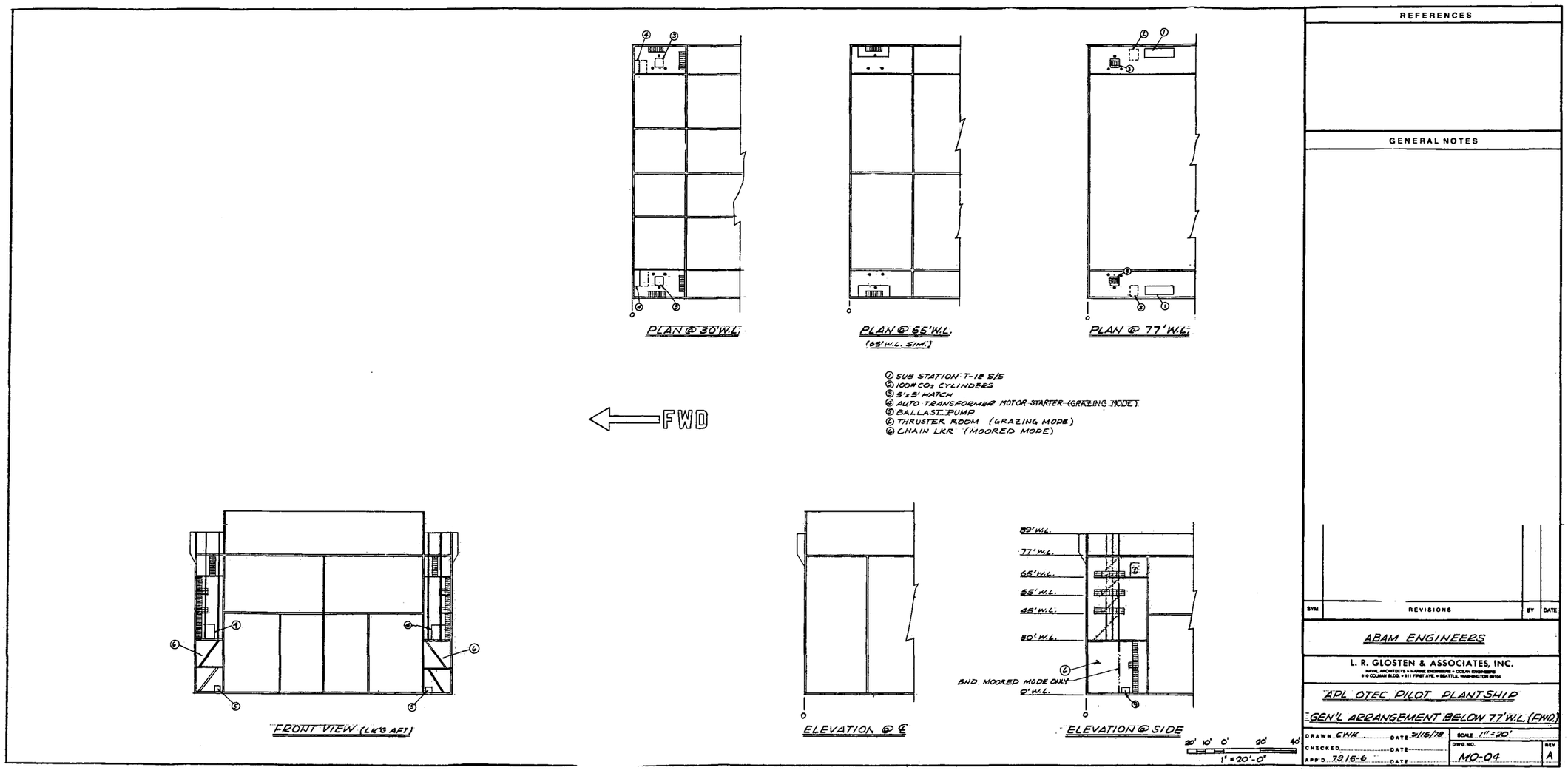
APL OTEC PILOT PLANTSHIP

GEN'L ARRANGEMENT BELOW 77' W.L. (AFT)

DRAWN CWK	DATE 11/28/79	SCALE 1"=20'-0"	
CHECKED CHF	DATE 11/28/79	DWG. NO.	REV
APP'D 7916-4	DATE	MO-03	

Fig. 36 General arrangement below 77-ft water level: aft (MO-03).



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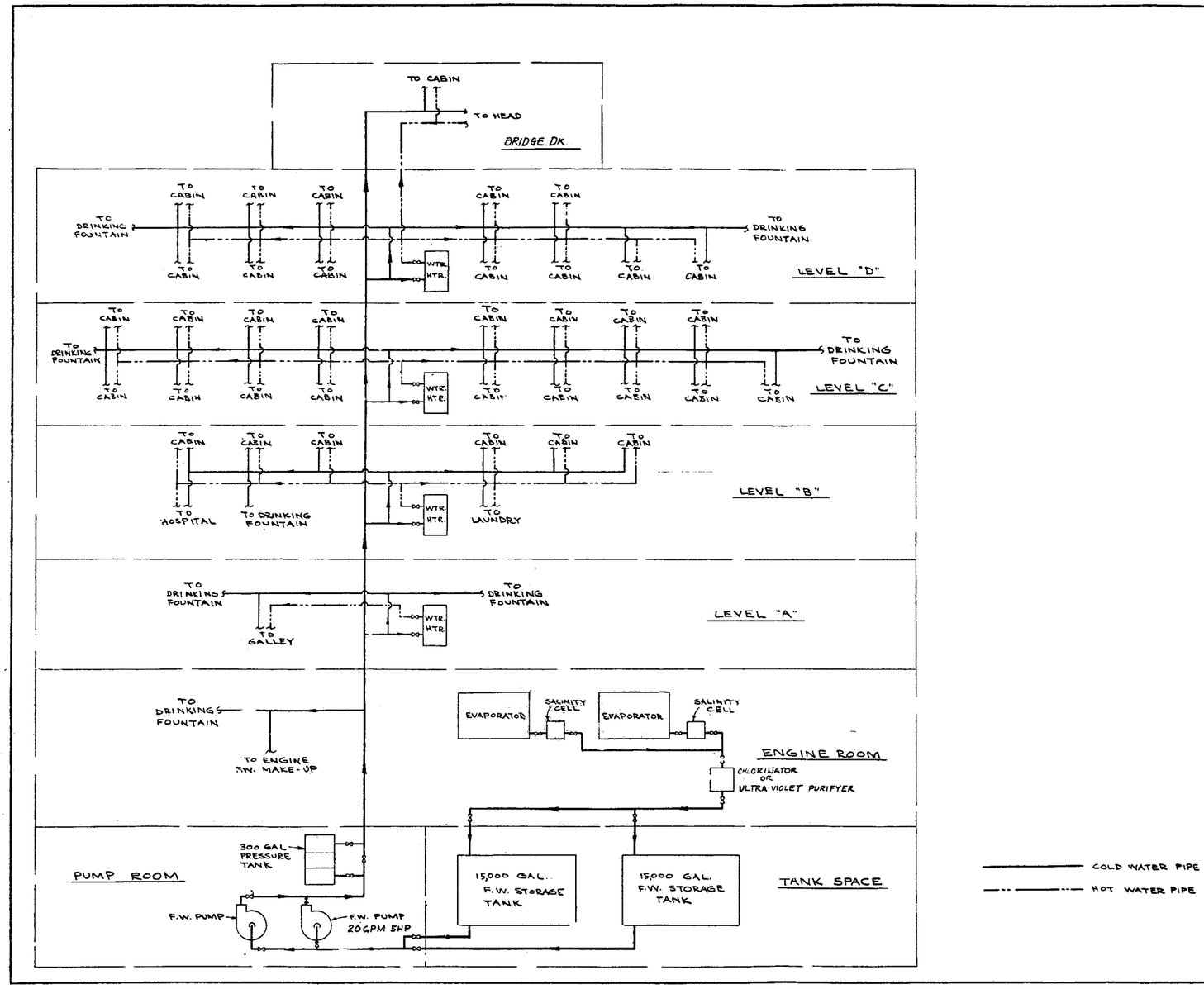
APL OTEC PILOT PLANTSHIP

GEN'L ARRANGEMENT BELOW 77' W.L. (FWD.)

DRAWN CWK	DATE 5/15/78	SCALE 1" = 20'	
CHECKED	DATE	DWG NO. MO-04	REV A
APP'D 7916-6	DATE		

Fig. 37 General arrangement below 77-ft water level: fwd (MO-04).



REFERENCES

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APL OTEC PILOT PLANTSHIP
FRESH WATER SYSTEM DIAGRAM

DRAWN EHS	DATE 8-21-78	SCALE NONE	
CHECKED EHF	DATE 11/28/79	DWG. NO. MO-05	REV A
APP'D 7915	DATE		

Fig. 38 Fresh water system diagram (MO-05).

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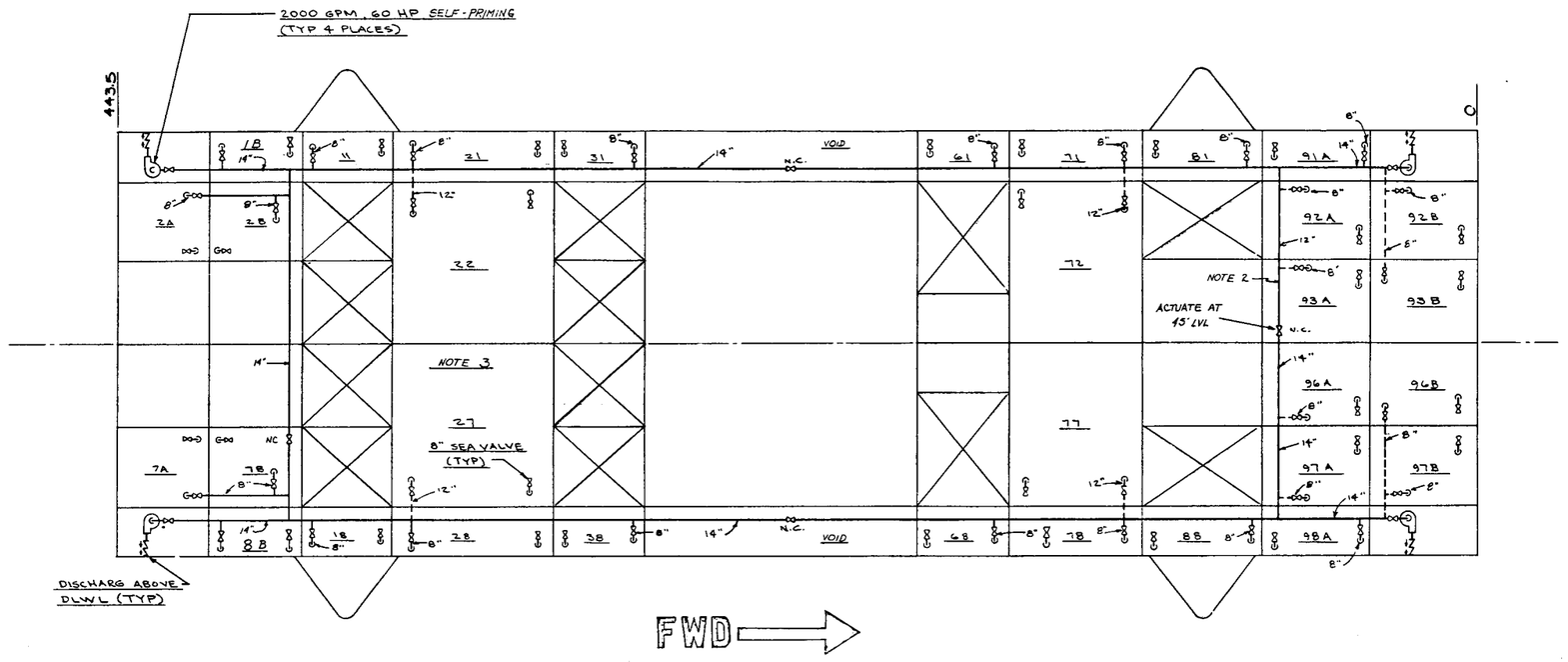
NOTE :
VALVES IN TANKS 21, 28, 71 AND 78 HYDRAULICALLY OPERATED FROM CONTROL PANEL FROM MAIN ENGINE ROOM-EL+77'. OTHER VALVES OPERATED BY REACH RODS FROM MAIN DECK-EL+89' EXCEPT AS NOTED. TANKS 92 A&B, 93 A&B, 96 A&B AND 97 A&B USED IN GRAZING MODE ONLY.



