UC-38
LBID-417

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

Engineering & Technical Services Division

DISCLAIMER

LBID 417

LAWRENCE BERKELEY LABORATORY - UNIVERSITY OF CALIFORNIA	CODE	SERIAL	PAGE
ENGINEERING NOTE	TF020d	M5356	1 of 27

AUTHOR	DEPARTMENT	LOCATION	DATE
JOHN CARRIERI	MECHANICAL	BERKELEY	APRIL 27-1979

PROGRAM — PROJECT — JOB

NBSTF -TFTR

CRYOGENICS SUPPLY SYSTEM

TITLE

He TRANSFER LINES

CONTENTS

He TRANSFER LINES DESCRIPTION —

THE TFTR TRANSFER LINES CONSIST OF A 3/4 O.D.X.035 IN. WALL, TYPE 304 STAINL. STL. TUBE FOR THE COLD SUPPLY, AND 1 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 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 1 1/4 DIA. COLD RETURN LINE; WHILE THE 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.

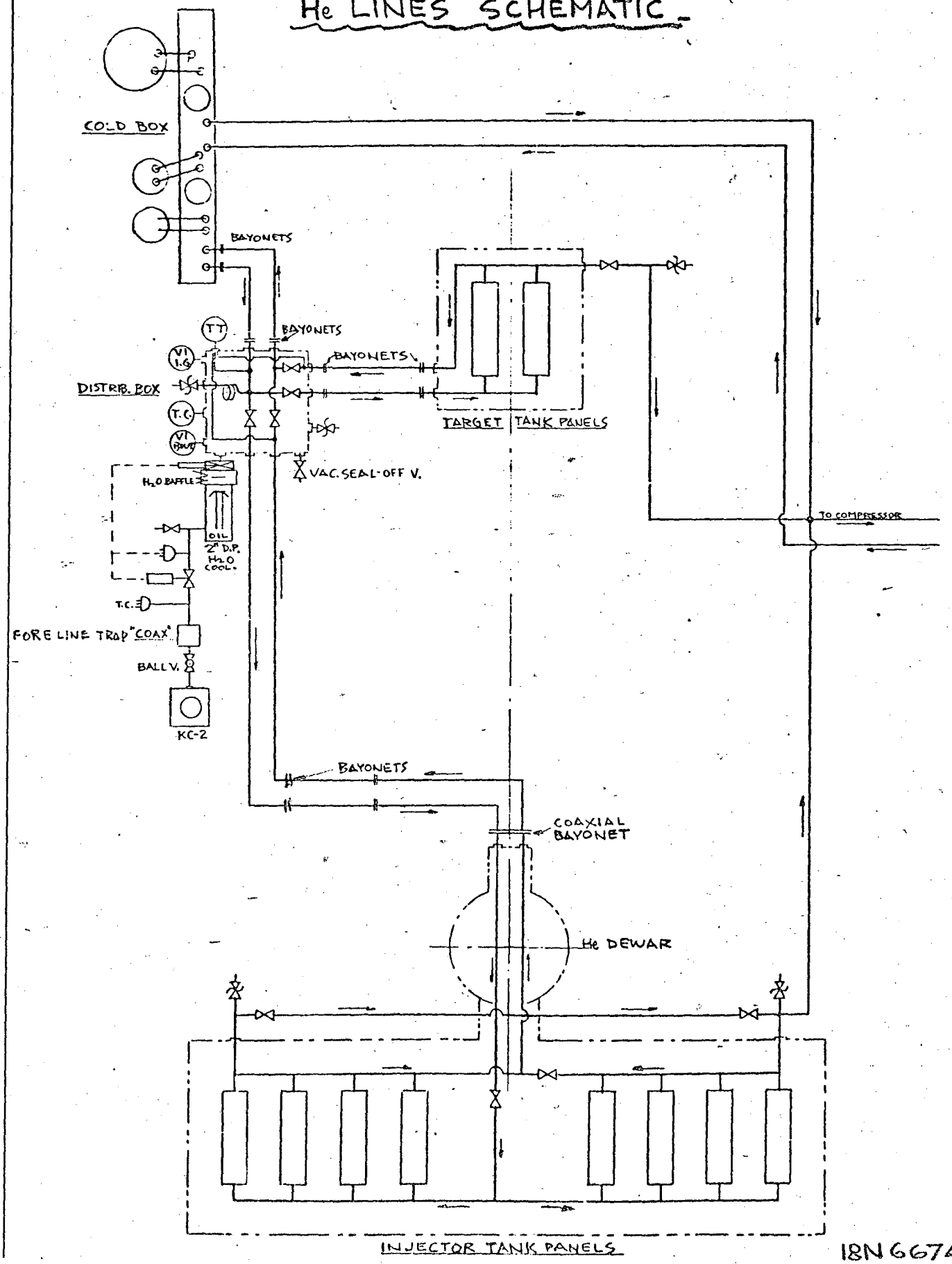
FIELD JOINTS (AFTER BEING TESTED) AND ELBOWS ARE WRAPPED AND INTERLEAVED WITH ADIACENT WRAPPING WITH 40 LAYERS OF ALUMINIZED MYLAR, AND CLOSED WITH 45° OR 90° OR STRAIGHT VACUUM JACKET SEGMENTS.

