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He TRANSFER LINES

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**Author**

Carrieri, John.

**Publication Date**

1979-04-01



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JOHN CARRIERI	MECHANICAL	BERKELEY	APRIL 27-1979	
PROGRAM - PROJECT - JOB				
NBSTF -TFTR				
CRYOGENICS SUPPLY SYSTEM				
TITLE				
He TRANSFER LINES				

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He TRANSFER LINES DESCRIPTION

THE TETR TRANSFER LINES CONSIST OF A  $\frac{3}{4}$  O.D. X .035 IN. WALL, TYPE 304 STAINL. STL. TUBE FOR THE COLD SUPPLY, AND  $\frac{1}{4}$  O.D. X .035 WALL TUBE FOR THE COLD RETURN.

THE INNER TUBE IS INSULATED WITH 40 LAYERS OF ALUMINIZED (ONE SIDE), PERFORATED AND CRINKLED MYLAR, AND CENTERED WITHIN A  $2\frac{7}{8}$  O.D. (2.5 IN. SCHED. 5) ALUMINUM VACUUM JACKET, BY 3 NYLON BALLS (120° APART) ANNULAR SUPPORT.

SUPPORTS ARE PLACED APPROXIMATELY 10 FT. APART; 2 LOCATED NEAR EACH END AND AT CENTER OR, DEPENDING ON LINE LENGTH, AT EACH END, OR AT CENTER ONLY.

TOTALLY 26 SUPPORTS WERE REQUIRED.

DIFFERENTIAL EXPANSION BETWEEN THE INNER LINE AND OUTER JACKET IS OBTAINED BY USING CORRUGATED-METAL-HOSE ELBOWS FOR THE  $\frac{1}{4}$  DIA. COLD RETURN LINE; WHILE THE  $\frac{3}{4}$  DIA. ALL-RIGID-ELBOWS SUPPLY LINE CAN MOVE WITHIN THE VACUUM JACKET.

THE TRANSFER LINES ARE SUBASSEMBLED IN 20 FT. OR LESS LENGTHS, AND JOINED IN THE FIELD BY "ASTRO-ARC" WELDING THE INNER TUBE.

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FIELD JOINTS (AFTER BEING TESTED) AND ELBOWS ARE WRAPPED AND INTERLEAVED WITH ADJACENT WRAPPING WITH 40 LAYERS OF ALUMINIZED MYLAR, AND CLOSED WITH 45° OR 90° OR STRAIGHT VACUUM JACKET SEGMENTS.

PUMP-DOWN AND PRESSURE RELIEF PORTS ARE PROVIDED AT EACH VACUUM JACKET SEGMENT. THE INSULATION AT EACH PORT IS RESTRAINED WITH NETTING TO PREVENT PLUGGING WITH FRAGMENTS OF MYLAR IN THE EVENT OF RUPTURE OF THE INNER LINE.

THE TRANSFER LINES TOTAL LENGTH IS 118 FT. SUPPLY AND 118 FT. COLD RETURN - TOTALLY 72 METERS -

THE INSULATING VACUUM SPACE IS PARTITIONED BY BARRIERS AT THE DISTRIBUTION BOX AND AT THE INJECTION DEWAR AND TARGET BOX CONNECTIONS -

FURTHER PARTITIONING RESULTED BY THE USE OF 8 MALE AND 8 FEMALE BAYONETS, WHICH ENABLE QUICK DISCONNECTION OF LINES SECTIONS AT LIQUIFIER AND AT INJECTION AND TARGET TANK FOR REMOVAL OF THE ROOF SHIELDING BLOCKS -

# ENGINEERING NOTE

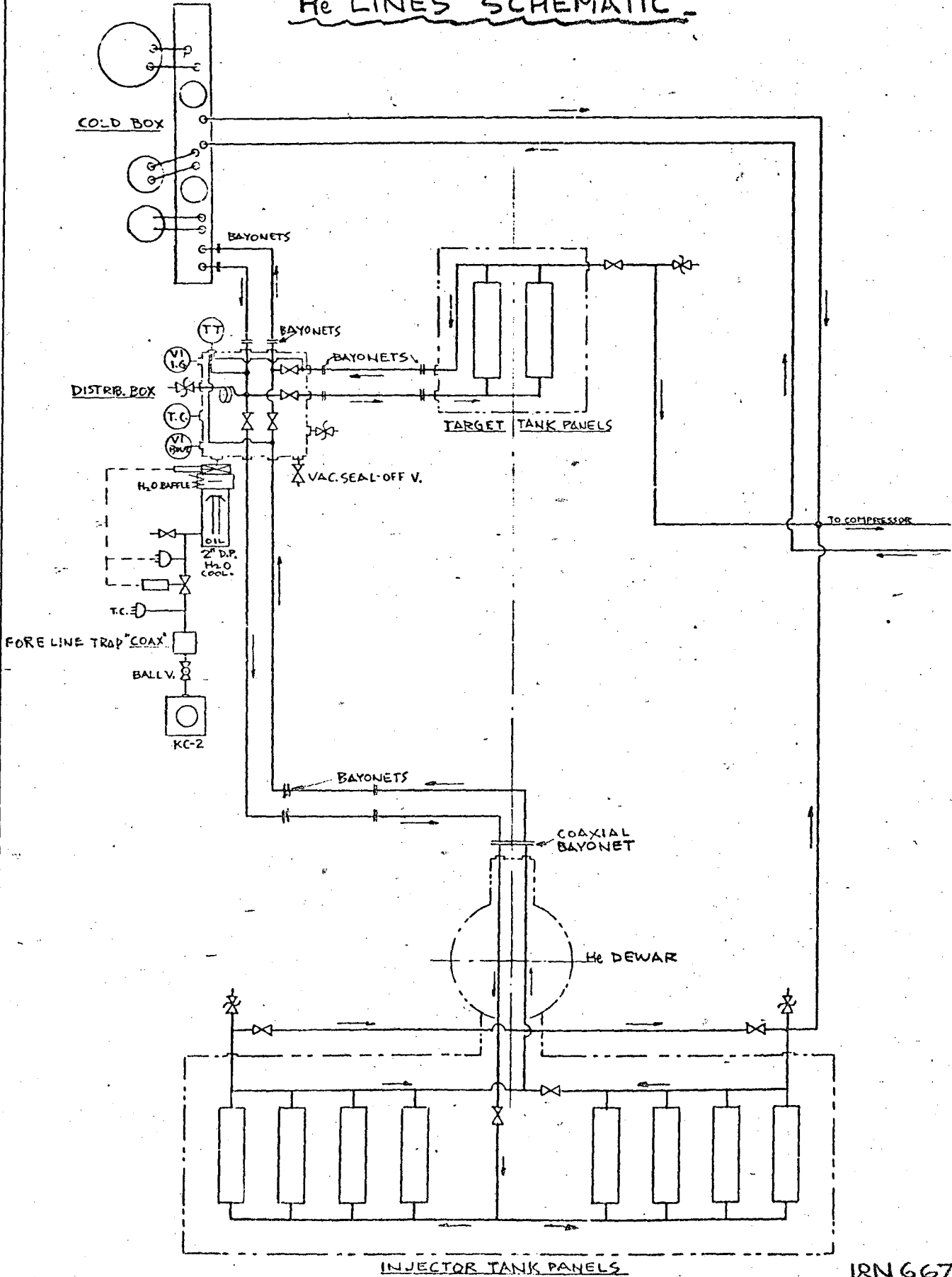
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## He LINES SCHEMATIC