BALLAST SYSTEM

PLAN BELOW 10' LEVEL

REFERENCES

GENERAL NOTES

1. CAN BE DEBALLASTED TO SURVIVAL MODE IN 8 HRS.
2. CROSS CONNECT SHALL NOT BE WITHIN 5' OF CABLE ENTRY POINT.
3. TKS 22, 27, 72 & 77 FOR PRODUCT STORAGE ONLY IN GRAZING MODE

SYM	REVISIONS	BY	DATE

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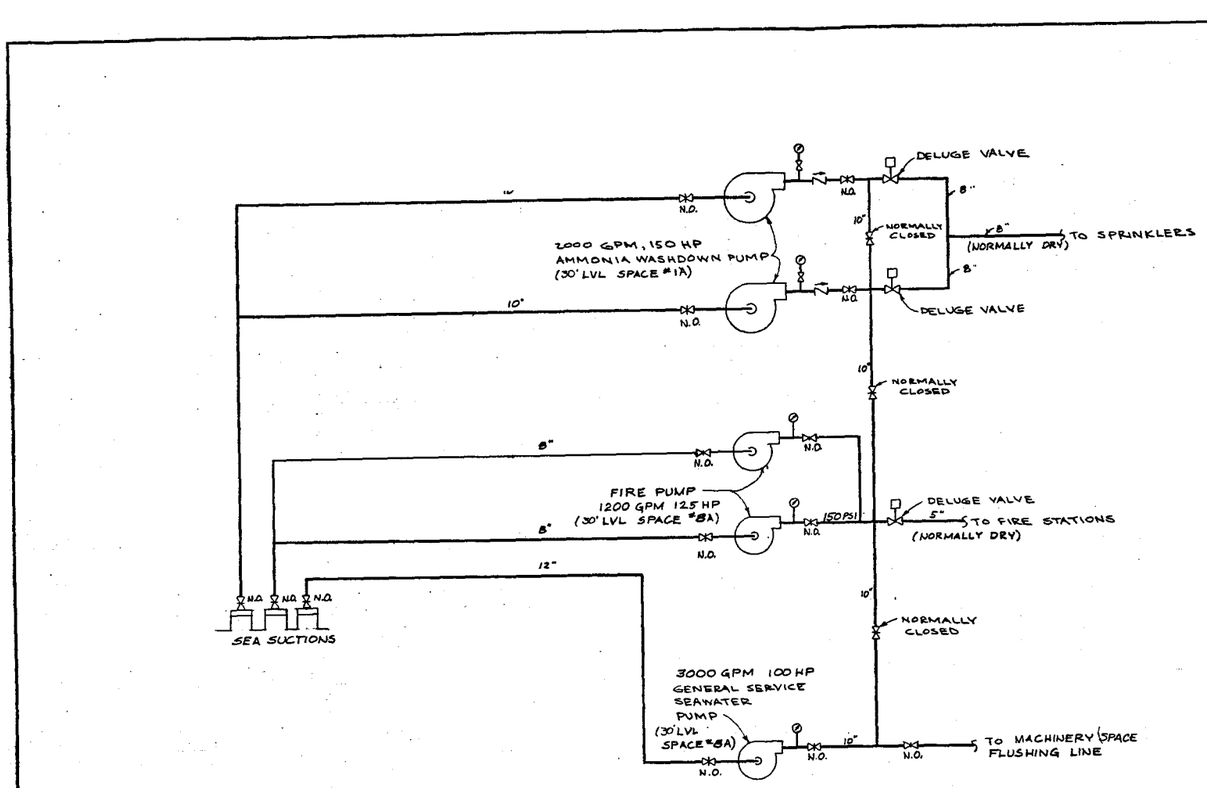
APL OTEC PILOT PLANTSHIP
BILGE AND BALLAST SYSTEM DIA.

DRAWN EHS	DATE 11-20-79	SCALE NONE	
CHECKED EWF	DATE 11-27-79	DWG. NO. MO-06	REV
APP'D 7915	DATE		

Fig. 39 Bilge and ballast system diagram (MO-06).



REFERENCES

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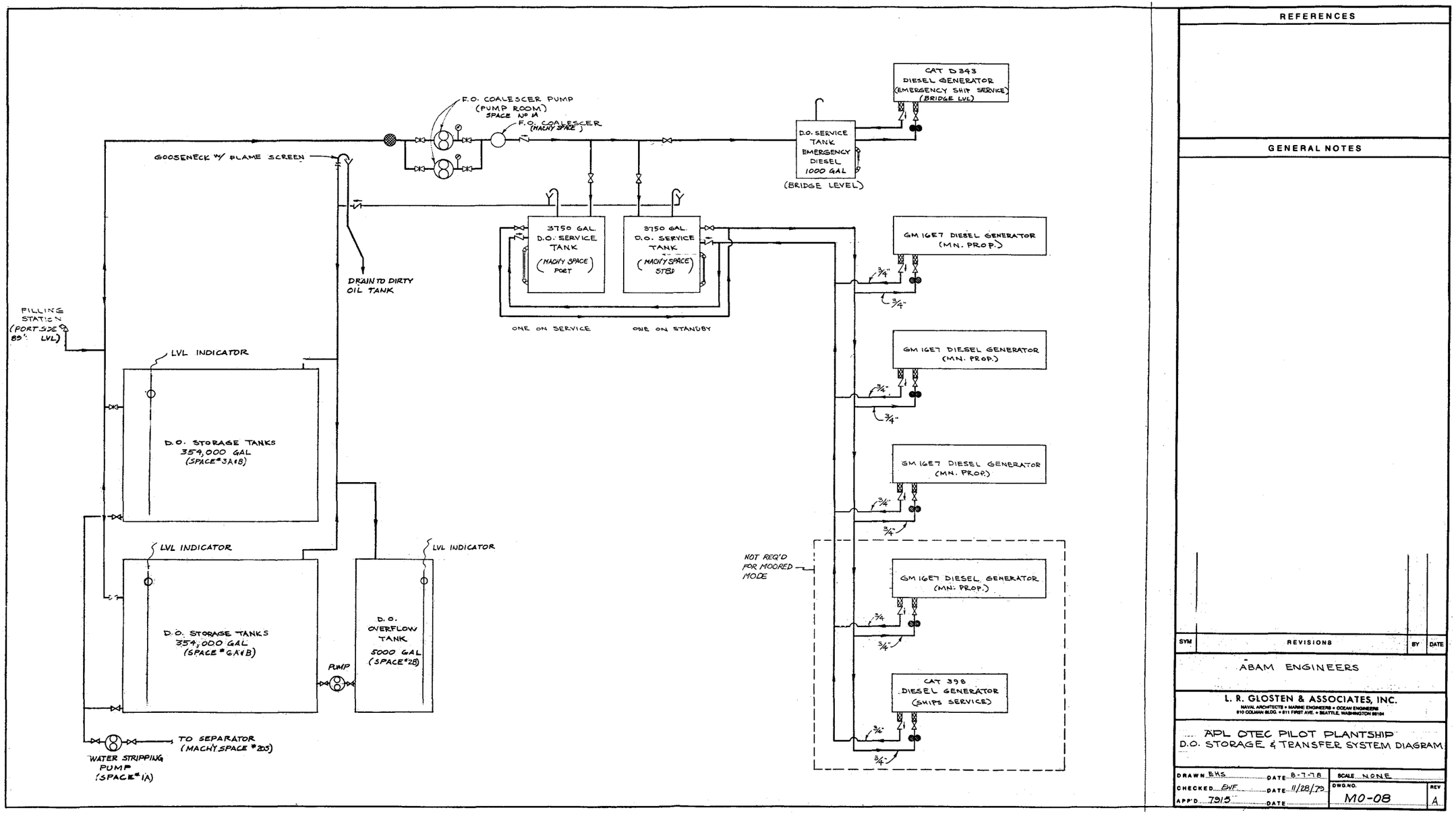
APL OTEC PILOT PLANTSHIP
FIRE AND WASHDOWN SYSTEM DIAGRAM

DRAWN EHS DATE 8-14-78 SCALE NONE
CHECKED EHE DATE 11/28/79 DWG NO. MO-07 REV A
APP'D 7915 DATE

Fig. 40 Fire and washdown system diagram (MO-07).



REFERENCES

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APL OTEC PILOT PLANTSHIP
D.O. STORAGE & TRANSFER SYSTEM DIAGRAM

DRAWN EHS	DATE 8-7-78	SCALE NONE	
CHECKED EHF	DATE 11/28/79	DWG NO. MO-08	REV A
APP'D 7915	DATE		

Fig. 41 Dirty oil storage and transfer system diagram (MO-08).

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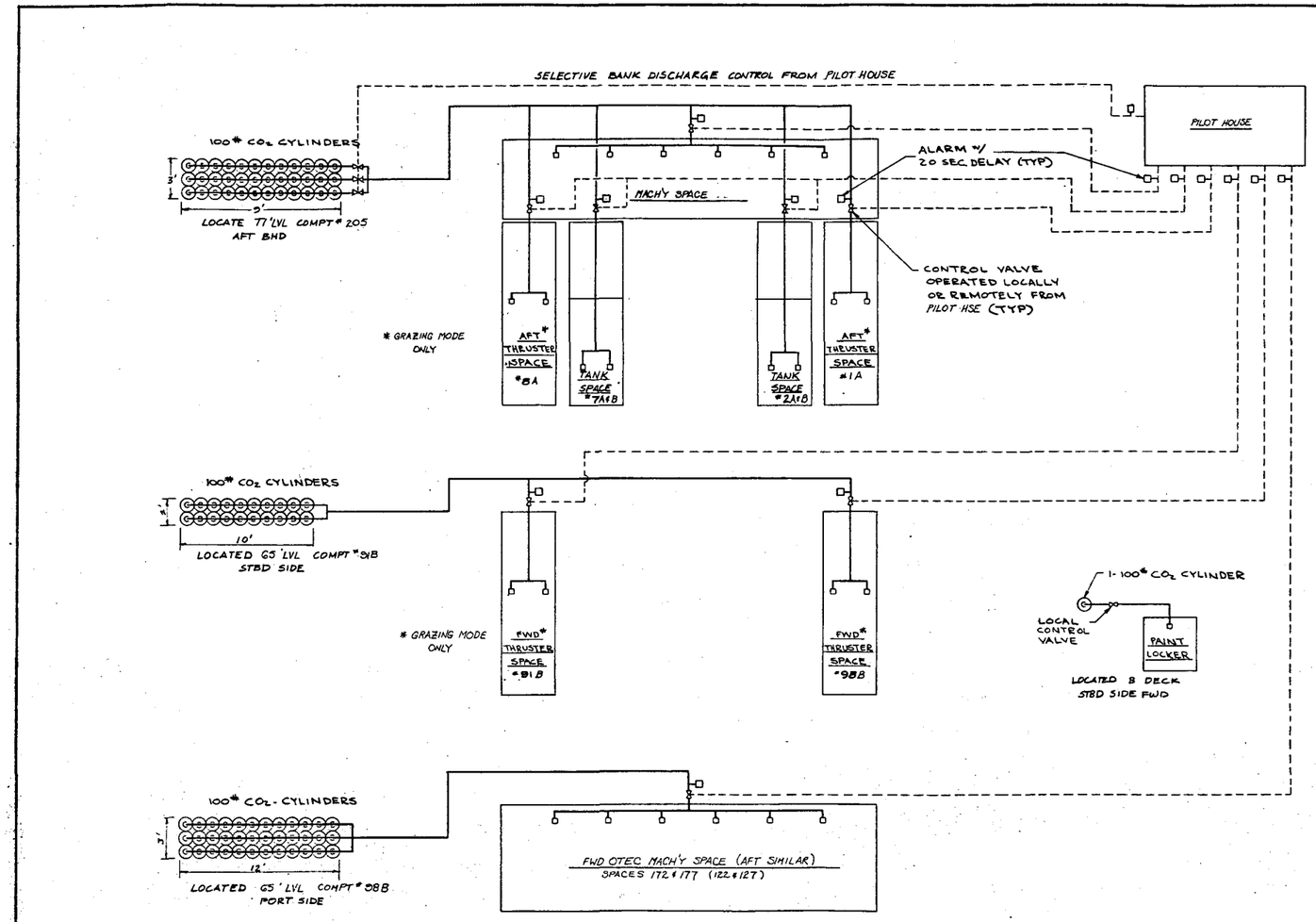

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APL OTEC PILOT PLANTSHIP
CO_2 SYSTEM DIAGRAM

DRAWN EHS	DATE 8-22-78	SCALE NONE	
CHECKED EHF	DATE 11/28/78	DWG.NO. MO-09	REV A
APP'D 7915	DATE		

Fig. 42 CO_2 system diagram (MO-09).