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.

He LINES SCHEMATIC



18N6674

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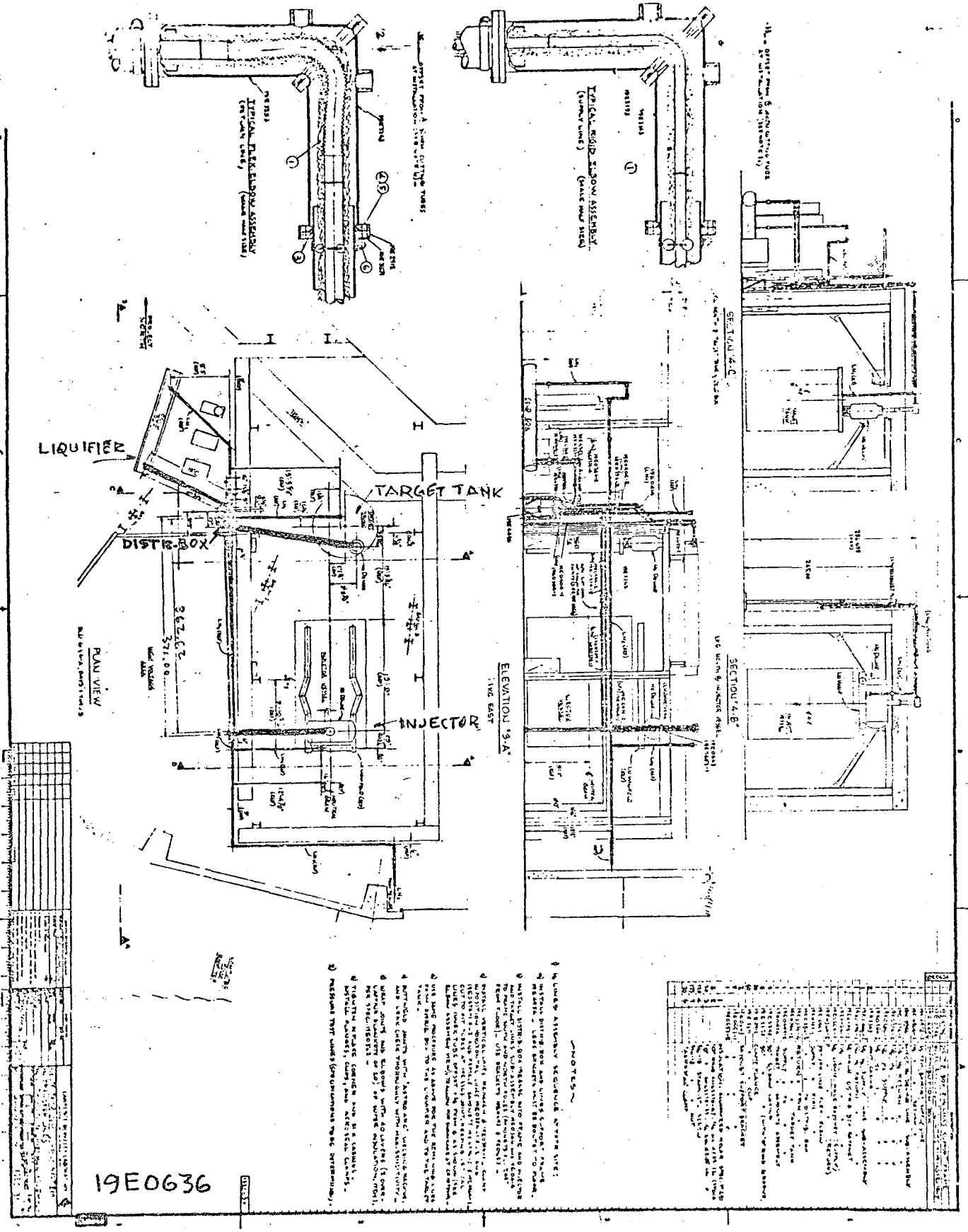
He LINES MAIN ASSEMBLY.