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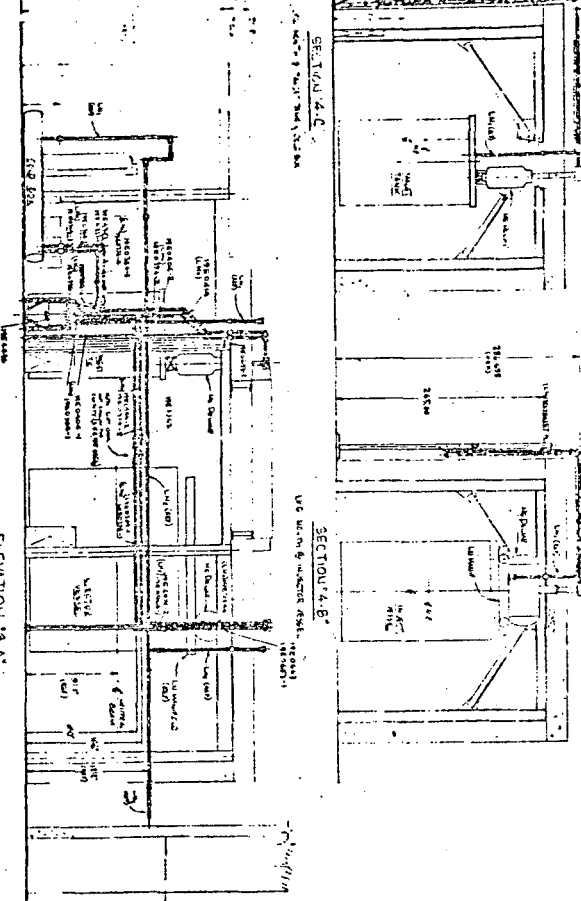
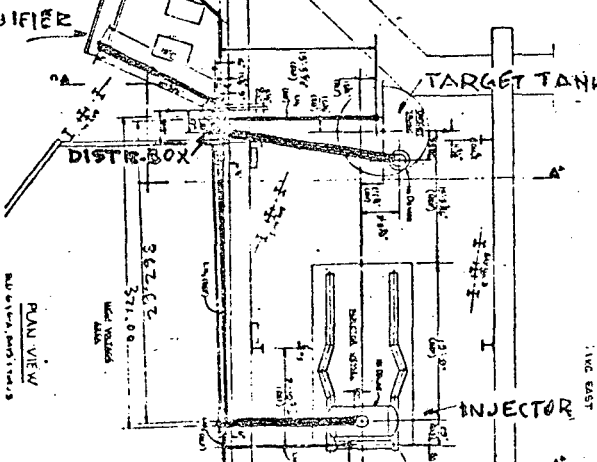
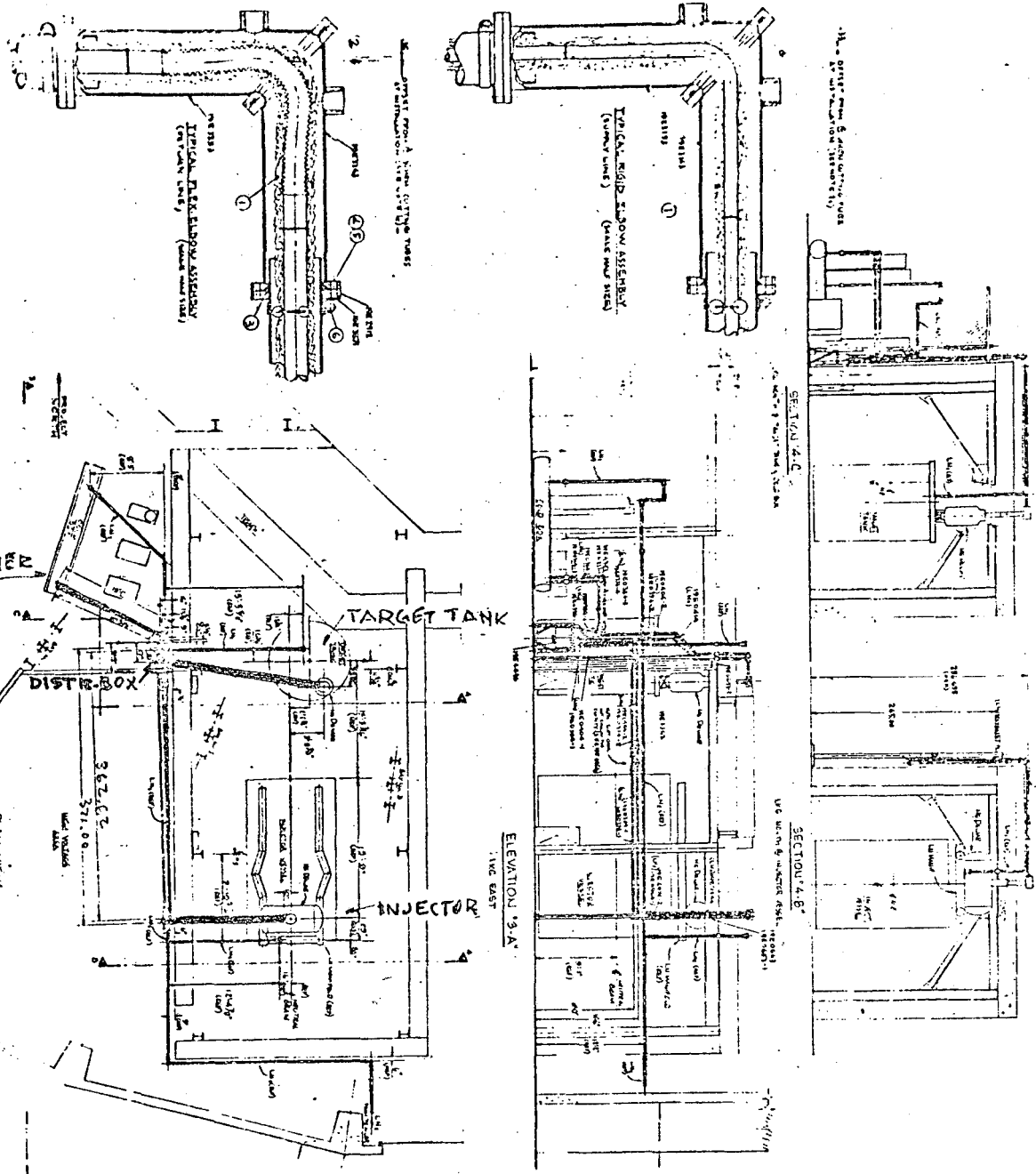
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## He LINES MAIN ASSEMBLY



REV	DATE	DESCRIPTION

19E0636

- NOTES
- 1) He Lines Assembly requires separate design.
  - 2) Initial design for low speed (up to 1000 RPM) is for design - last design will be for 2000 RPM.
  - 3) Initial design for high speed (up to 5000 RPM) is for design - last design will be for 8000 RPM.
  - 4) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
  - 5) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
  - 6) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
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  - 17) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
  - 18) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
  - 19) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.
  - 20) Design for high speed is based on 1/2" thick steel with 1/4" thick copper plating.