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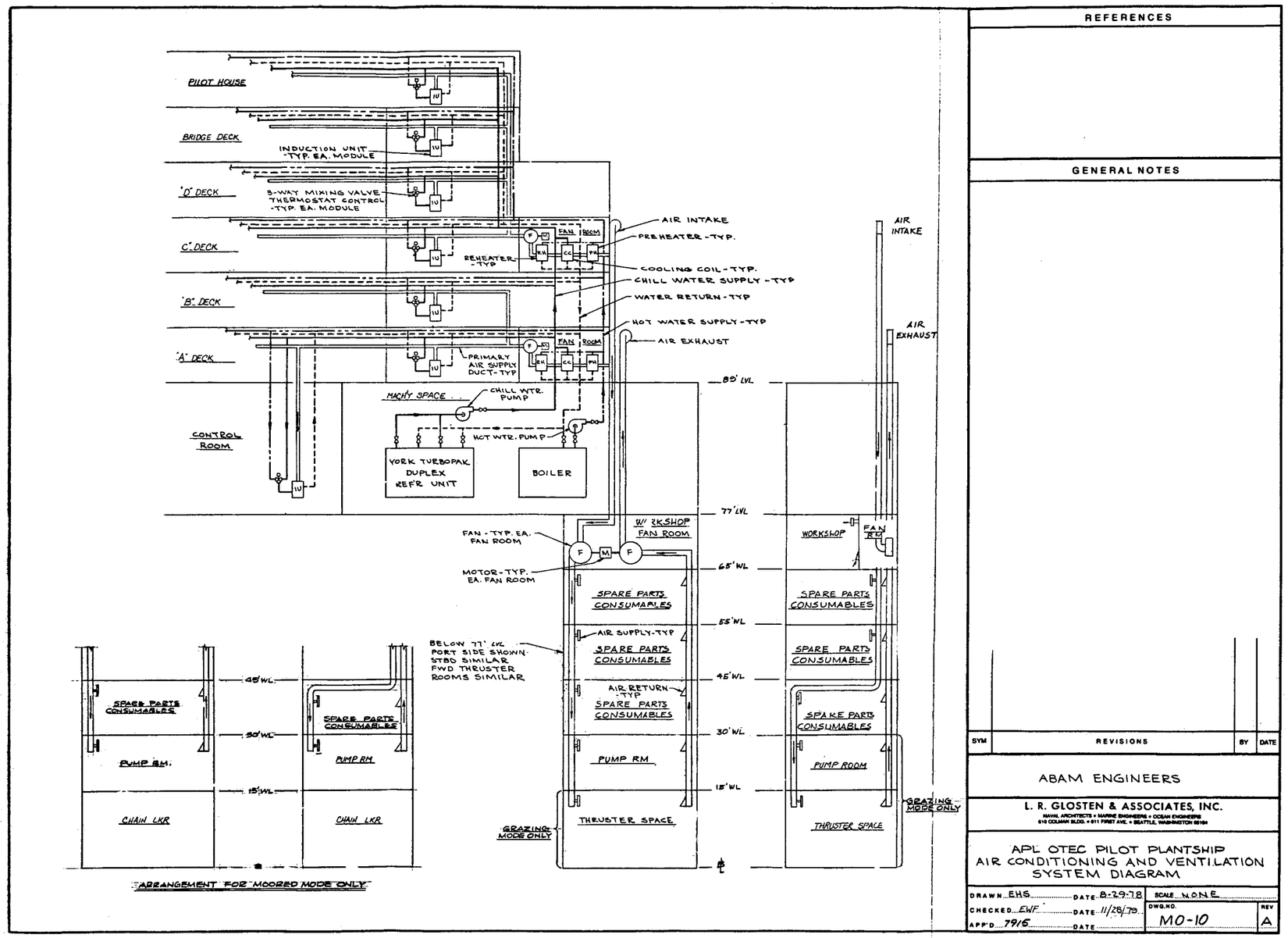

REFERENCES

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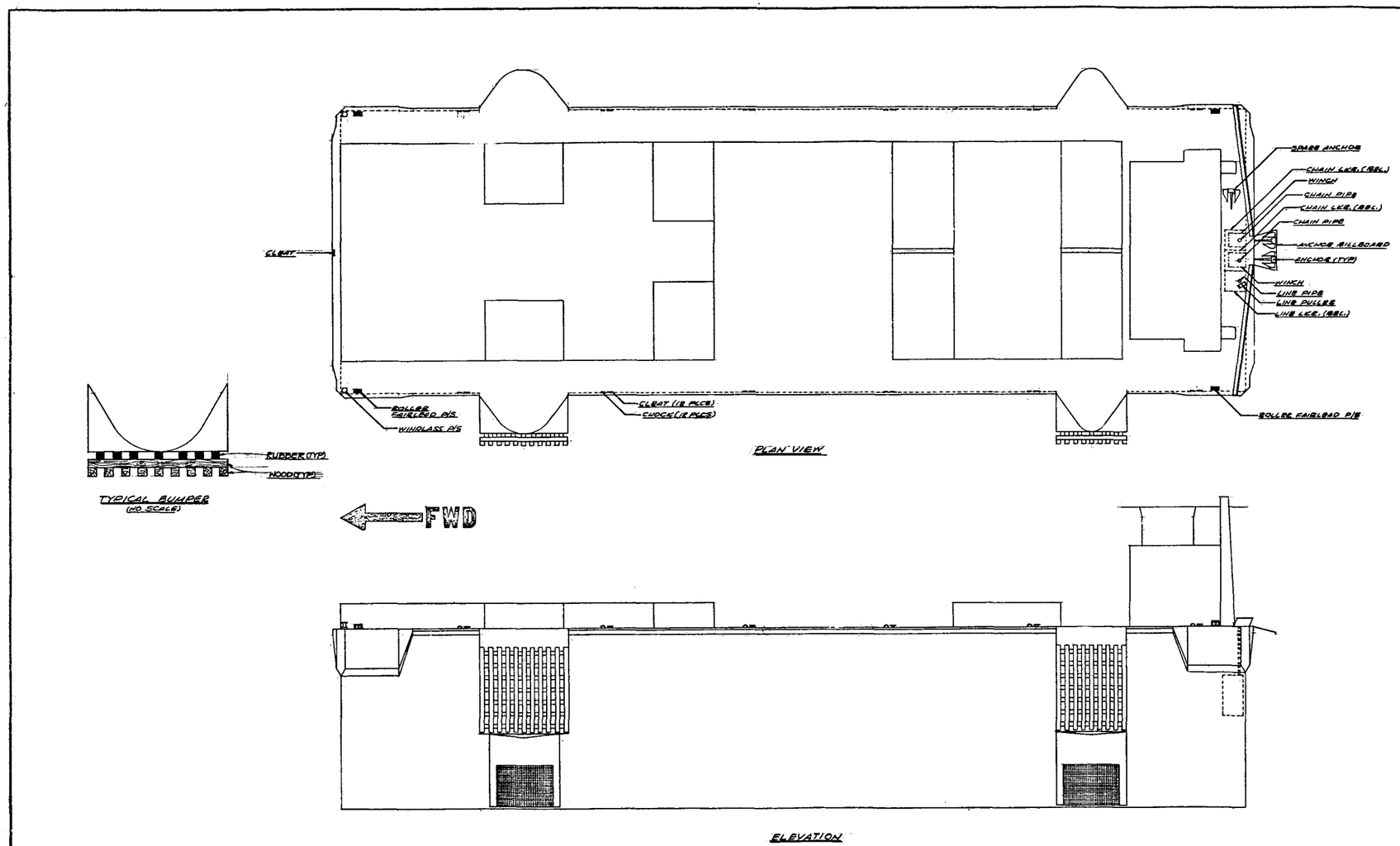
APL OTEC PILOT PLANTSHIP
AIR CONDITIONING AND VENTILATION SYSTEM DIAGRAM

DRAWN EHS	DATE 8-29-78	SCALE NONE	
CHECKED EWF	DATE 11/28/79	DWG.NO. MO-10	REV A
APP'D 79/6	DATE		

Fig. 43 Air conditioning and ventilation system diagram (MO-10).



REFERENCES

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APL OTEC PILOT PLANTSHIP
MISC. DETAILS—MOORING & FENDERING
GRAZING MODE ONLY

DRAWN CWC	DATE 11/26/79	SCALE 1"=20'-0"	
CHECKED CWC	DATE 11/28/79	DWG. NO.	REV
APPD. 7915-5	DATE	MO-12 (SHT. 1 OF 2)	

Fig. 44 Miscellaneous details, mooring and fendering: grazing mode only (MO-12, sheet 1 of 2).

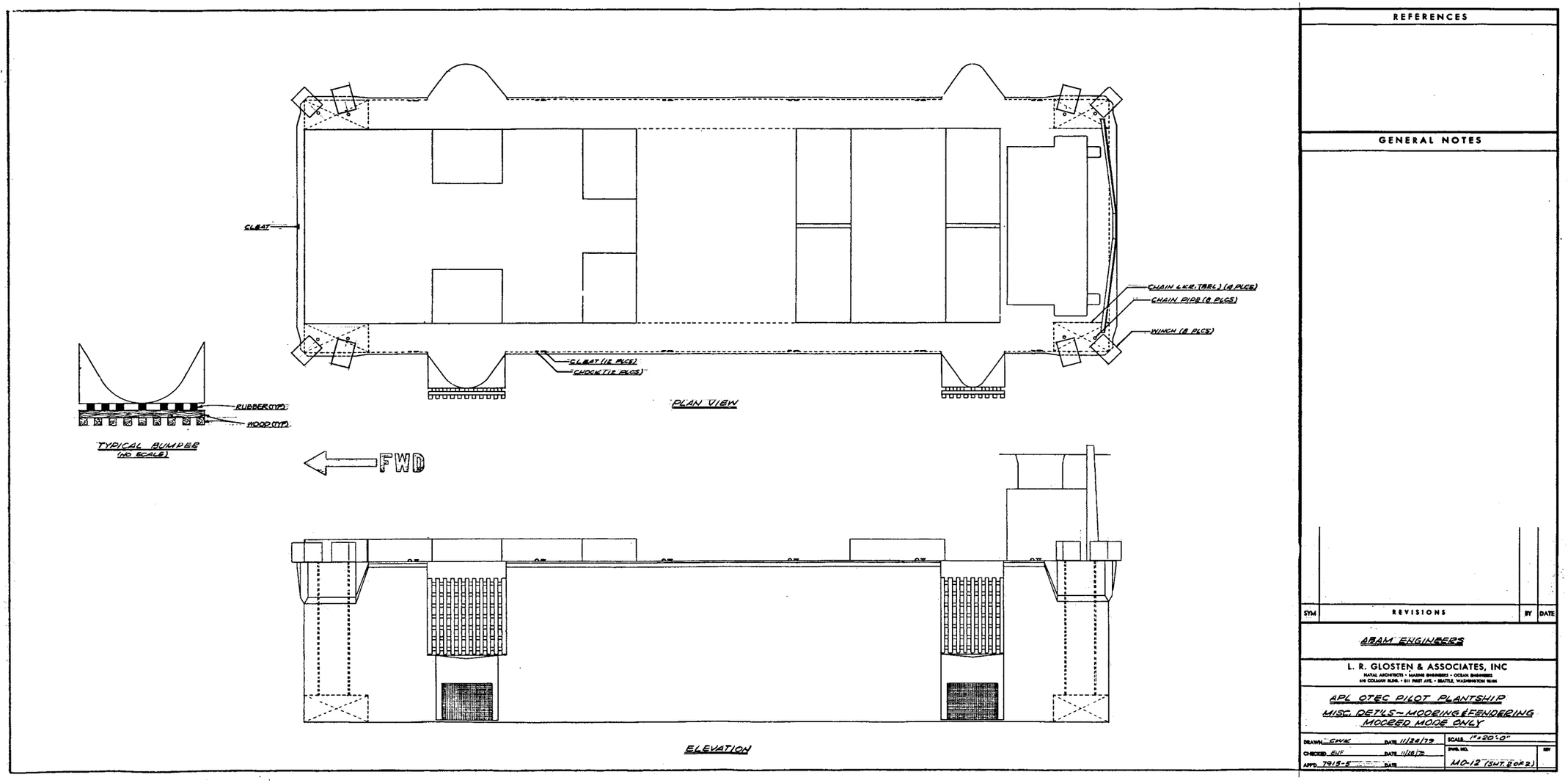

Fig. 45 Miscellaneous details, mooring and fendering: moored mode only (MO-12, sheet 2 of 2).