LAWRENCE RADIATION LABORATORY - UNIVERSITY OF CALIFORNIA

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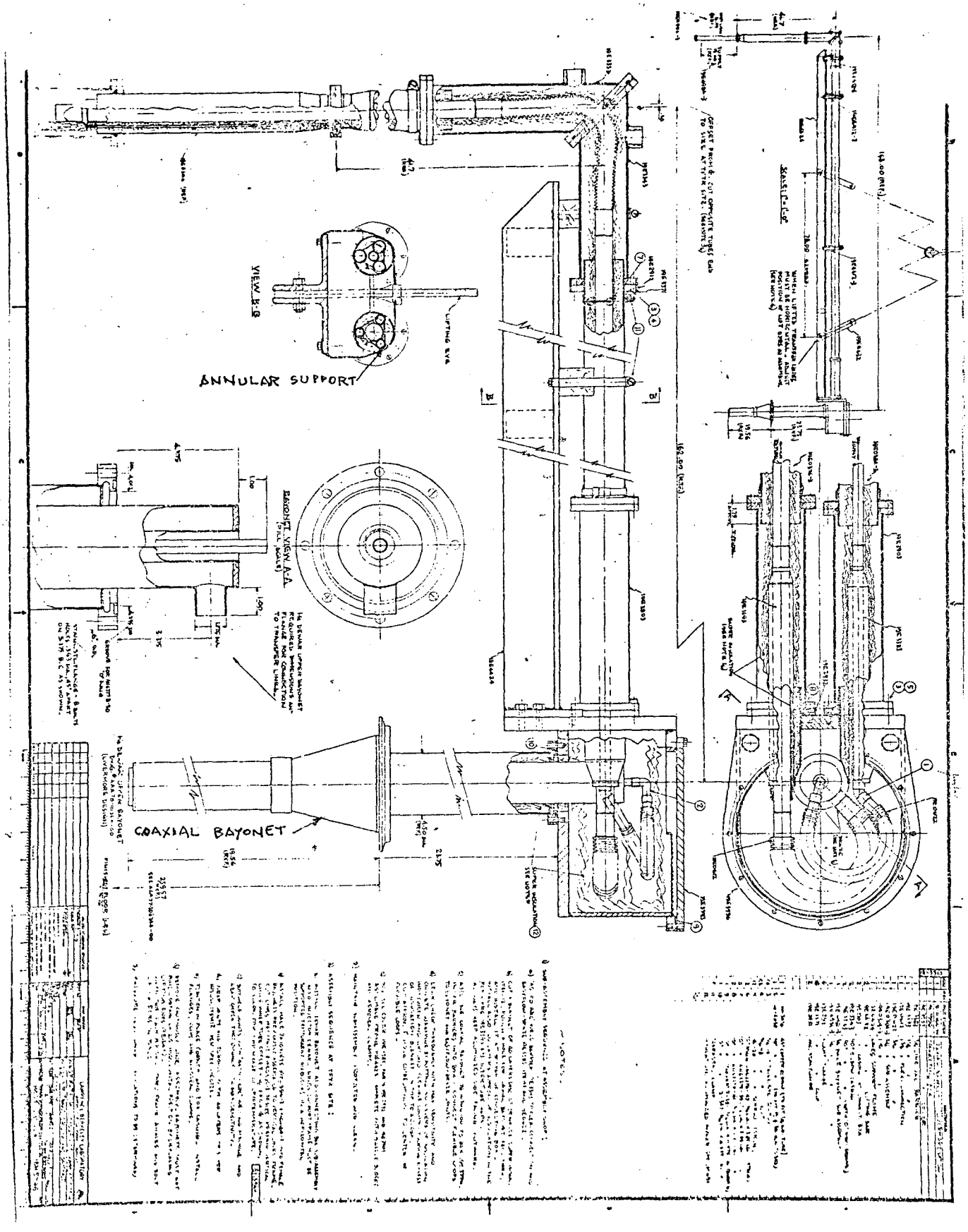
He INJECTOR LINES AND BAYONETS SUB-ASSEMBLY -



18N5946

He LINES HEAT LEAK -

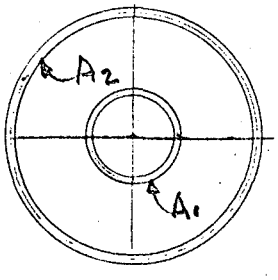
EXCEPT FOR THE ANNULAR SUPPORTS THE TFTR LINES ARE SIMILAR TO THE ESCAR LINES AND BOTH HAVE 40 LAYERS OF SUPER INSULATION. THEREFORE PRACTICAL DATA DERIVED FROM THE 20 FT. (APPROX. 6 METERS) LINE TESTS, DESCRIBED IN ENG. NOTE M5086, CAN BE USED.