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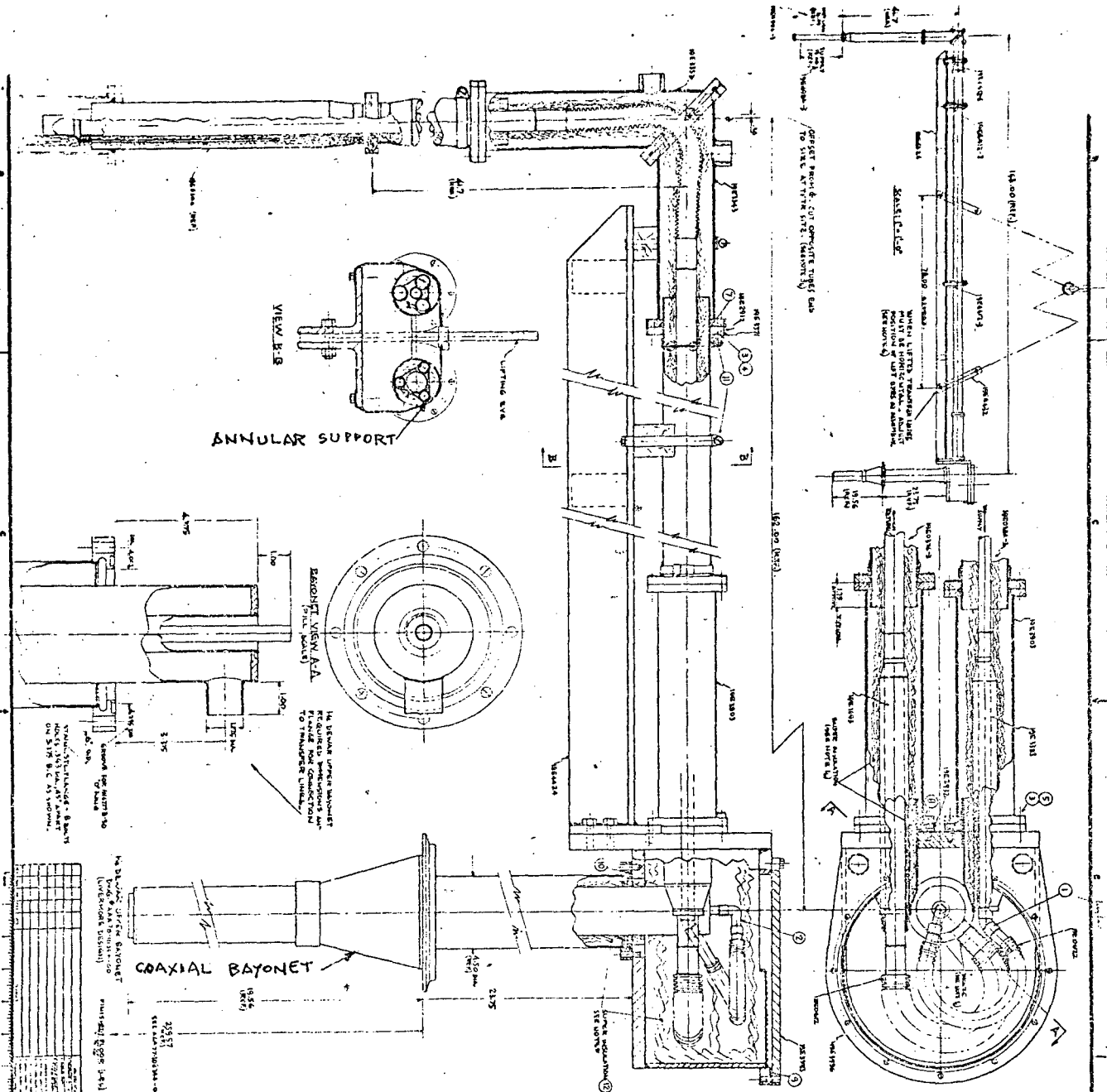
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## He INJECTOR LINES AND BAYONETS SUB-ASSEMBLY -



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He LINES HEAT LEAK -

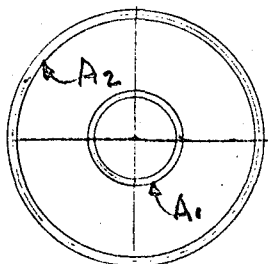
EXCEPT FOR THE ANNULAR SUPPORTS THE TFTR LINES ARE SIMILAR TO THE ESCAR LINES AND BOTH HAVE 40 LAYERS OF SUPER INSULATION. THEREFORE PRACTICAL DATA DERIVED FROM THE 20 FT. (APPROX. 6 METERS) LINE TESTS, DESCRIBED IN ENG. NOTE M5086, CAN BE USED.

THE ESCAR LINE TESTS INDICATE .25 WATTS/m TOTAL HEAT LEAK, OF WHICH .1 WATTS IS ATTRIBUTED TO CONDUCTION PER EACH ANNULAR SUPPORT (2 PINS CONTACTING THE OUTER JACKET), 3 SUPPORTS PER 20 FT. LINE.

THEREFORE THE 6 METER LONG TEST LINE RADIANT HEAT LEAK WAS:

$$(\text{ESCAR LINE}) Q_R = \frac{.25(6) - .1(3)}{6} \approx .2 \text{ WATTS/m}$$

THE TFTR LINE RADIANT HEAT LEAK FIRST APPROXIMATION IS:



$$Q_R = (.2) \frac{\left(\frac{A_1}{A_2}\right)_{\text{ESCAR}} A_{\text{TFTR}}}{\left(\frac{A_1}{A_2}\right)_{\text{TFTR}} A_{\text{ESCAR}}} = (.2) \frac{A_2 \text{TFTR}}{A_2 \text{ESCAR}}$$

$$= (.2) \left(\frac{21.62}{26.6}\right)^* \approx .162 \text{ WATTS/m}$$

\* ESCAR TUBING WAS 2" OD., JACKET 3.334 I.D. COMPARED TO TFTR TUBING 1" AVERAGE, JACKET 2.709 I.D. -

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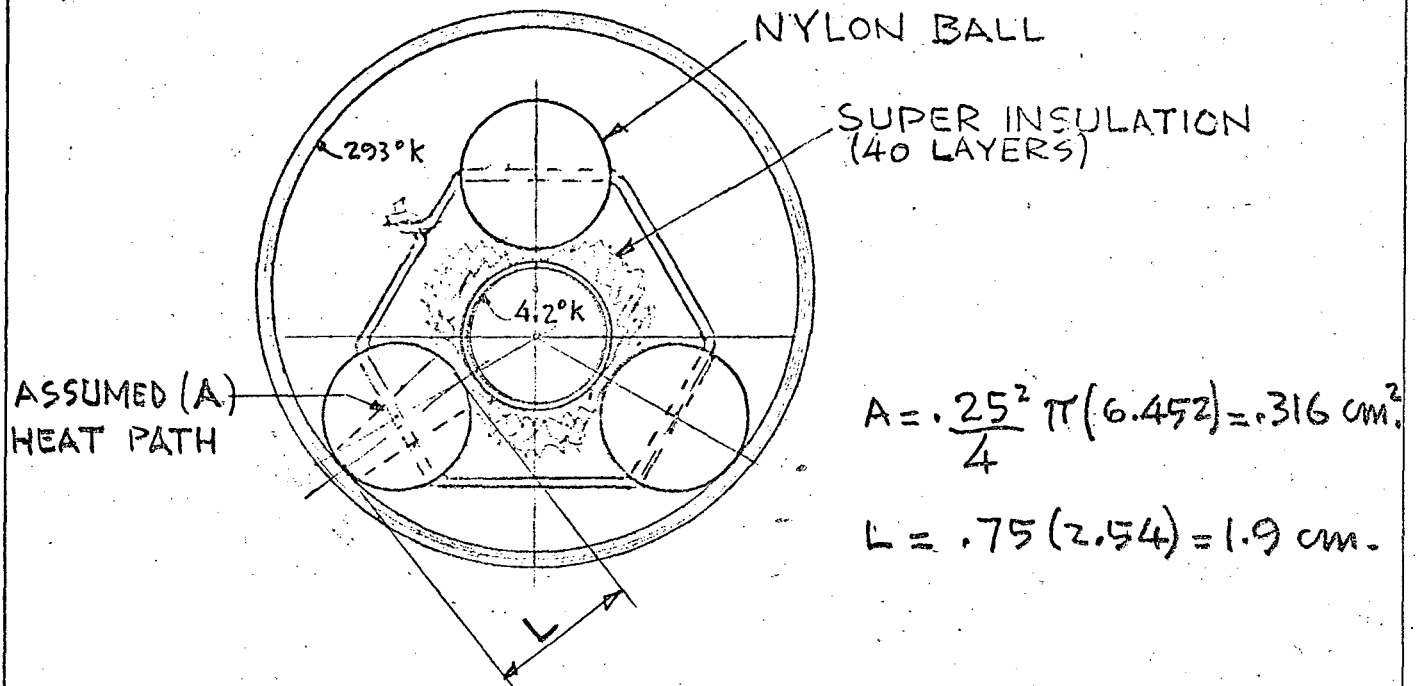
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ANNULAR SUPPORT NYLON BALLS CONDUCTION  
HEAT LEAK -

$$A = \frac{.25^2 \pi (6.452)}{4} = .316 \text{ cm}^2$$

$$L = .75 (2.54) = 1.9 \text{ cm.}$$

CONSIDERING 2 BALLS CONTACT TO OUTER JACKET  
AND DISREGARDING INSULATION WRAP :

293°K → 4.2°K HEAT LEAK

$$Q_c = \frac{A}{L} \int_{4.2^\circ}^{293^\circ} k dt = \frac{.316}{1.9} (.8) \cong .135 \text{ WATTS (ONE BALL)}$$

THE ACTUAL HEAT LEAK PER SUPPORT UNIT WILL  
BE MUCH LESS CONSIDERING THE 40 LAYERS OF  
SUPER INSULATION, AND ALSO DUE TO THE NYLON  
BALLS AND OUTER JACKET SURFACES CONTACT RESISTANCE  
IN VACUUM.