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LAUREL, MARYLAND

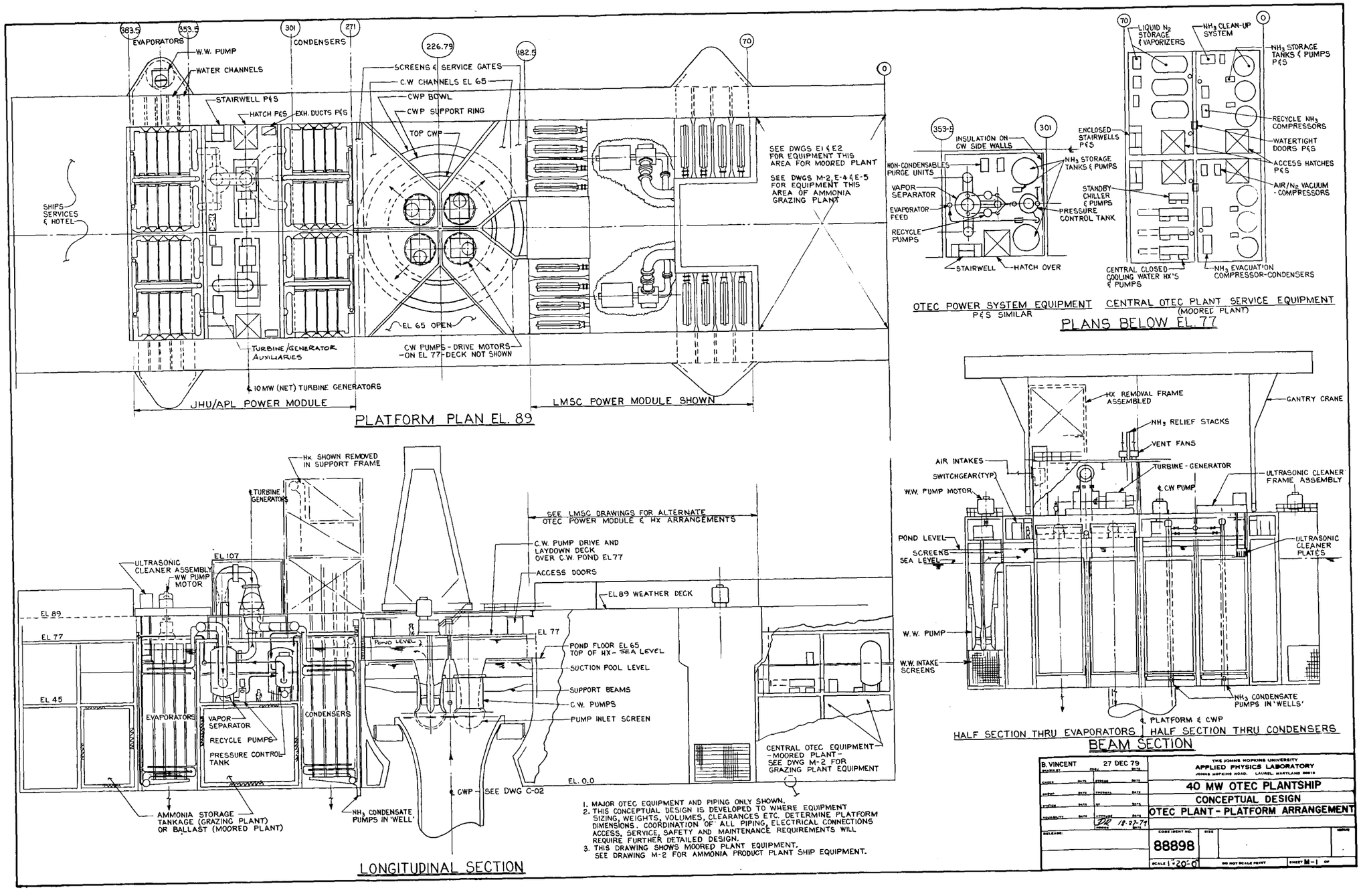
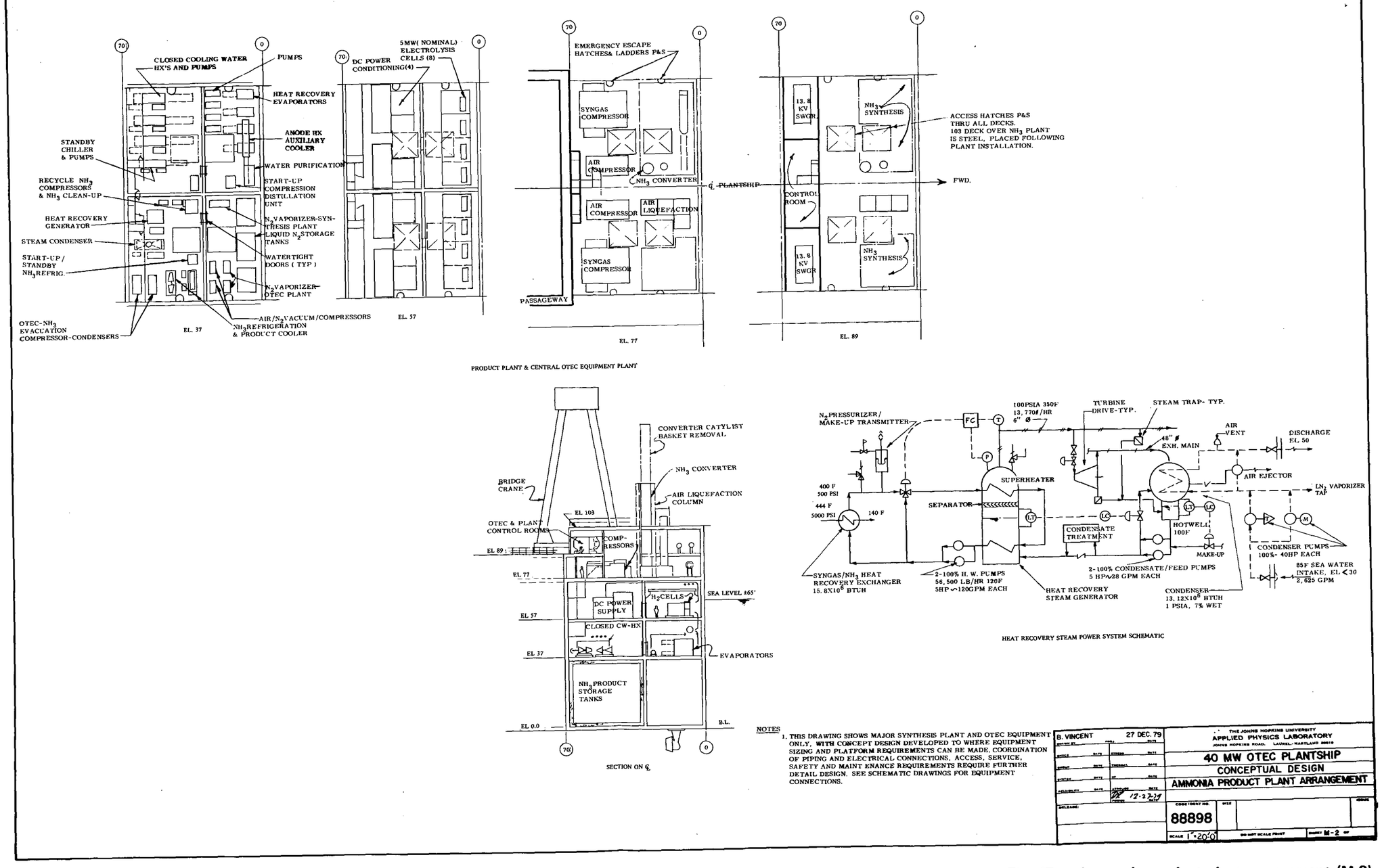


Fig. 46 OTEC plant: platform arrangement (M-1).



NOTES

1. THIS DRAWING SHOWS MAJOR SYNTHESIS PLANT AND OTEC EQUIPMENT ONLY, WITH CORCEPT DESIGN DEVELOPED TO WHERE EQUIPMENT SIZING AND PLATFORM REQUIREMENTS CAN BE MADE. COORDINATION OF PIPING AND ELECTRICAL CONNECTIONS, ACCESS, SERVICE, SAFETY AND MAINT ENANCE REQUIREMENTS REQUIRE FURTHER DETAIL DESIGN. SEE SCHEMATIC DRAWINGS FOR EQUIPMENT CONNECTIONS.

B. VINCENT 27 DEC. 79

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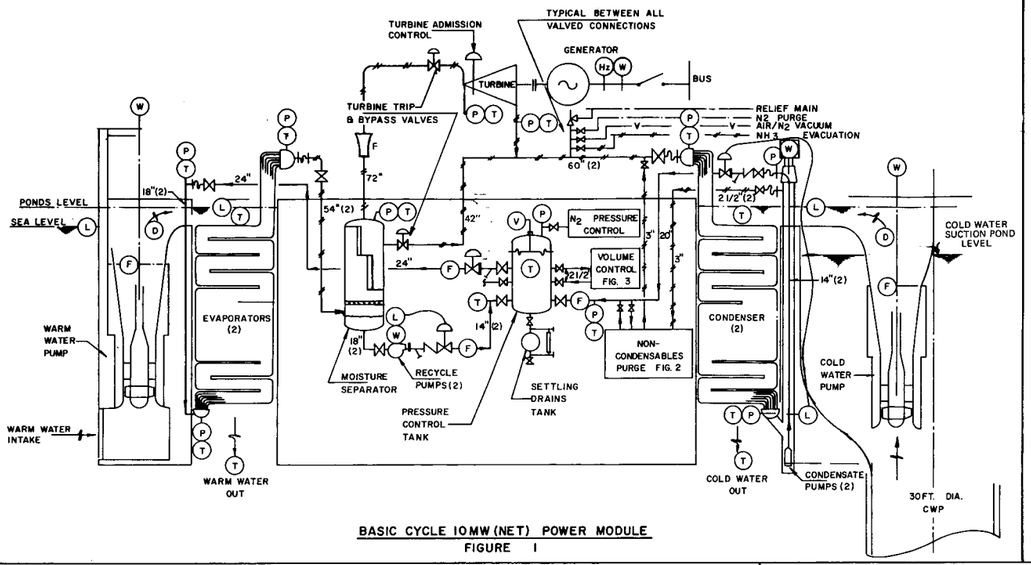
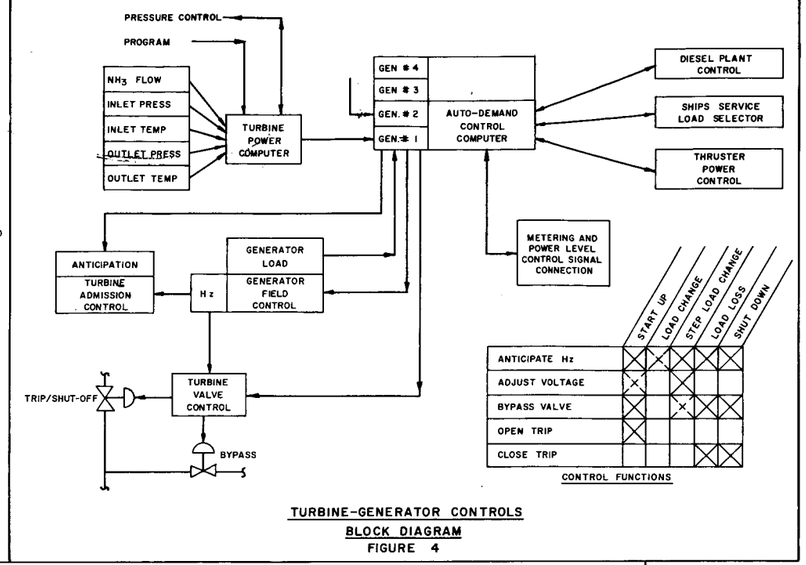
40 MW OTEC PLANTSHIP
CONCEPTUAL DESIGN
AMMONIA PRODUCT PLANT ARRANGEMENT

CODE IDENT NO. 88898 SIZE D SCALE 1"=20'-0" DO NOT SCALE PRINT SHEET M-2

Fig. 47 Ammonia product plant arrangement (M-2).



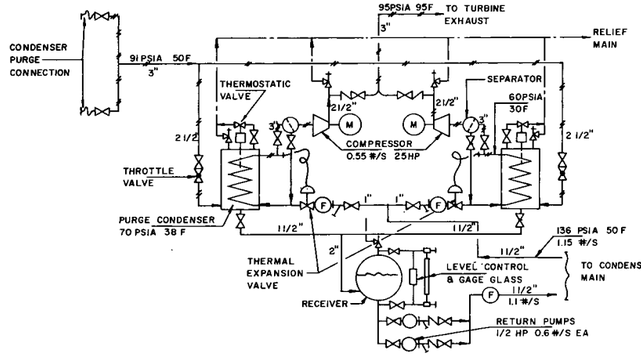
BASIC CYCLE 10MW(NET) POWER MODULE
FIGURE 1



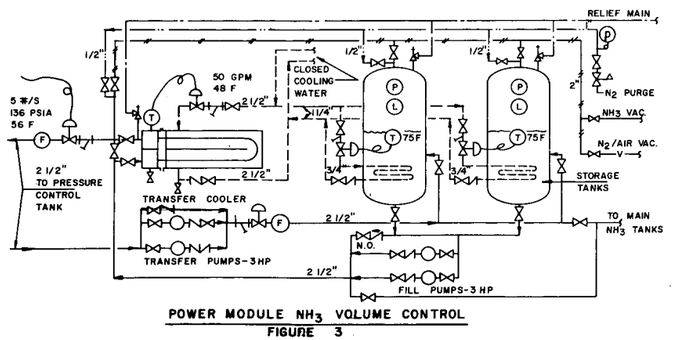
TURBINE-GENERATOR CONTROLS
BLOCK DIAGRAM
FIGURE 4