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:

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

THE TFTR LINE RADIANT HEAT LEAK FIRST APPROXIMATION IS:

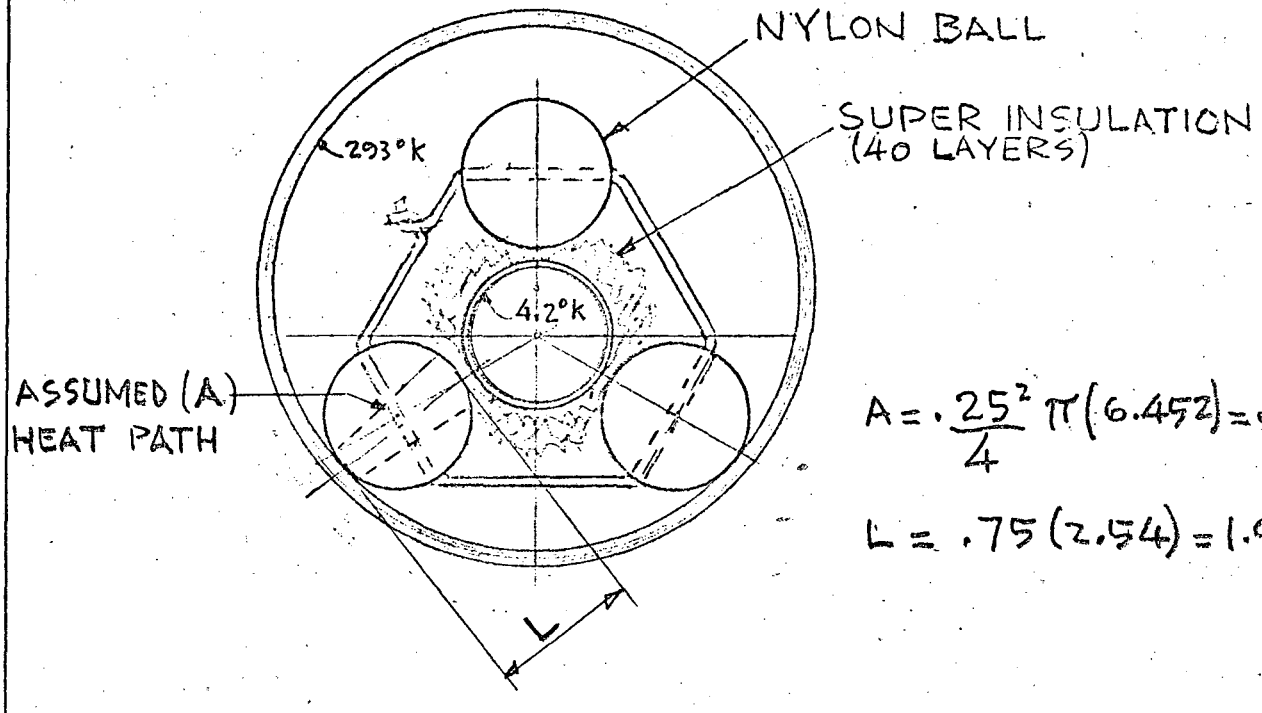


$$Q_R = (.2)\frac{\left(\frac{A_1}{A_2}\right)_{ESCAR} A_T TFTR}{\left(\frac{A_1}{A_2}\right)_{TFTR} A_T ESCAR} = (.2)\frac{A_2 TFTR}{A_2 ESCAR} =$$

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

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

ANNULAR SUPPORT NYLON BALLS CONDUCTION HEAT LEAK-



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

$L = .75(2.54) = 1.9\ cm.$

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)

DISTRIBUTION BOX DESCRIPTION.