ESTIMATED HEAT LEAK PER SUPPORT (2 BALLS  
CONTACT) :

$$Q_c = .135 (2) \cong .27 \text{ WATTS}$$

\* WADD TECH. REPORT 60-56 P.VII-P-3 (SEE REFS. P.22)

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DISTRIBUTION BOX DESCRIPTION -

THE DISTRIBUTION BOX HAS A CAPACITY OF 6.4 FT.<sup>3</sup> - CONSISTS OF (4) BROKEN STEM CRYOGENIC VALVES WHICH CONTROL THE SUPPLY AND RETURN FLOW TO THE INJECTOR AND TARGET TANK - IT IS ALSO PROVIDED WITH PUMP-DOWN AND PRESSURE RELIEF PORTS AND VACUUM GAGES -

THE SUPPLY AND RETURN CIRCUITRY IS CONNECTED TO THE LIQUIFIER LINES WITH (2) BAYONETS AND THRU (4) VACUUM BARRIERS TO THE INJECTOR AND TARGET LINES.

THE SUPPLY CIRCUITRY IS PROVIDED WITH ONE FEED THRU RELIEF VALVE CONNECTION.

THE BOX IS FITTED WITH (3) PRESSURE GAGES TEMPERATURE TRANSDUCERS, WHICH HELIUM GAS PODS (3) ARE CONNECTED TO THE INJECTOR AND TARGET RETURN CIRCUITRY AND TO THE SUPPLY MANIFOLD.

ALL TUBES ARE INDIVIDUALLY WRAPPED WITH SUPER INSULATION, FURTHERMORE THE WHOLE CIRCUITRY IS WRAPPED WITH A BLANKET OF 40 LAYERS OF INSULATION -

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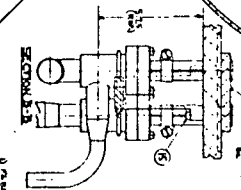
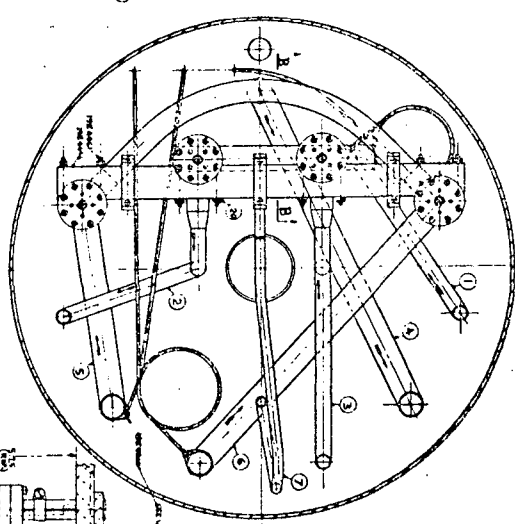
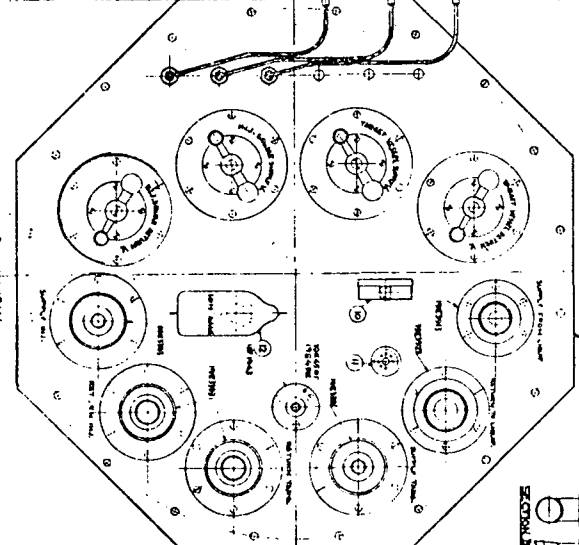
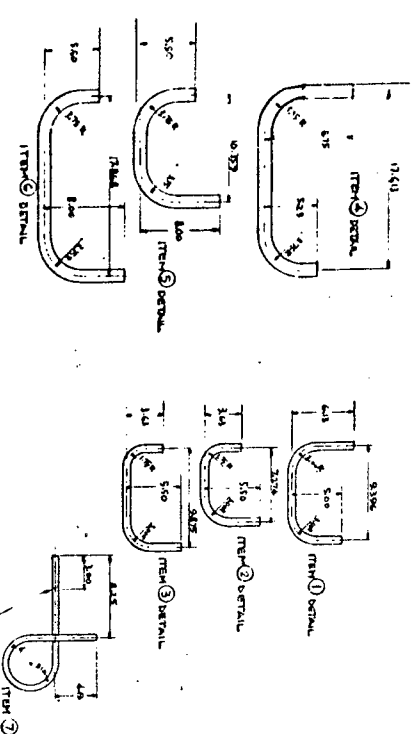
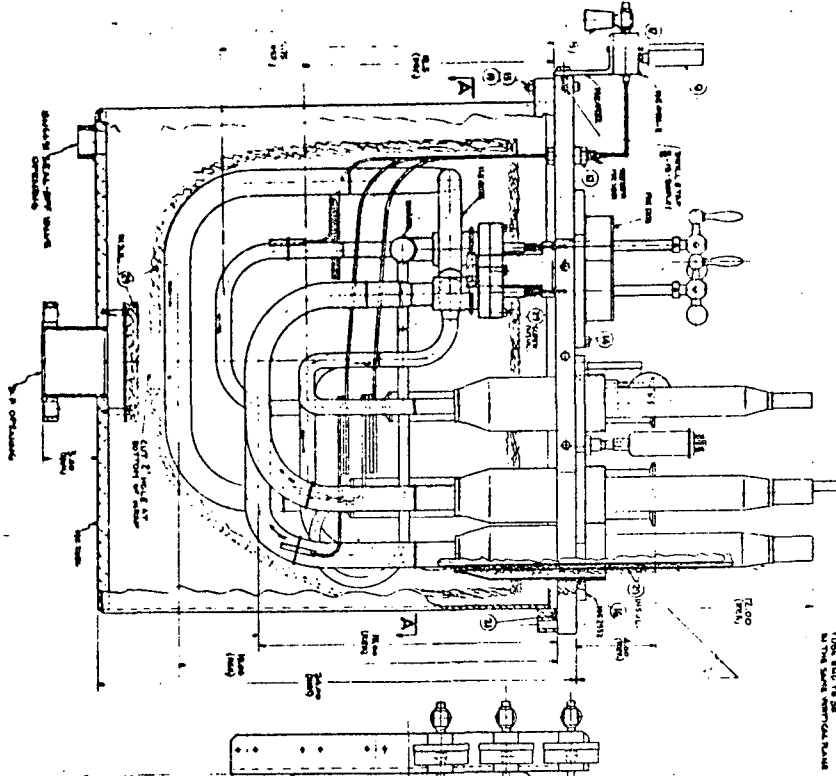
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## DISTRIBUTION BOX ASSEMBLY



- NOTES:
1. Assembly is shown in position.
  2. Assembly is shown in position.
  3. Assembly is shown in position.
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NO.	DESCRIPTION	QTY	UNIT
1	TERMINAL BLOCK	1	PCB
2	WIRING HARNESS	1	PCB
3	DISTRIBUTION BOX	1	PCB
4	LID	1	PCB
5	ITEM 1	3	PCB
6	ITEM 2	3	PCB
7	ITEM 3	3	PCB
8	ROLLER	1	PCB