PIPING

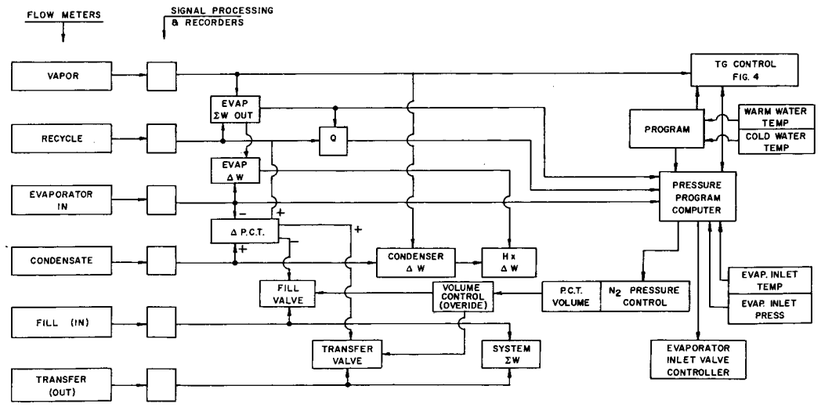
- NH_3 VAPOR
- NH_3 LIQUID
- NH_3 RELIEF
- 80 N_2 VAPOR & PRESSURE
- V AIR/N_2 VACUUM
- CLOSED COOLING WATER
- D DISTILLED WATER
- S SALT COOLING WATER
- GATE VALVE
- CHECK VALVE
- STRAINER
- FLEXIBLE CONNECTOR
- (F) FLOW METER
- CONTROL VALVE
- RELIEF VALVE
- PRESSURE REGULATING VALVE
- GLOBE VALVE



POWER MODULE NON-CONDENSABLES PURGE PUMPS
FIGURE 2



POWER MODULE NH_3 VOLUME CONTROL
FIGURE 3



FLOW METERING, VOLUME & PRESSURE CONTROL
BLOCK DIAGRAM
FIGURE 5

INSTRUMENTATION

- (P) PRESSURE MEASUREMENT
- (T) TEMPERATURE
- (F) FLOW
- (L) LEVEL
- (D) DENSITY
- (W) WORK-LOAD
- (HZ) FREQUENCY

NOTES:

1. SEE DWGS. M1 & M2 FOR PHYSICAL EQUIPMENT ARRANGEMENTS AND E1–E6 FOR POWER & CONTROL EQUIPMENT.
2. SEE EQUIPMENT SCHEDULE & SPECIFICATIONS FOR EQUIPMENT DESCRIPTIONS.

DRAWN BY	PROJ.	DATE
CHECK	DESIGN	
GROUP	THERMAL	
SYSTEM	HT	
RELIABILITY	STRUCTURE	
RELEASE:	ZE 12-27-77	

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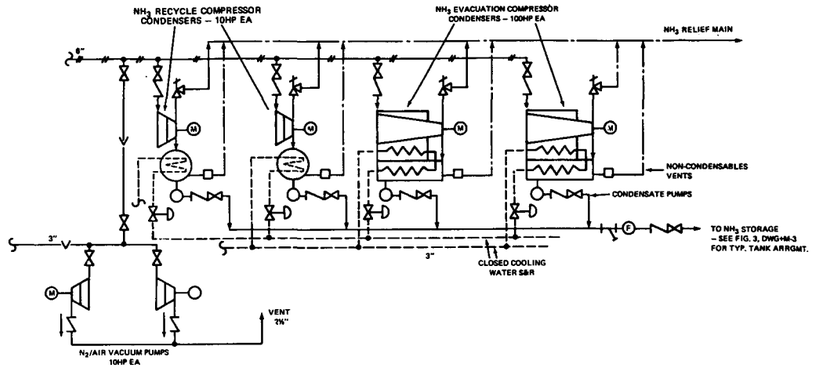
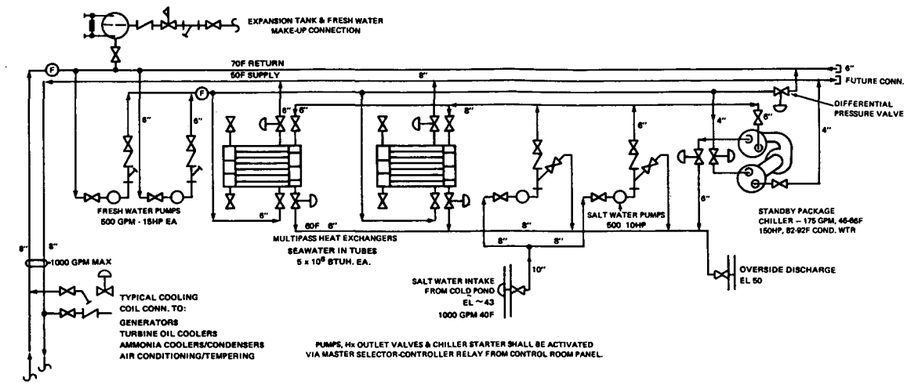
OTEC PILOT PLANT SHIP
CONCEPTUAL DESIGN
10 MW(NET) POWER MODULE SCHEMATICS

CODE IDENT NO. 88898 | SIZE | ISSUE A
SCALE NONE | DO NOT SCALE PRINT | SHEET M-3 OF

Fig. 48 10-MW(net) power module schematics (M-3).

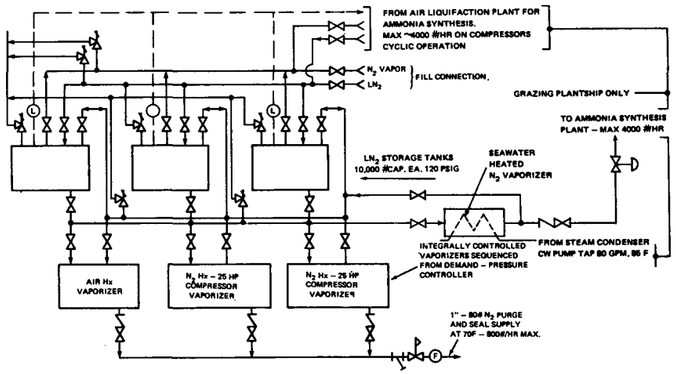


OTEC PUMP DOWN – EVACUATION SYSTEM

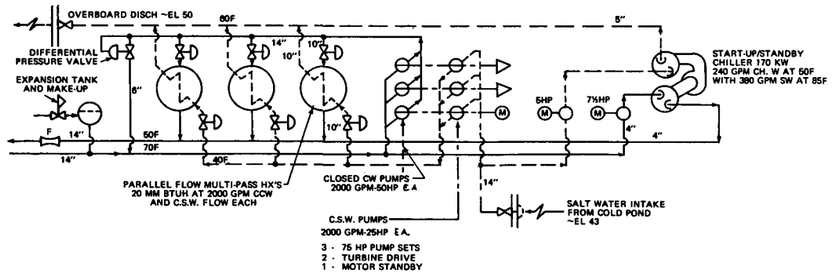


CLOSED COOLING WATER SYSTEM – MOORED PLANT

NOTE: TWO 50% CAPACITY Hx AND PUMP SETS SHOWN - PROVIDE THREE FOR RESERVE CAPACITY.



NITROGEN SUPPLY SYSTEM



CLOSED COOLING WATER SYSTEM - AMMONIA PLANTSHIP.

INLET VALVES, PUMPS, EVAPORATOR CONTROLS, TO BE INTERLOCKED AND OPERATED FROM CENTRAL CONTROL PANEL AND ELECTROLYSIS CELL CONTROLS. MAJOR CONTROLS AND CONNECTIONS INDICATED ONLY. ISOLATING, CHECK, VENT AND DRAIN VALVES, STRAINERS ETC, NOT SHOWN.

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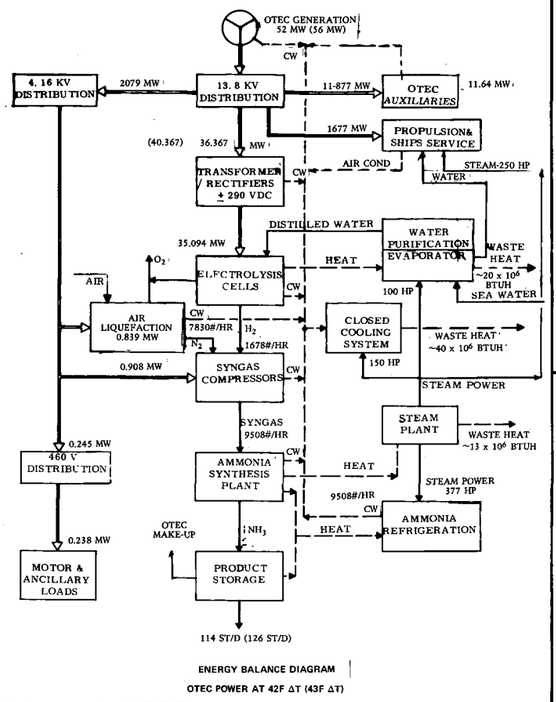
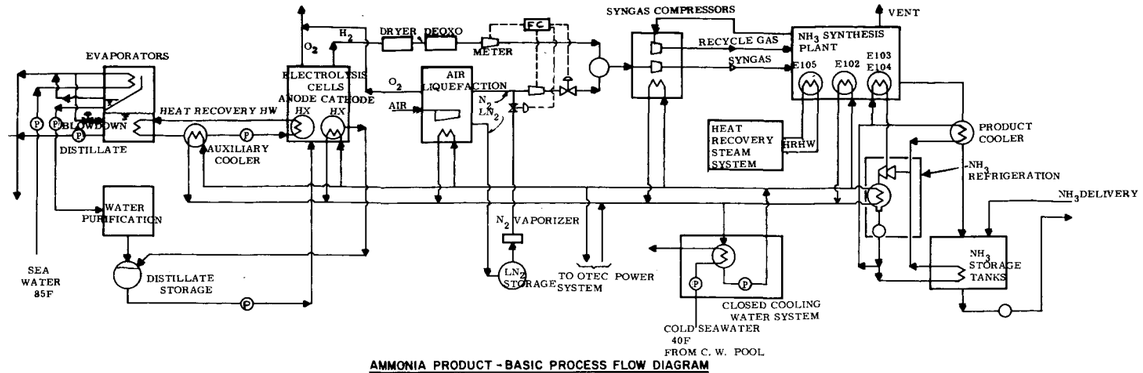
40 MW OTEC plantship conceptual design.
ANCILLARY SYSTEMS SCHEMATICS

CODE IDENT NO 88898 | SIZE | ISSUE A
SCALE ~ | DO NOT SCALE PRINT | SHEET M-4 OF

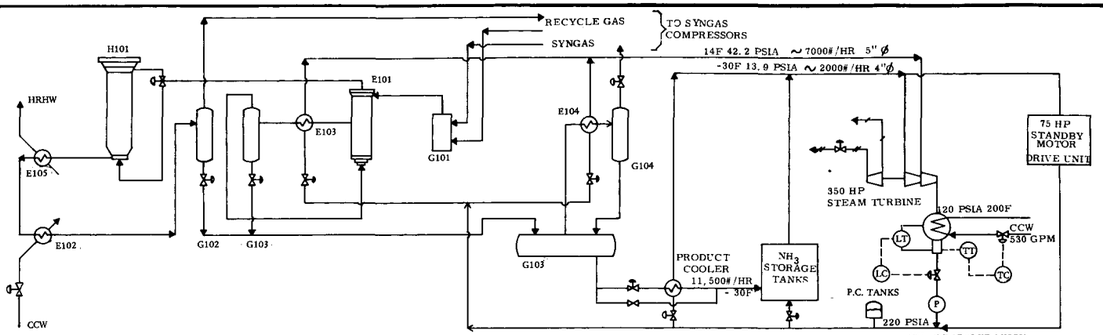
Fig. 49 Ancillary systems schematics (M-4).



ENERGY BALANCE DIAGRAM
OTEC POWER AT 42F ΔT (43F ΔT)



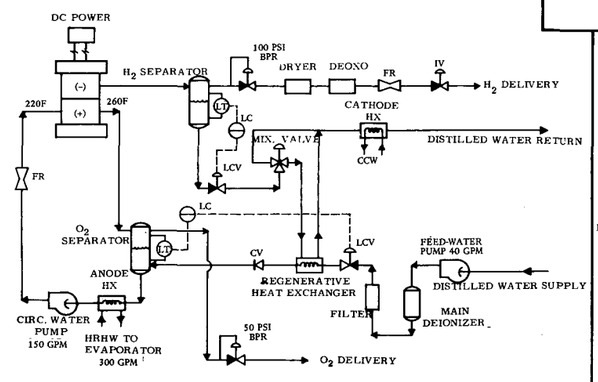
AMMONIA PRODUCT - BASIC PROCESS FLOW DIAGRAM



AMMONIA SYNTHESIS FLOW DIAGRAM
(JAMES CHEMICAL ENGINEERING INC.)