THE DISRIBUTION BOX HAS A CAPACITY OF 6.4 FT.^{3} . 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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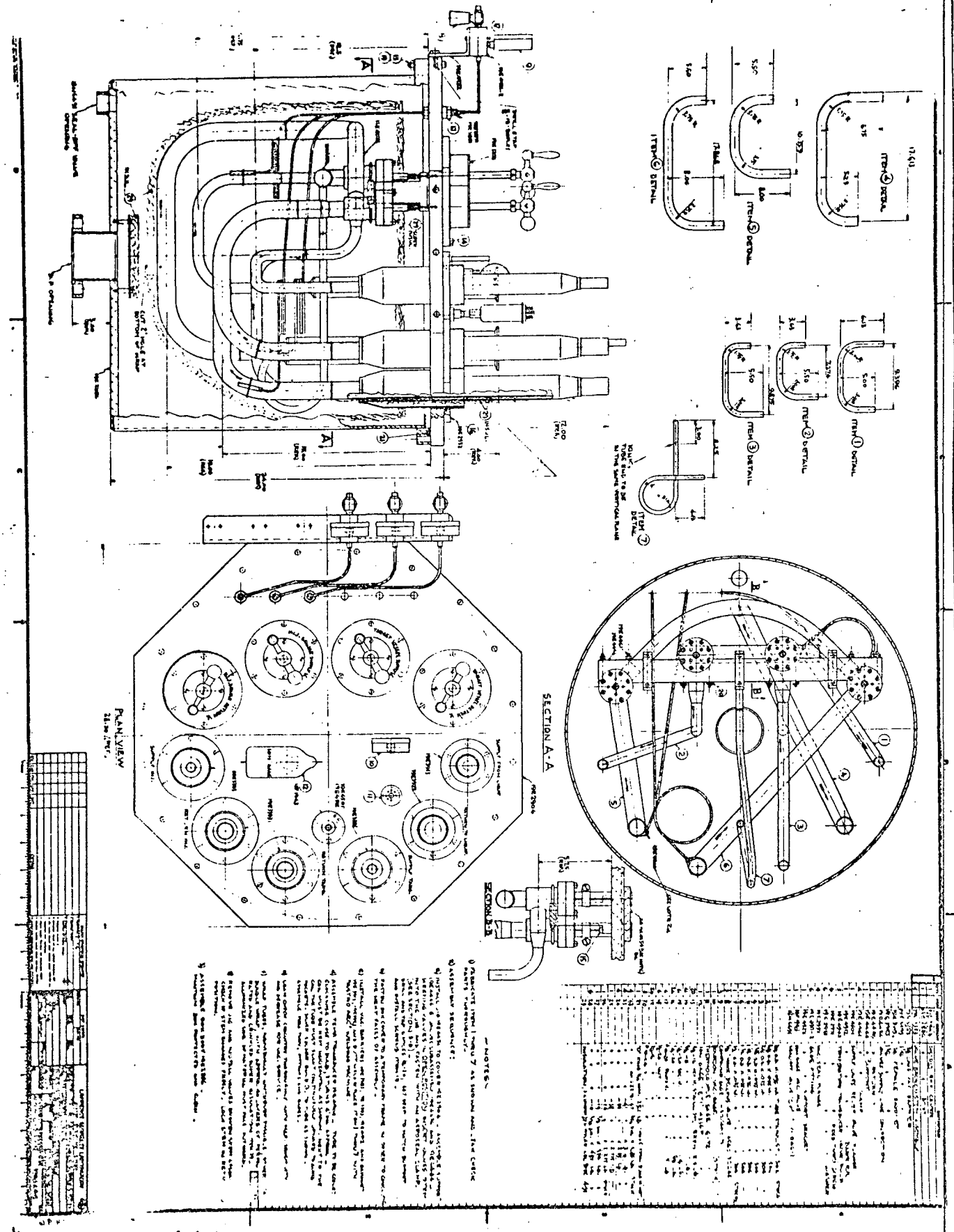
DISTRIBUTION BOX ASSEMBLY -