19E4496

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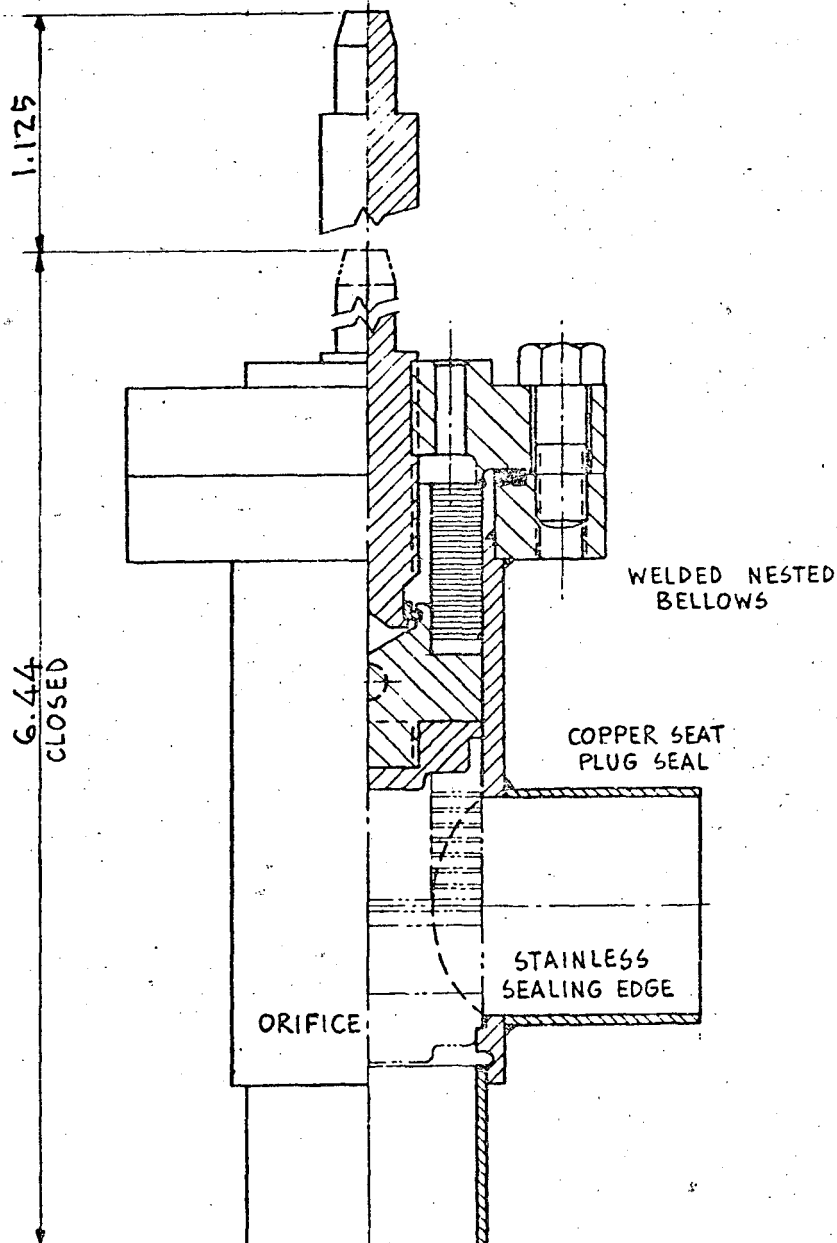
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CRYOGENIC VALVE - "CALIFORNIA PHYSICS PRODUCTS Co"

MODEL No SLT 511-1 $\frac{1}{8}$  RA, ALL METAL, NON DIRECTIONAL FLOW,  
 FOR USE IN VACUUM, WITH REPLACEABLE METAL SEALS -  
 MAX. OPERATING PRESSURE 90 PSIG -



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DISTRIBUTION BOX RADIANT HEAT LEAK -BOX RADIATING SURFACE AREA  $A_2 \cong 17,736 \text{ cm}^2$ CIRCUITRY COLD " "  $A_1 \cong 4,864 \text{ cm}^2$ 

FROM UCRL 3421 CRYOGENIC DATA :

$$\frac{Q}{A_1} = \sigma \frac{1}{\frac{1}{\epsilon_1} + \frac{A_1}{A_2} \left( \frac{1}{\epsilon_2} - 1 \right)} (T_2^4 - T_1^4) = W/\text{ft}^2$$

ASSUME  $\epsilon_1 \cong 0.1 = \epsilon_2$ 

$$\frac{Q}{A_1} = (5.333 \times 10^{-8}) \frac{1}{\frac{1}{.1} + \frac{4864}{17736} \left( \frac{1}{.1} - 1 \right)} (293^4 - 4.2^4) =$$

$$W/\text{ft}^2 \left( \frac{1}{929} \right) = W/\text{cm}^2$$

W/  
SUP. INSUL.

$$Q_{W/0} = \frac{(5.333 \times 10^{-8}) (73.7 \times 10^8) (4864)}{12.468 (929)} = 16.5 \text{ WATTS}$$

WITH  
SUP. INSUL.

$$Q_R = \frac{Q_W}{Q_{W/0}} = \frac{1}{n+1}^*$$

$$n = 40 \text{ LAYERS}$$

CONSIDER 5% OF  $Q_{W/0}$  AS ADDITIONAL HEAT LEAK THRU BROKEN STEM VALVE OPENINGS AND GAPS AROUND BARRIERS -

$$Q_R = 16.5 \left( \frac{1}{40+1} \right) + 16.5(0.05) \cong \underline{\underline{1.23}} \text{ WATTS}$$

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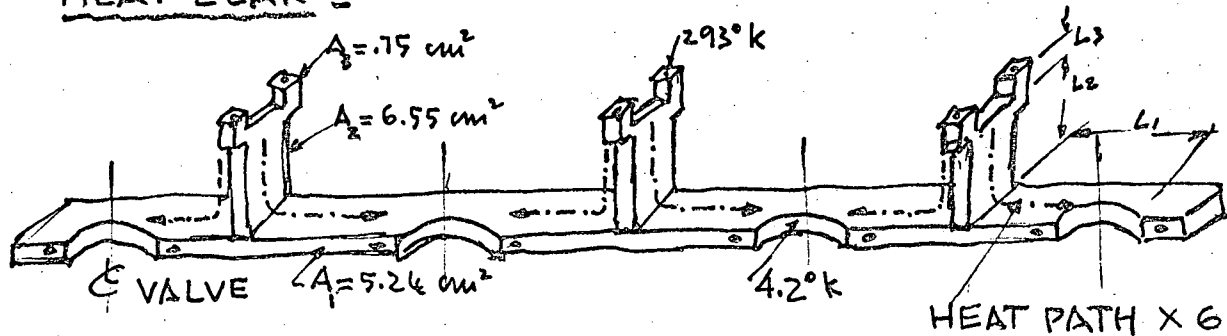
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DISTRIBUTION BOX (4) VALVES SUPPORT CONDUCTION HEAT LEAK -

NEMA G-10 SUPPORT (19E4444) :

$$A_1 = 5.24 \text{ cm}^2$$

$$L_1 = 8.57 \text{ cm}$$

$$A_2 = 6.55 \text{ cm}^2$$

$$L_2 = 9.52 \text{ cm}$$

$$A_3 = .75(2) = 1.5 \text{ cm}^2$$

$$L_3 = .32 \text{ cm}$$

$$Q = kA \frac{\Delta T}{\Delta L} =$$

$$* K = .003 \text{ WATTS/cm}^{\circ}\text{K}$$

$$Q = \frac{(293 - 4.2)}{\frac{8.57}{.003(5.24)} + \frac{9.52}{.003(6.55)} + \frac{.32}{.003(1.5)}} =$$

$$Q = \frac{288.8}{545.2 + 484.5 + 71.1} \cong .262 \text{ WATTS (ONE HEAT PATH)}$$

DISREGARDING THE SUPPORT LEGS SURFACES CONTACT RESISTANCE IN VACUUM THE TOTAL ESTIMATED HEAT LEAK IS:

$$Q_c = .262(6) \cong \underline{\underline{1.57}} \text{ WATTS}$$

\* WADD TECH. REPORT 60-56 P.VII-P-2 (SEE REFS. P.22)