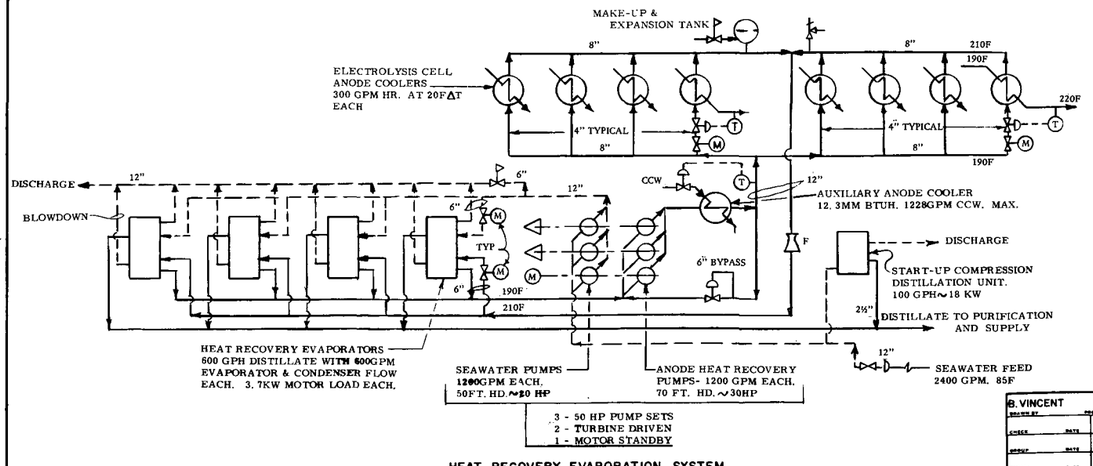
AMMONIA SYNTHESIS PLANT EQUIPMENT LIST

E 101 COLD EXCHANGER
E 102 WATER COOLED CONDENSER
E 103 AMMONIA COOLED CONDENSER
E 104 VENT CONDENSER
E 105 HEAT RECOVERY EXCHANGER
G 101 OIL FILTER
G 102 PRIMARY SEPARATOR
G 103 LETDOWN TANK
G 104 SECONDARY SEPARATOR
H 101 AMMONIA CONVERTER



G.E. ELECTROLYSIS CELL
HYDROGEN GENERATION FLOW DIAGRAM

BPR = BACK PRESSURE REGULATOR
FR = FLOW RATOR
CV = CHECK VALVE
IV = ISOLATION VALVE
LC = LEVEL CONTROLLER
LT = LEVEL TRANSMITTER
LCV = LEVEL CONTROL VALVE



HEAT RECOVERY EVAPORATION SYSTEM

INLET VALVES, PUMPS, EVAPORATOR CONTROLS, TO BE INTERLOCKED AND OPERATED FROM CENTRAL CONTROL PANEL ANDELECTROLYSIS CELL CONTROLS. MAJOR CONTROLS & CONNECTIONS INDICATED ONLY. ISOLATING, CHECK, VENT & DRAIN VALVES, STRAINERS, ETC. NOT SHOWN.

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40 MW OTEC PLANTSHIP
CONCEPTUAL DESIGN
AMMONIA PRODUCT PLANT SCHEMATICS
CODE IDENT NO. 88898
SIZE
SCALE —
DO NOT SCALE PRINT
SHEET M-5

Fig. 50 Ammonia product plant schematics (M-5).

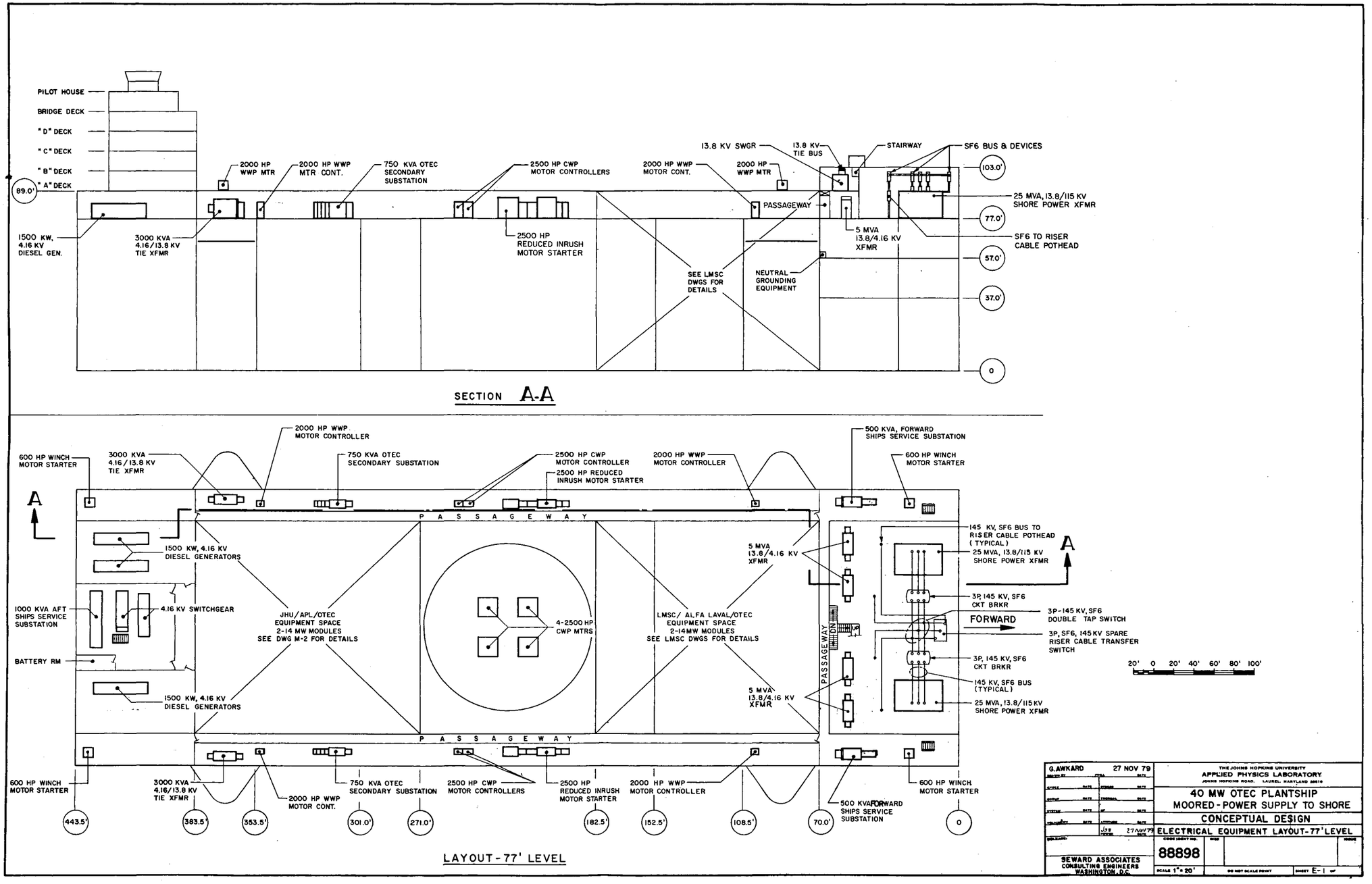

Fig. 51 Electrical equipment layout: 77-ft level (moored) (E-1).

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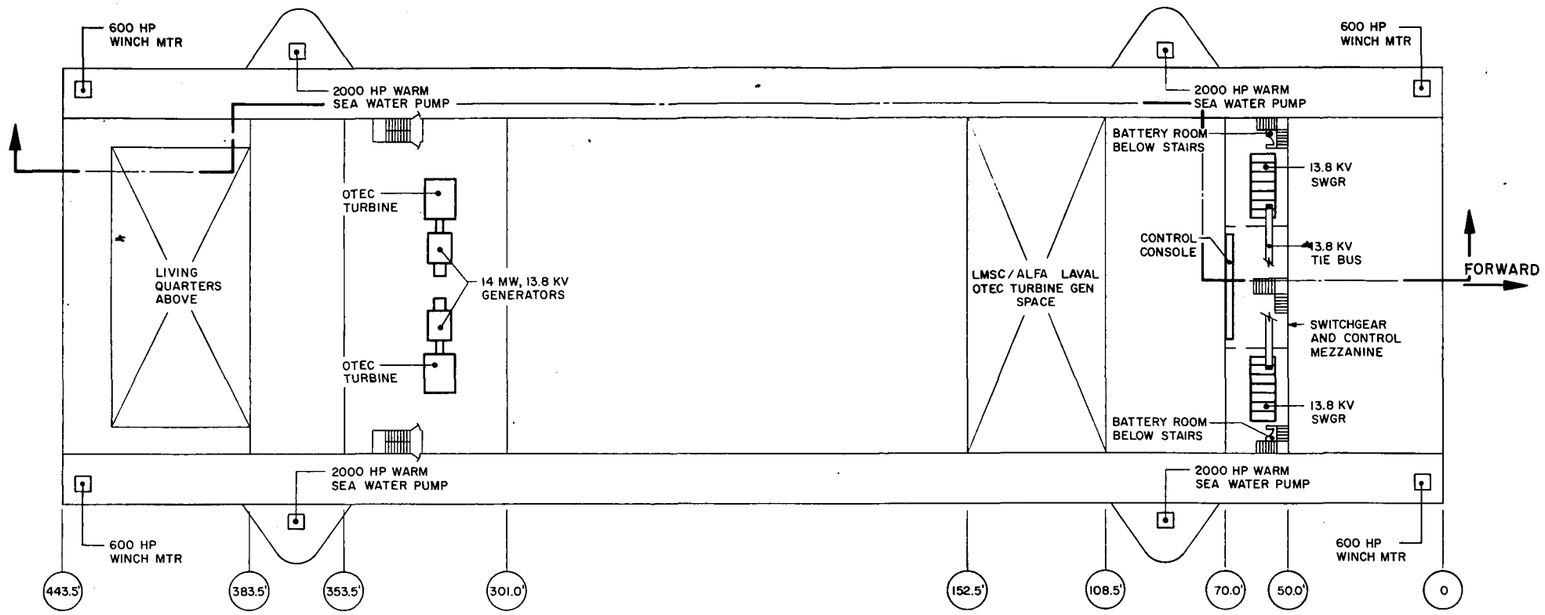
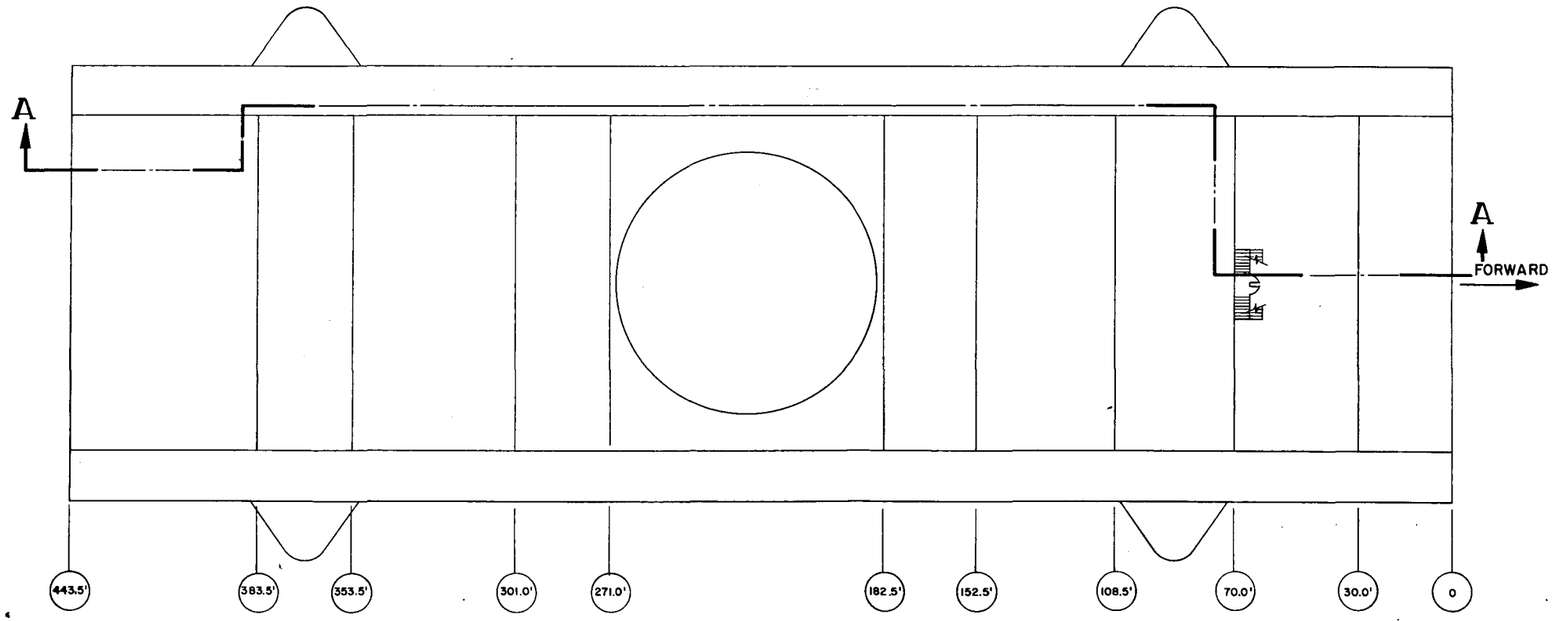


LAYOUT - 89' LEVEL AND ABOVE



LAYOUT - 5' LEVEL

20' 0 20' 40' 60' 80' 100'

G.AWKARD	27 NOV 79	THE JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY	
		40 MW OTEC PLANTSHIP	
		MOORED-POWER SUPPLY TO SHORE	
		CONCEPTUAL DESIGN	
	27 NOV 79	ELECTRICAL EQUIPMENT LAYOUT 5' & 89' LEVEL	
SEWARD ASSOCIATES CONSULTING ENGINEERS WASHINGTON, D.C.		88898	E-2

Fig. 52 Electrical equipment layout: 5-ft and 89-ft level (moored (E-2).