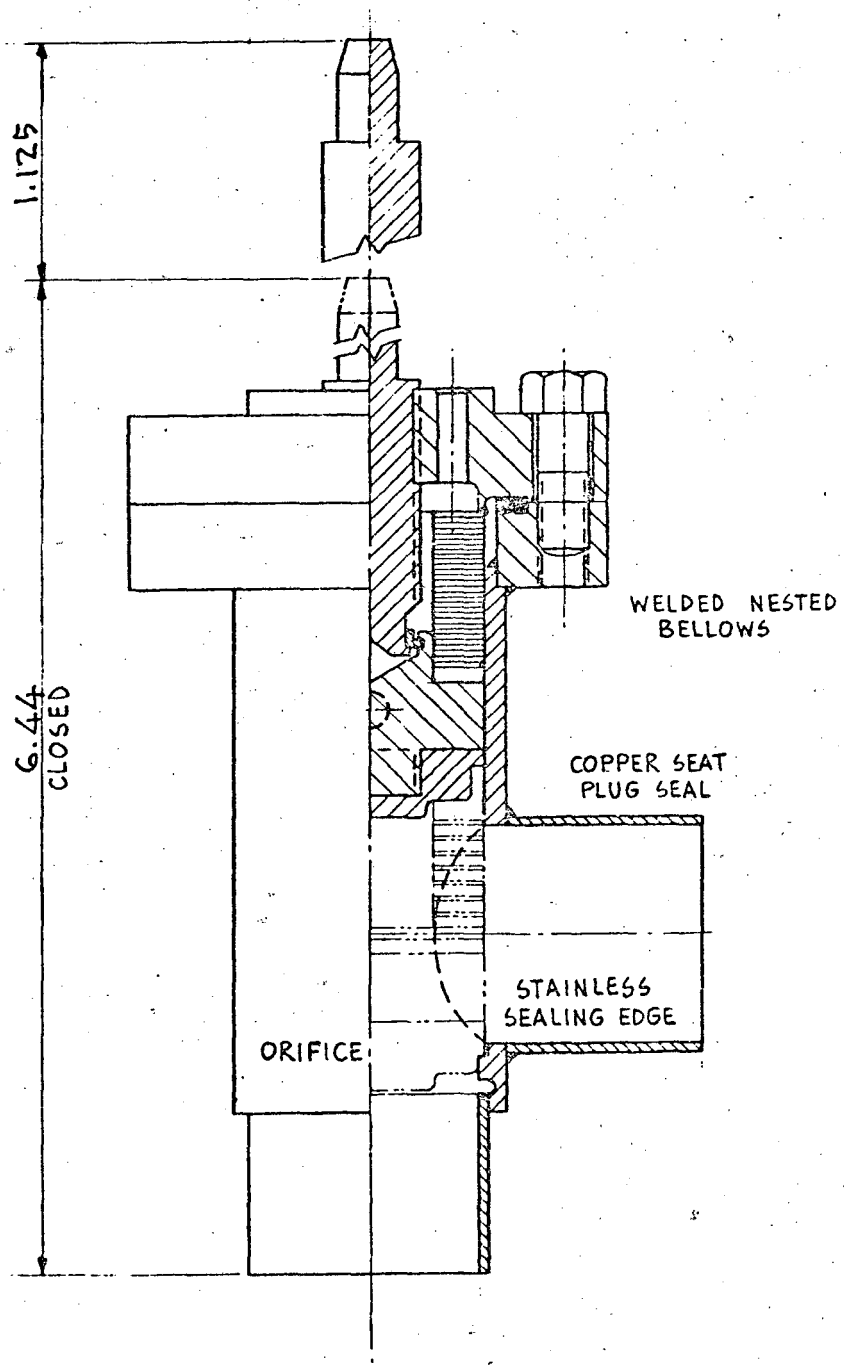


19E4496

LAWRENCE BERKELEY LABORATORY • UNIVERSITY OF CALIFORNIA. ENGINEERING NOTE	CODE TF 0200	SERIAL M5356	PAGE 11 OF 27
AUTHOR JOHN CARRIERI	DEPARTMENT MECHANICAL	LOCATION BERKELEY	DATE APRIL 27- 1979

CRYOGENIC VALVE - "CALIFORNIA PHYSICS PRODUCTS Co"

MODEL No SLT 511 - 1⅛ RA, ALL METAL, NON DIRECTIONAL FLOW, FOR USE IN VACUUM, WITH REPLACEABLE METAL SEALS - MAX. OPERATING PRESSURE 90 PSIG -



19B1973-2

DISTRIBUTION BOX RADIANT HEAT LEAK -

BOX RADIATING SURFACE AREA $A_2 \cong 17{,}736$ cm^2

CIRCUITRY COLD " " $A_1 \cong 4{,}864$ cm^2.

FROM UCRL 3421 CRYOGENIC DATA :

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

ASSUME $\epsilon_1 \cong .1 = \epsilon_2$

$$\frac{Q}{A_1} = (.533 \times 10^{-8}) \frac{1}{\frac{1}{.1} + \frac{4864}{17736}\left(\frac{1}{.1} - 1\right)} (293^4 - 4.2^4) =$$

12.468

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

W/o SUP. INSUL.
$$Q_{W/o} = \frac{(.533 \times 10^{-8})(73.7 \times 10^8)(4864)}{12.468\,(929)} = 16.5 \text{ WATTS}$$