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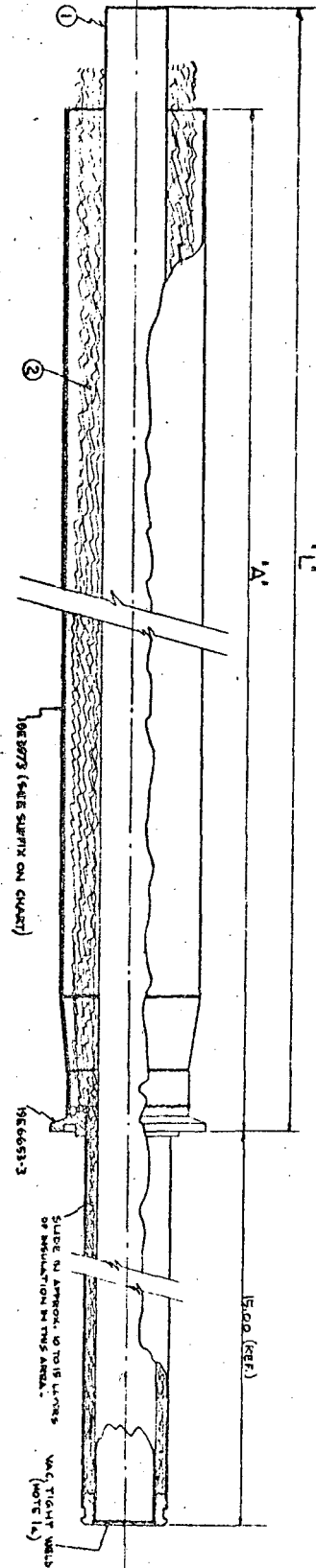
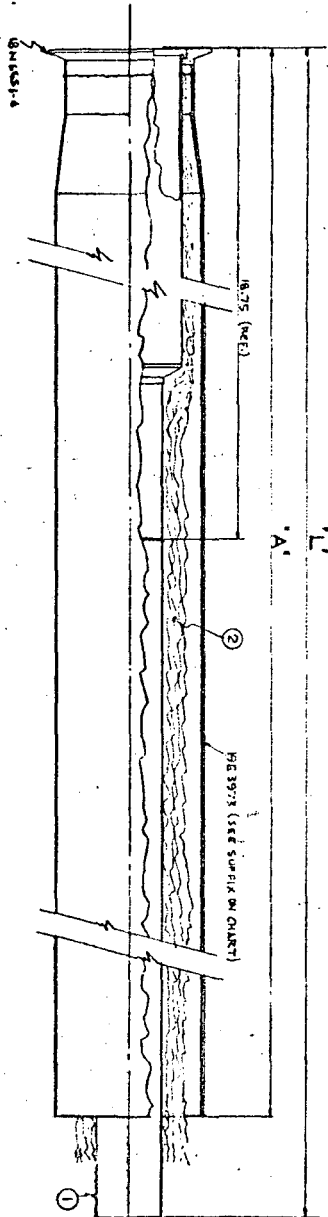
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## FEMALE BAYONET SUB-ASSEMBLY



## MALE BAYONET SUB-ASSEMBLY

19E4994

19E4964

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BAYONETS CONDUCTION HEAT LEAK -

$$Q \frac{L}{A} = \int_0^{T_1} KDT - \int_0^{T_2} KDT = \left[ \int_0^{293^{\circ}} KDT - \int_0^{4.2} KDT \right]_{SS}$$

3/4 BAYONET UNIT (MALE & FEMALE, SEE P.14)

$$(TM) \quad A \cong D\pi t = (1.25 - .02) \pi (.02) 6.452 = .499 \text{ cm}^2$$

$$(TF) \quad A = (1.5 - .02) \pi (.02) 6.452 = .6 \text{ cm}^2$$

$$L \cong 13.00'' = 33.02 \text{ cm.}$$

$$Q = \frac{.499 + .6}{33.02} (32^* - 0) = \underline{\underline{1.06 \text{ WATTS}}}$$

1/4 BAYONET UNIT

$$(TM) \quad A = (1.75 - .028) \pi (.028) 6.452 = .977 \text{ cm}^2$$

$$(TF) \quad A = (2.00 - .02) \pi (.02) 6.452 = .803 \text{ cm}^2$$

$$L = 15.00'' = 38.1 \text{ cm.}$$

$$Q = \frac{.977 + .803}{38.1} (32 - 0) = \underline{\underline{1.49 \text{ WATTS}}}$$

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DEPARTMENT

LOCATION

DATE

JOHN CARRIERI

MECHANICAL

BERKELEY

APRIL 27 - 1979

BAYONET TUBES STABILITY -

TUBE UNDER UNIFORM EXTERNAL PRESSURE  
(MAX. OPERATING PRESS. 65 PSI, CONSIDERING RELIEF  
VALVES SET AT 50 PSI):

1) (T<sub>M</sub>) 1.75" O.D. X .028 W., 15.00" LG

$$L > 4.90 r \sqrt{\frac{r}{t}} > 23.96 \text{ DOESN'T APPLY}$$

ROARK  
P. 354

$$P'_{\text{CRIT.}} = \frac{.807 E t^2}{L r} \sqrt[4]{\left(\frac{1}{1-\nu^2}\right)^3 \frac{t^2}{r^2}} =$$

$$= \frac{.807 (28 \times 10^6) .028^2}{15 (.875)} \sqrt[4]{1.33 \left(\frac{.028}{.875}\right)^2} =$$

$$P'_{\text{CRIT.}} = \underline{\underline{259 \text{ PSI}}}$$

2) (T<sub>M</sub>) 1.25" O.D. X .020 W., 13.00" LG.

$$P'_{\text{CRIT.}} = \frac{.807 (28 \times 10^6) .020^2}{13 (.625)} \sqrt[4]{1.33 \left(\frac{.02}{.625}\right)^2} = \underline{\underline{213 \text{ PSI}}}$$

TUBE UNDER EXTERNAL PRESSURE  
(ATMOSPHERIC 14.7 PSI):

3) (T<sub>F</sub>) 2.00" O.D. X .020 W., 15.00" LG.

$$P'_{\text{CRIT.}} = \frac{.807 (28 \times 10^6) .02^2}{15 (1.0)} \sqrt[4]{1.33 \left(\frac{.02}{1}\right)^2} = \underline{\underline{91.5 \text{ PSI}}}$$

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TUBE UNDER UNIFORM INTERNAL PRESSURE  
(MAX. OPERATING PRESS. 65 PSI, CONSIDERING  
RELIEF VALVES SET AT 50 PSI) :

$$\text{YIELD STRESS } P = \frac{2St}{D}$$

4) (TF) 2.00" O.D. X .020 W.

$$P = \frac{\frac{1}{2}(30,000)(.020)}{\frac{1}{2}} = \underline{\underline{600 \text{ PSI}}}$$

RELIEF VALVE FEED THRU (DWG. 19E4912 & 19E4496)  
CONDUCTION HEAT LEAK:

S. STL. TUBE .5" O.D. X .035 W., 40" LG.

293°K → 4.2°K HEAT LEAK

$$A = D\pi t = (.5 - .035)\pi (.035) 6.452 = .33 \text{ cm}^2$$

$$L \cong 40.00" = 101.6 \text{ cm.}$$

$$Q = \frac{A}{L} \int_{4.2^\circ}^{293^\circ} k dt =$$

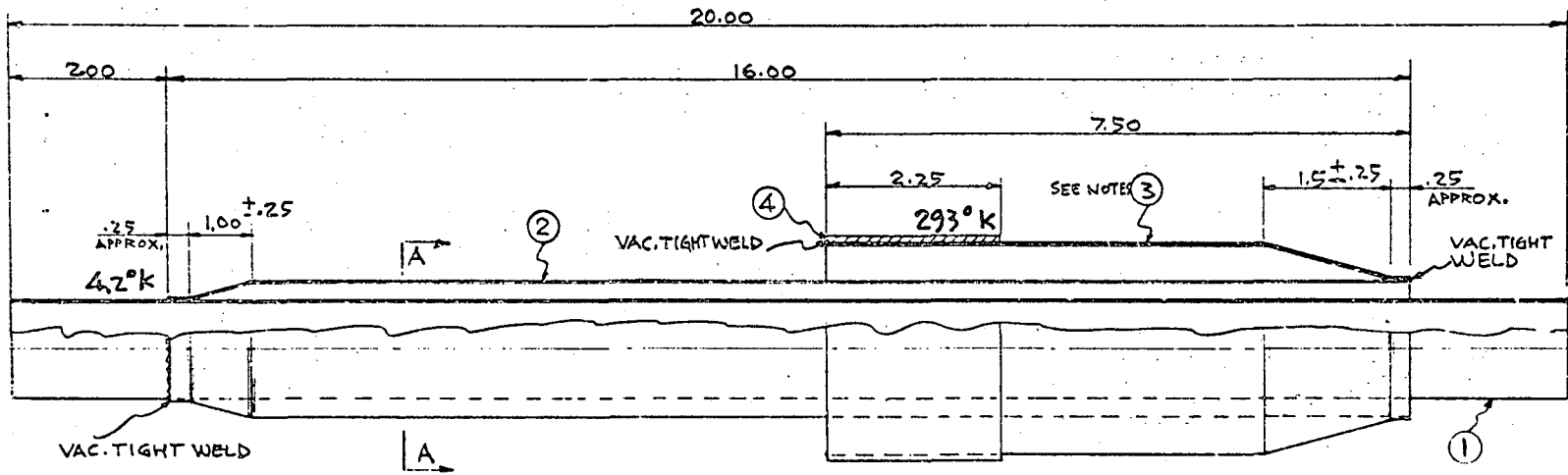
$$Q = \frac{.33}{101.6} (32 - 0) = \underline{\underline{.104 \text{ WATTS}}}$$

ENGINEERING NOTE

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MECHANICAL  
VACUUM BARRIER -

REQ.	ITEM	PART NUMBER	DESCRIPTION
1	1		1.25 O.D. X .035 W. TUBE STAINL. STL. 304
1	2		1.75 O.D. X .020 W. " " 304
1	3		MAKE FROM .036 SHEET (STOCK) " " 304
1	4		PIPE 2 1/2 SCHED. 5 (2.875 O.D. X .083 W.) STAINL. STL. 304



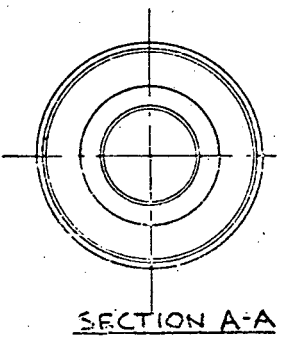
NOTES:

- 1) ITEM 3 TUBE TO BE FABRICATED 2.7 O.D. X .036 W. TO FIT INSIDE ITEM 4 - NECK DOWN AS SHOWN TO FIT ITEM 2 - NECK DOWN AS SHOWN ITEM 2 TO FIT ITEM 1.
- 2) ALL ITEMS WHEN WELDED TOGETHER MUST BE CONCENTRIC WITHIN .03.

Vacuum check with helium leak detector.  
Leak rate at any location not to exceed  $10^{-9}$  std. cc/sec.

Clean thoroughly for high vacuum service.

Protect to maintain cleanliness during shipment and storage.



UNLESS OTHERWISE SPECIFIED		SURF. CHARS.		LAWRENCE BERKELEY LABORATORY	
1 TOLERANCES .06 AND NOTES	LOC. OF	DATE	BY	UNIVERSITY OF CALIFORNIA - BERKELEY	
2 SURFACE FINISH	DATE	DATE	BY	NBSTF-TFTR	
3 WELD TO BE WELDED	DATE	DATE	BY	H <sub>2</sub> TRANSFER LINES	
4 BREAKER OR STICK FINISH	DATE	DATE	BY	DISTRIB. BOX 1/2 LINE VAC. BARRIER	
5 FINISH CLASS 3	DATE	DATE	BY	TAG	
6 CHARACT. EDGE OF ALL SCREW THREADS UP	DATE	DATE	BY	DATE 8-21-78	
7 1/4" FITCH RELIEF WITH ROUND ROSS TOOL ON ALL MACHINE CUT THREADS	DATE	DATE	BY	DATE 4-28-80	
8 SPOT ANGLE 120° ON ALL MACHINED SURF.	DATE	DATE	BY	DATE 12-80-02-00	
9 REMOVE BURRS USING FILE AND FILE BRACKET	DATE	DATE	BY	DATE 19E3393	
10 REMOVE BURRS FROM SCREW HEADS AND WELDS	DATE	DATE	BY	DATE	

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VACUUM BARRIERS CONDUCTION HEAT LEAK-

293°K → 4.2°K HEAT LEAK

3/4 LINE BARRIER (SEE P. 19)

1) S. STL. TUBE 1.5" O.D. X .020 W, 16.00" LG.

$$A = D\pi t = (1.5 - .02)\pi(.02)6.452 = .6 \text{ cm}^2$$

$$L \cong 16.00'' = 40.64 \text{ cm.}$$

$$Q = \frac{A}{L} \int_{4.2^\circ}^{293^\circ} k dt =$$

$$Q = \frac{.6}{40.64} (32 - 0) = \underline{\underline{.472 \text{ WATTS}}}$$

1/4 LINE BARRIER :

2) S. STL. TUBE 1.75" O.D. X .02 W, 16.00" LG.

$$A = (1.75 - .02)\pi(.02)6.452 = .701 \text{ cm}^2$$

$$L \cong 16.00'' = 40.64 \text{ cm.}$$

$$Q = \frac{.701}{40.64} (32 - 0) = \underline{\underline{.552 \text{ WATTS}}}$$

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VACUUM BARRIER (SEE P.19) SKIRT STABILITY -  
TUBE UNDER UNIFORM EXTERNAL PRESSURE

S. STL. TUBE 2.7" O.D. x .036 W., 7.25" LG.

ROARK  
P.354

$$L > 4.9 r \sqrt{\frac{r}{t}} > 40.5 \text{ DOESN'T APPLY -}$$

$$P'_{CR.} = \frac{.807 E t^2}{L r} \sqrt[4]{\left(\frac{1}{1-\nu^2}\right)^3 \frac{t^2}{r^2}} =$$

$$= \frac{.807 (28 \times 10^6) (.036)^2}{7.25 (1.35)} \sqrt[4]{1.33 \left(\frac{.036}{1.35}\right)^2} =$$

$$P'_{CR.} = \underline{\underline{525 \text{ PSI}}}$$



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He TRANSFER LINES HEAT LEAK SUMMARY -

DESCRIPTION	RADIANT HEAT LEAK WATTS	CONDUCTION HEAT LEAK WATTS
(336 FT.) LINES 72m(.162) (P.7)	11.7	
ANNULAR SUPPORTS 26(.27) (P.8)		7.02
DISTRIBUTION BOX (P.12)	1.23	
"  BOX VALVES SUPPORT (P.13)		1.57
3/4 BAYONET UNIT 1.06(8) (P.16)		8.48
1/4 " " 1.49(8) (P.16)		11.92
RELIEF VALVE FEED THRU (P.18)		.11
3/4 VACUUM BARRIER .472(4) (P.20)		1.89
1/4 " " .552(4) (P.20)		2.21
	12.93	33.20

TOTAL HEAT LEAK =  $12.93 + 33.20 \approx 46.13$  WATTS

REFERENCES -

- 1) S. HICKMAN, E.N. M241, HEAT TRANSFER CONDUCTIVITY CURVES.
- 2) R. WARREN, E.N. M5086, ESCAR TRANSFER LINES TEST.
- 3) UCRL 3421, CRYOGENIC DATA -
- 4) WADD TECH. REPORT 60-56, BY R.B. STEWARD & V.J. JOHNSON DEC. 1961
- 5) VERBAL COMMUNICATION WITH J. HAUGHIAN, R. BYRNS, R. WOLGAST -

## ENGINEERING NOTE

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He TRANSFER LINES FABRICATION & MATERIAL COST (BAYONETS NOT INCLUDED) :

236 FT. OF LINES CONSISTING OF 20 FT. OR SHORTER SUB-ASSEMBLIES WHICH INCLUDE (4) 45° JOINTS, (4) STRAIGHT JOINTS, (12) 90° JOINTS AND CORNER ASSEMBLIES (19E0374 & 84) -

FABRICATION 654 M.HRS. @ 24.4/m. = \$15958

STORES STOCK MATERIAL - - - - - 581

## PURCHASED MATERIAL:

5/8 3/4, 1 1/4, 2 1/2 TUBE & PIPE, 2 1/2 AL. PIPE - - - - - 1645

(18) SEAL-OFF VALVES & OPERATOR - - - 2407

BUSHINGS, COUPL., NIPPLES, PLUGS, O" RINGS - - - 221

NYLON BALLS - - - - - 68

5/8 1 1/4 & 3/4 ANNULAR CORRUGATED HOSE - - - 225

56" WIDE, 11000 FT.<sup>2</sup> ALUMINIZ. MYLAR - - - 216

MYLAR ADESIVE TAPE - - - - - 98

\* TOTAL \$ 21,419.