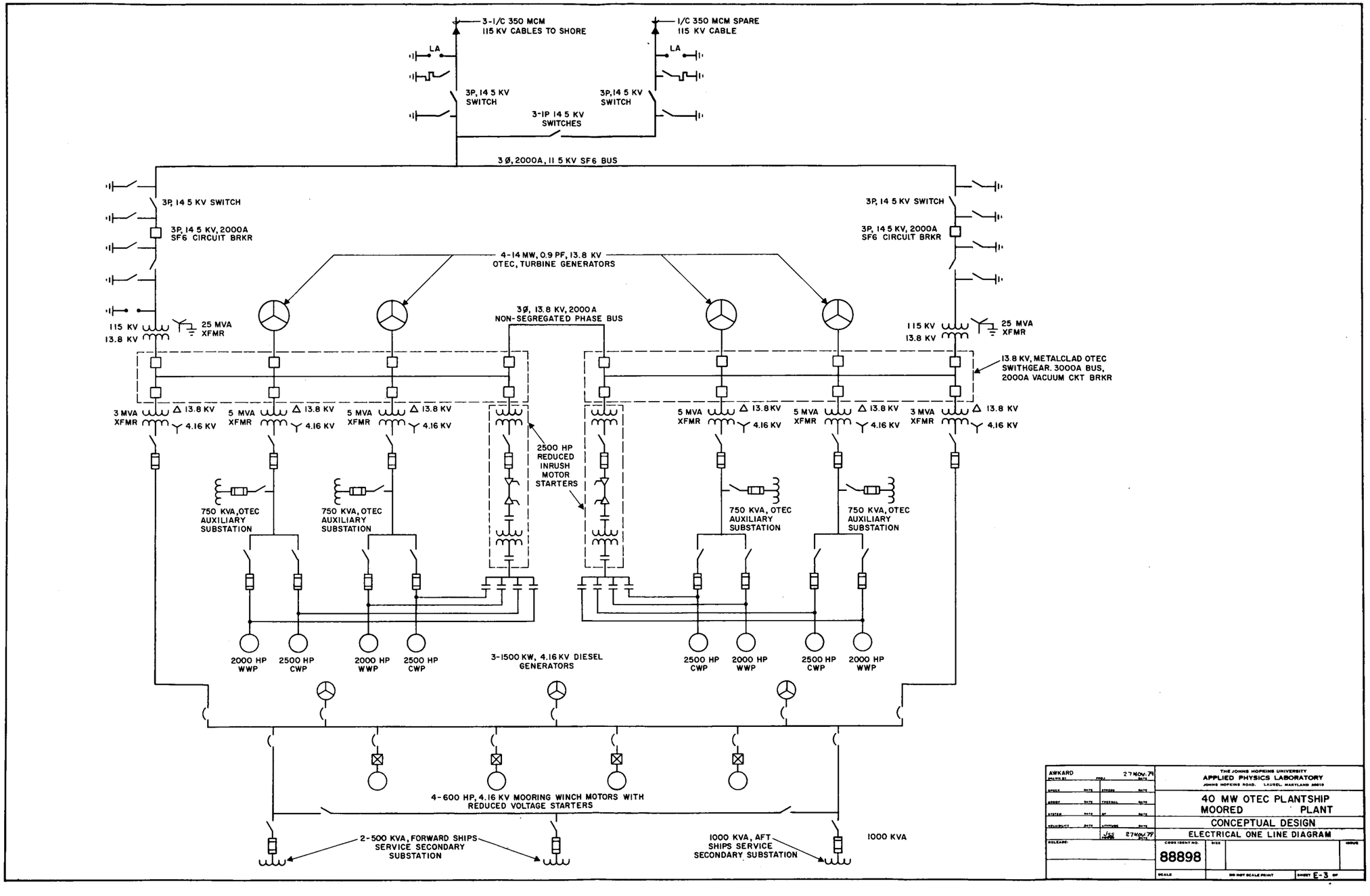


Fig. 53 Electrical one-line diagram (moored) (E-3).

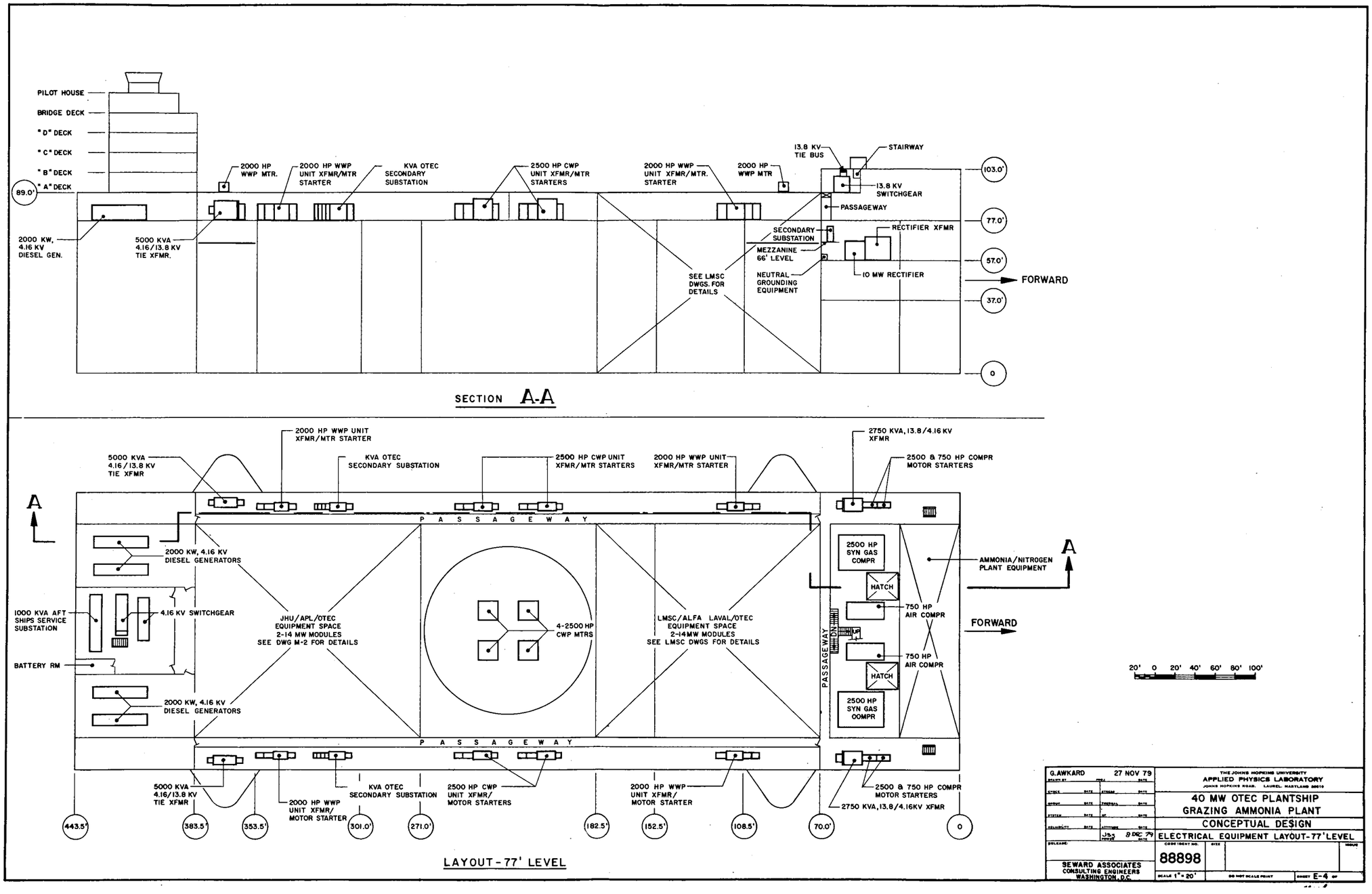


Fig. 54 Electrical equipment layout: 77-ft level (grazing) (E-4).

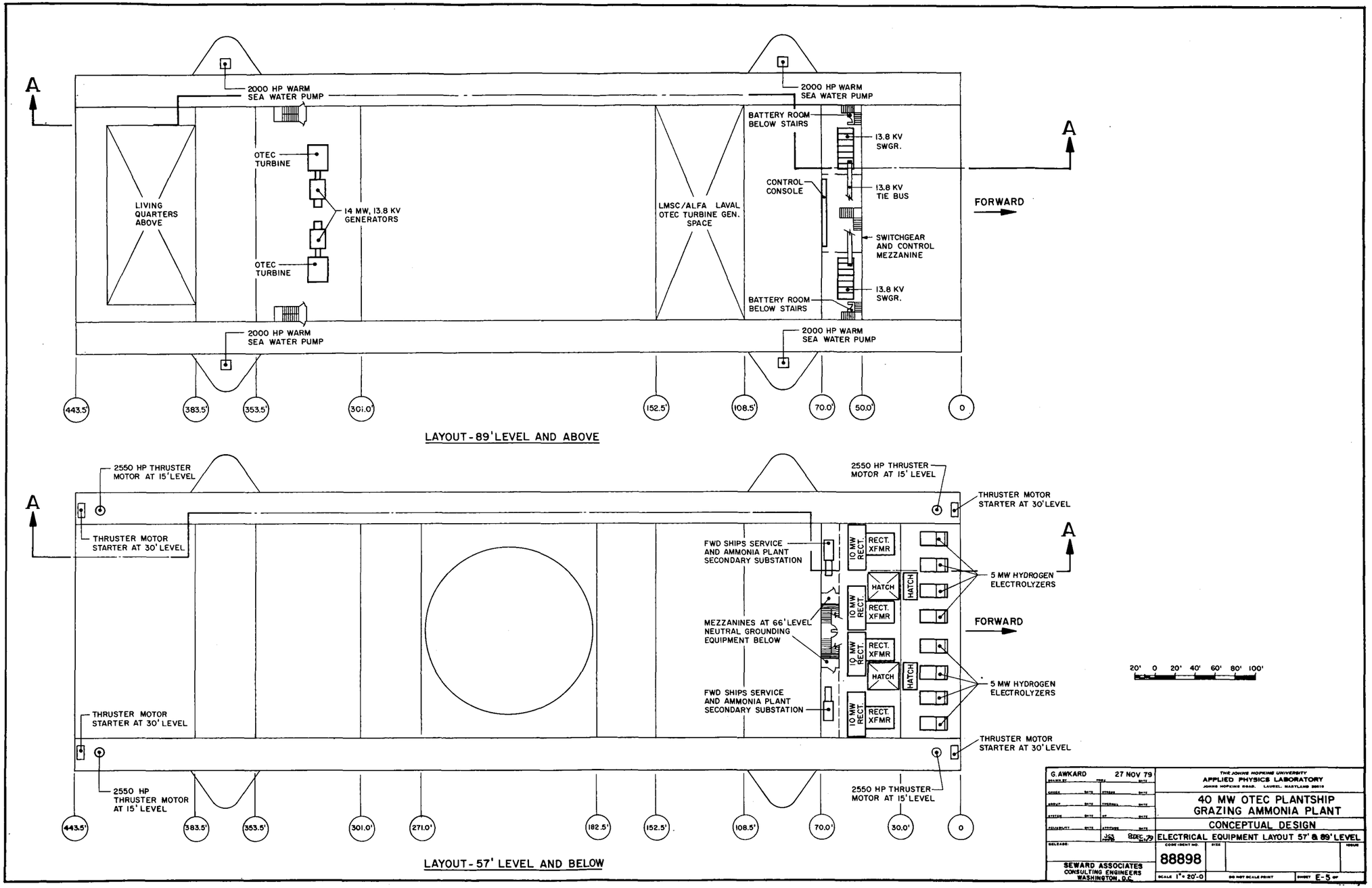


Fig. 55 Electrical equipment layout: 57-ft and 89-ft level (grazing) (E-5).