WITH SUP. INSUL.
$$Q_R = \frac{Q_W}{Q_{W/o}} = \frac{1}{n+1} \quad *$$

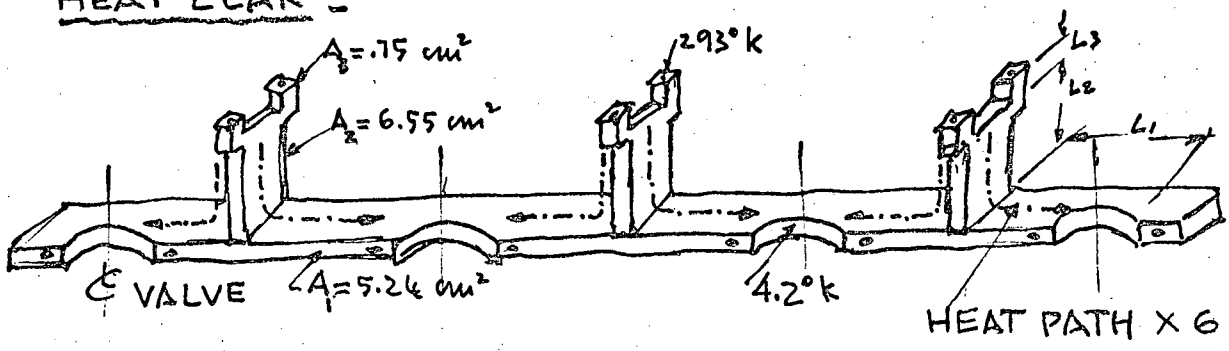
$n = 40$ LAYERS

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

$$Q_R = 16.5\left(\frac{1}{40+1}\right) + 16.5(.05) \cong 1.23 \text{ WATTS}$$

* J.P. HOLMAN, HEAT TRANSFER, MC GRAW 1968, P. 241 -

DISTRIBUTION BOX (4) VALVES SUPPORT CONDUCTION HEAT LEAK -



NEMA G-10 SUPPORT (19E4444) :

$A_1 = 5.24$ cm² $\qquad L_1 = 8.57$ cm.

$A_2 = 6.55$ cm² $\qquad L_2 = 9.52$ cm

$A_3 = .75(2) = 1.5$ cm² $\qquad L_3 = .32$ cm

$Q = kA \frac{\Delta T}{\Delta L} =$ $\qquad$ *$K = .003$ WATTS/cm°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:

$Q_c = .262(6) \cong 1.57$ WATTS

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

LAWRENCE BERKELEY LABORATORY · UNIVERSITY OF CALIFORNIA

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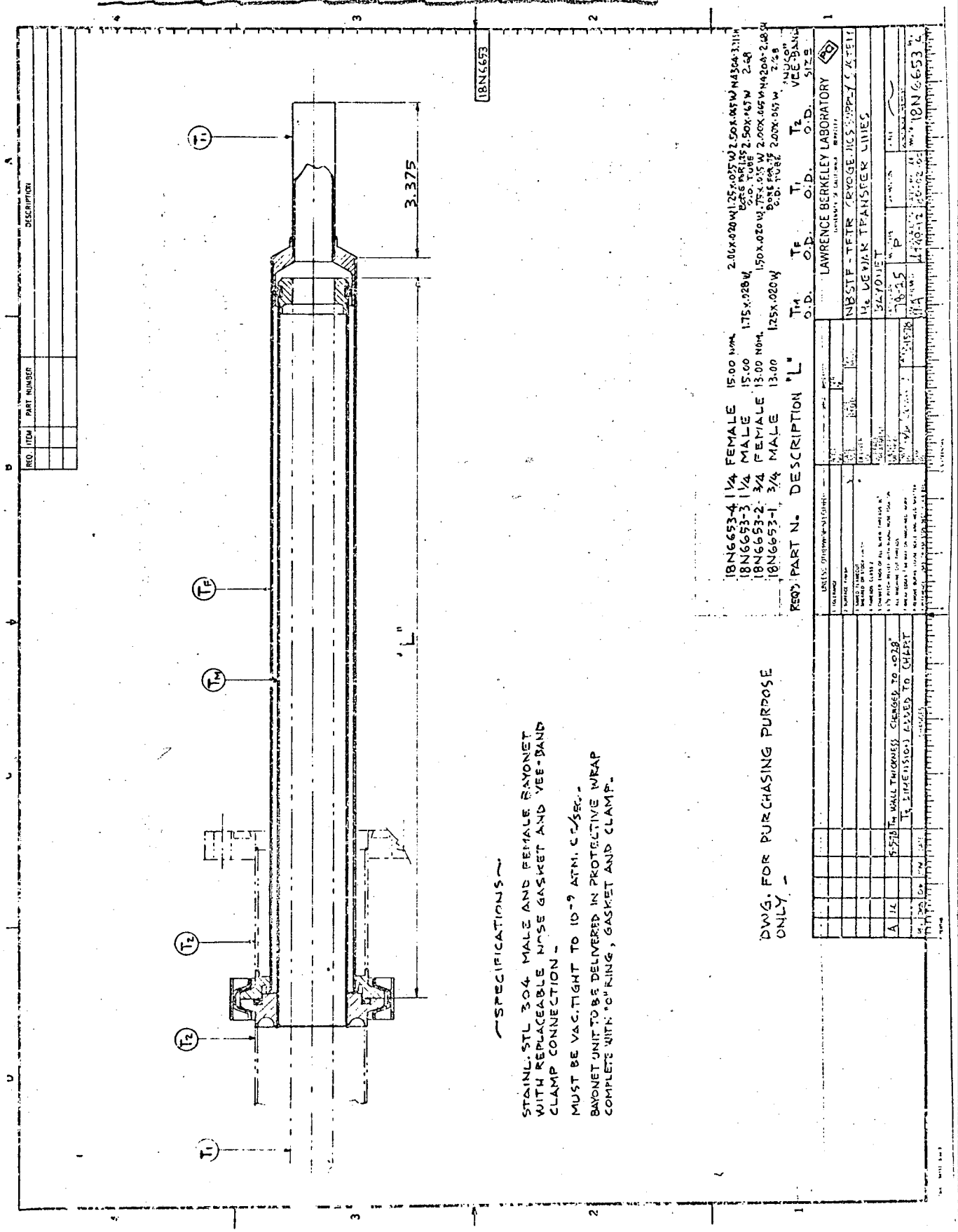
MALE AND FEMALE BAYONET UNIT -