He LINE UNIT COST =  $\frac{21419}{236} \approx 91$  \$/FT.

\* FIELD INSTALLATION & FIELD TESTING NOT INCLUDED -

DISTRIBUTION BOX FABRICATION & MATERIAL COST:

FABRICATION <u>661.5 M.HRS</u> @ 24.4/hr. ---	\$16140
STORES STOCK MATERIAL - - - - -	726
PURCHASED MATERIAL:	
(6) CRYOVALVES - - - - -	2226
" BROKEN STEM CRANK & COLLAR	70
S/S 1/8 X .049 TUBE	118

DISTRIB. BOX COST  $\cong$  \$ 19,280

NOTE: BOX VACUUM SYSTEM NOT INCLUDED.

INJEC. DEWAR BAYONET CONNECTING BOX COST:  
(18N5946) (COAXIAL BAYONET NOT INCLUDED)

FABRICATION <u>125.5 M.HRS.</u> @ 24.4/hr. \$	3063
STORES STOCK MATERIAL - - - - -	107

CONNECTING BOX COST  $\cong$  \$ 3,170

BAYONET ASSEMBLIES COST:

FABRICATION <u>293 M.HRS.</u> @ 24.4/hr. ---	\$ 7150
STORES STOCK MATERIAL - - - - -	143
PURCHASED MATERIAL:	

(8) "CRYENCO" PURCHASED BAYONET UNITS . . . . .	2334
(MALE & FEMALE)	
TOTAL \$	<u>9627</u>

UNIT COST PER ASSEMBLED =  $\frac{9627}{8} \cong$  1203 \$  
BAYONET (MALE & FEMALE)

J.C.  
3-29-79

TFTR 80-02-00 He TRANSFER LINES

DWGS LIST

(OBSOLETE)	18 N	5926	LN COOLED DISTRIB. BOX ASSEMBLY
	18 N	5934	TRANSF. LINES LAYOUT (PRELIM.)
A	"	5946	He DEWAR TRANSF. LINES & BAYONET ASSEMBLY
	"	6653	TRANSF. LINES BAYONET (PURCH. DWG.)
	"	6674	" " SCHEMATIC
	"	6681	He LINE ANNULAR SUPPORT BALL
	"	6691	" VAC. SEAL-OFF VALVE
	19 E	2886	TRANSF. LINES DISTRIB. BOX BODY
	"	2893	" " 90° ELBOW FL.
	"	2904	" " DISTR. BOX COVER
	"	2912	" " VAC. CASING CLAMP FL.
	"	2922	" " " " FLANGE
	"	2932	DISTRIB. BOX VAC. SEAL "
	"	2942	" " " CASING "
	"	2951	TRANSF. LINES 1/4 BAYONET FL.
	"	2961	" " 3/4 " "
	"	2971	DISTRIB. BOX FEED THRU
	"	2981	" " " " WASHER
	"	2992	" " VALVE BROKEN STEM BRKT
	19 E	3301	DISTRIB. BOX VALVE BROKEN STEM STUFFING
	"	3311	" " " " " " COVER
	"	3321	" " " " " " EXTENSION
	"	3333	" " " " " " ASSEMBLY
	"	3343	TRANSF. LINES 90° ELBOW CASING (PLAIN FL.)
	"	3353	" " " " " " (GROOVE)
	"	3363	" " JOINT STRAIGHT CASING
	"	3371	" " CASING FL. LOCK CLIP
	"	3383	DISTRIB. BOX 3/4 LINE VAC. BARRIER
	"	3393	" " 1/4 " " "
	19 E	3903	TRANSF. LINES DISTR. BOX CASING
	"	3913	" " " " 3/4 FEM. BAYONET
	"	3923	" " " " 1/4 " "
	"	3933	" " 45° ELBOW FL.

19E 3943 TRANSF. LINES 45° ELBOW CASING (GROOVE INFL.)  
 " 3953 " " " " " (PLAIN FL.)  
 " 3963 " " 3/4 BAYONET OUTER TUBE  
 " 3973 " " 1/4 " " "  
 " 3983 " " DEWAR CONNECTING BOX COVER  
 " 3996 " " " " BOX

19E 4412 DEWAR LINES SUPPORT SADDLE  
 " 4424 " " " FRAME  
 " 4432 " " " LIFTING BAR  
 " 4444 DISTR. BOX VALVES SUPPORT  
 " 4454 " " " ASSY JIG  
 " 4464 " " " SUPPORT CLAMP  
 " 4474 " " " RETURN LINE CONNECTION  
 " 4484 " " " SUPPLY " "  
 " 4496 " " ASSEMBLY  
 " 4501 " " SUPPLY LINE RELIEF VALVE FL.

19E 4894 DEWAR TRANSF. LINES STORAGE FRAME  
 " 4902 DISTRIB. BOX TEMP. TRANSD. VAPOR BULB  
 " 4911 " " GAGE FITTING  
 " 4922 " " " SUPPORT BRKT  
 " 4933 RETURN LINE FLEX. ELBOW  
 " 4943 " " " " (AT LIQUIF.)  
 " 4956 DISTRIB. BOX AND He LINES SUPPORT FRAME  
 " 4964 1/4 FEM. BAYONET SUB-ASSEMBLY  
 " 4974 3/4 " " " "  
 " 4984 3/4 MALE " " "  
 " 4994 1/4 " " " "

19E 0322 SUPER INSUL. PREPARATION & USE SPECS.  
 " 0333 SUPPLY LINE ELBOWS  
 " 0344 INJECTOR REMOVABLE LINE SECTION ASSY  
 " 0354 " " " " SUPPORT FRAM  
 " 0364 LIQUIF. MALE BAYONET SUB-ASSEMBLY  
 " 0374 HORIZONTAL RETURN 1/4 LINE & ELBOW SUB-ASSEM  
 " 0384 " " " 3/4 " " "

A

DRWG LIST

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19 E	0394	VERTICAL (RETURN) 1/4 LINES SUB-ASSEMBLY
"	0404	" (SUPPLY) 3/4 "
"	0414	TARGET He SUPPLY & RETURN LINES BAYONET ASS'Y
"	0422	" " " " INTERMED. BRKT
"	0432	" " " " UPPER "
19 E	0612	He RETURN FLEX. LINE AT DEWAR CONNEX. BOX
"	0622	" SUPPLY " " " "
A	0636	He DISTRIB. LINES MAIN ASSEMBLY
"	0643	" " SUPPORT BRKT
"	0653	" " POLE " "
"	0663	" " LOWER SUPPORT
19 E	1433	LIQUIF. He LINES LIFTING FORK
"	1443	" " SUPPORT CHANNEL
"	1453	" RETURN LINE ELBOW SUPPORT
"	1463	He DEWAR LINES CORNER SUPPORT

FABRICATION ORDERS

No.:	
035342	036210
035343	036211
035344	036262
035592	036346
035633	
035634	
035687	
035688	
035755	
035868	
035958	
036044	
036105	
036188	
036206	
036207	

PURCHASE ORDERS

No.:	
4586402	BAYONETS
4587202	CRYOVALVES
4765102	ALUMINIZ. MYLAR
4759402	NYLON BALLS
4765302	1" SEAL-OFF VALVES
4764922	ALUM. TUBE
4760902	S/S TUBE
4877202	MRC M-2 DIFF. PUM
4877302	2" VRC EL. PNEUM. VALV
95119A2	METAL BELLOWS
95158A2	" "

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