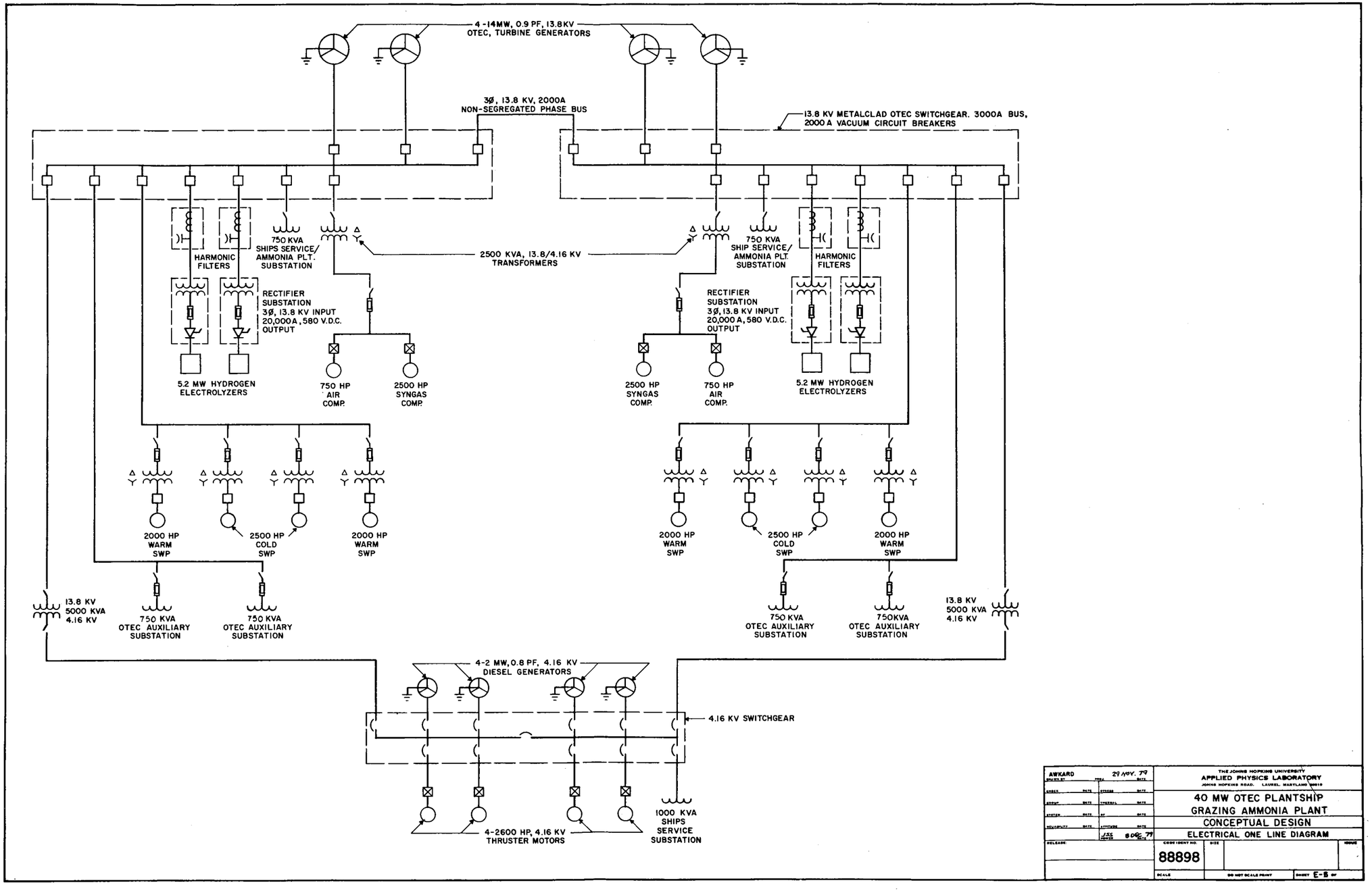
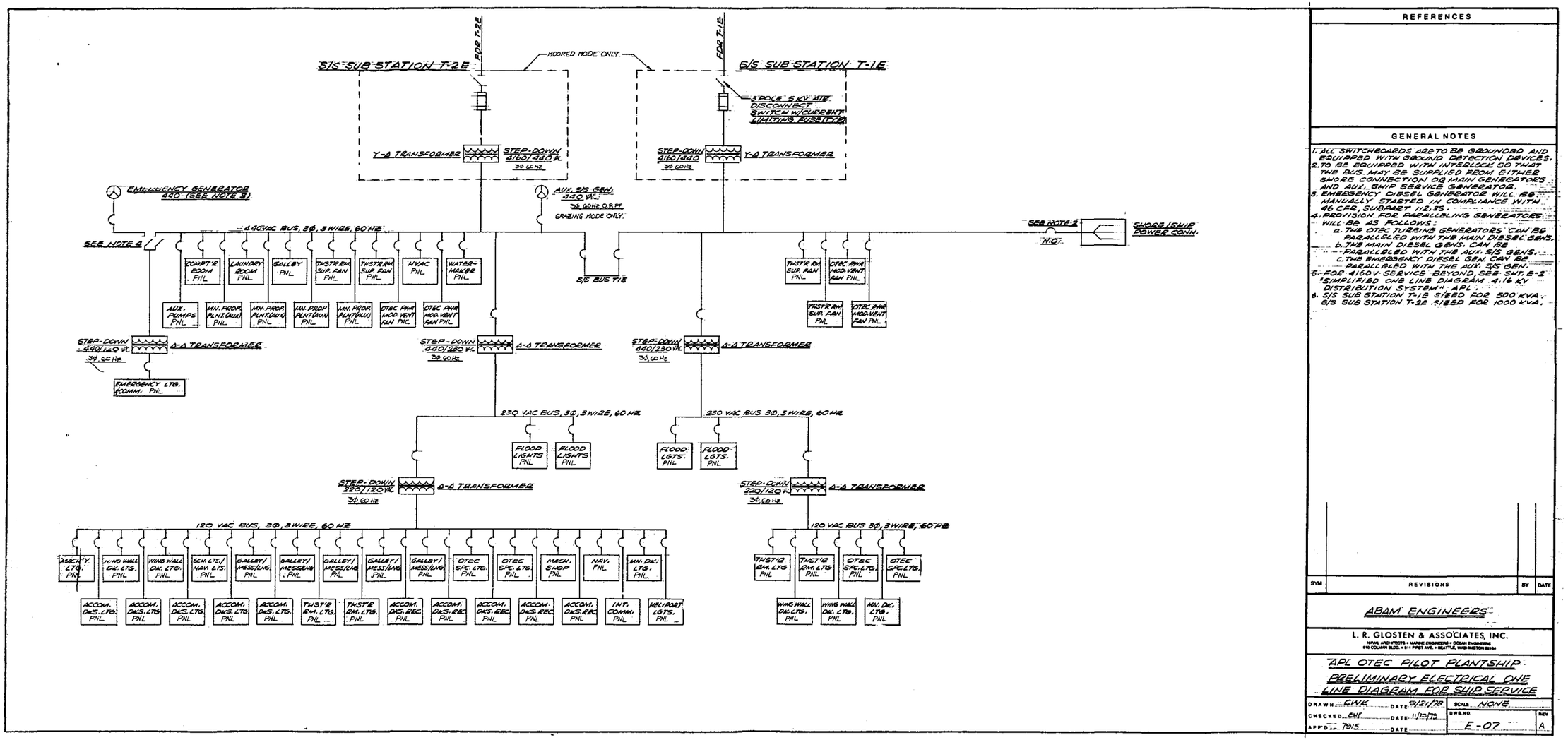


Fig. 56 Electrical one-line diagram (grazing) (E-6).



REFERENCES

GENERAL NOTES

1. ALL SWITCHBOARDS ARE TO BE GROUNDED AND EQUIPPED WITH GROUND DETECTION DEVICES.
2. TO BE EQUIPPED WITH INTERLOCK SO THAT THE BUS MAY BE SUPPLIED FROM EITHER SHORE CONNECTION OR MAIN GENERATORS AND AUX. SHIP SERVICE GENERATOR.
3. EMERGENCY DIESEL GENERATOR WILL BE MANUALLY STARTED IN COMPLIANCE WITH 46 CFR, SUBPART 112.15.
4. PROVISION FOR PARALLELING GENERATORS WILL BE AS FOLLOWS:
   a. THE OTEC TURBINE GENERATORS CAN BE PARALLELED WITH THE MAIN DIESEL GENS.
   b. THE MAIN DIESEL GENS. CAN BE PARALLELED WITH THE AUX. S/S GENS.
   c. THE EMERGENCY DIESEL GEN. CAN BE PARALLELED WITH THE AUX. S/S GEN.
5. FOR 4160V SERVICE BEYOND, SEE SHT. E-2 "SIMPLIFIED ONE LINE DIAGRAM 4.16 KV DISTRIBUTION SYSTEM H. APL."
6. S/S SUB STATION T-1E SIZED FOR 500 KVA, S/S SUB STATION T-2E SIZED FOR 1000 KVA.

SYM	REVISIONS	BY	DATE

ABAM ENGINEERS

L. R. GLOSTEN & ASSOCIATES, INC.
NAVAL ARCHITECTS • MARINE ENGINEERS • OCEAN ENGINEERS
910 COLMAN BLDG. • 811 FIRST AVE. • SEATTLE, WASHINGTON 98104

APL OTEC PILOT PLANTSHIP
PRELIMINARY ELECTRICAL ONE LINE DIAGRAM FOR SHIP SERVICE

DRAWN CWK	DATE 9/21/78	SCALE NONE	
CHECKED CWF	DATE 11/22/78	DWG. NO. E-07	REV A
APP'D TPIS	DATE		

Fig. 57 APL OTEC pilot plantship preliminary electrical one-line diagram for ship service (E-7).

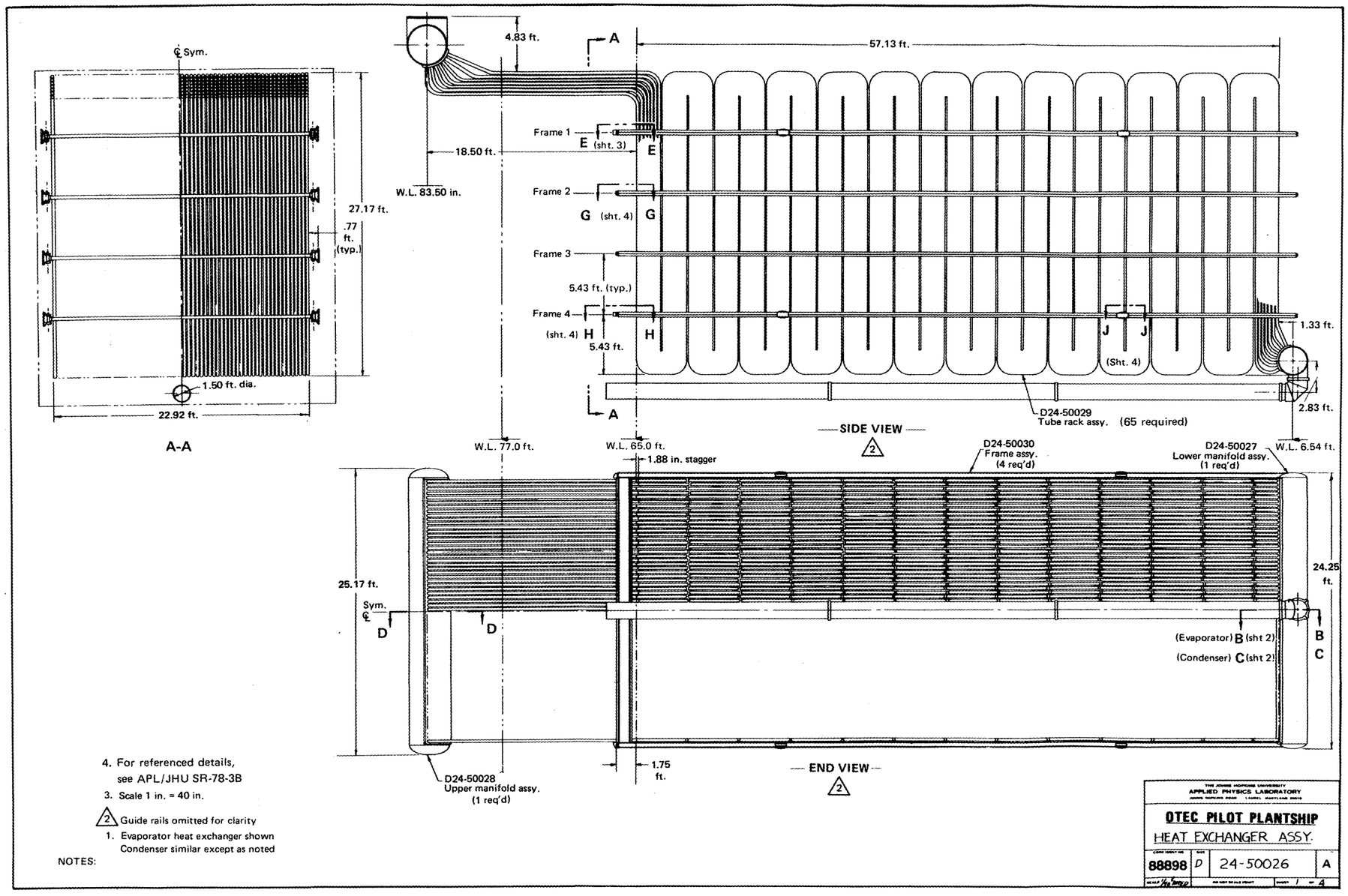


Fig. 58 Heat-exchanger assembly (D24-50026).