REQ.	ITEM	PART NUMBER	DESCRIPTION

REQ'D PART N.	DESCRIPTION "L"	TM O.D.	TF O.D.	T1 O.D.	T2 O.D.	SIZE
18N6653-4	1 1/4 FEMALE 15.00 NOM.	2.00X.020W	1.25X.025W	2.50X.065W	N4304-3	1 1/4
18N6653-3	1 1/4 MALE 15.00	1.75X.028W		2.50X.065W		2.48
18N6653-2	3/4 FEMALE 13.00 NOM.	1.50X.020W	1.75X.035W	2.00X.065W	N4208-2	2.48
18N6653-1	3/4 MALE 13.00	1.25X.020W		2.00X.065W		2.48

SPECIFICATIONS -

STAINL. STL 304 MALE AND FEMALE BAYONET WITH REPLACEABLE NOSE GASKET AND VEE-BAND CLAMP CONNECTION -

MUST BE VAC. TIGHT TO 10^{-9} ATM. CC/SEC.

BAYONET UNIT TO BE DELIVERED IN PROTECTIVE WRAP COMPLETE WITH "O" RING, GASKET AND CLAMP.

DWG. FOR PURCHASING PURPOSE ONLY -

LAWRENCE BERKELEY LABORATORY

NBSTF - TETR. CRYOGENICS SUPPLY SYSTEM

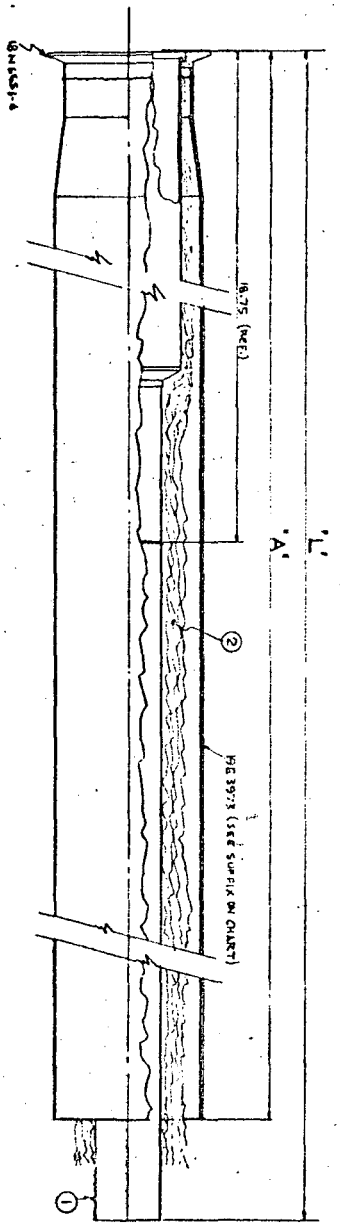
He VESSEL TRANSFER LINES

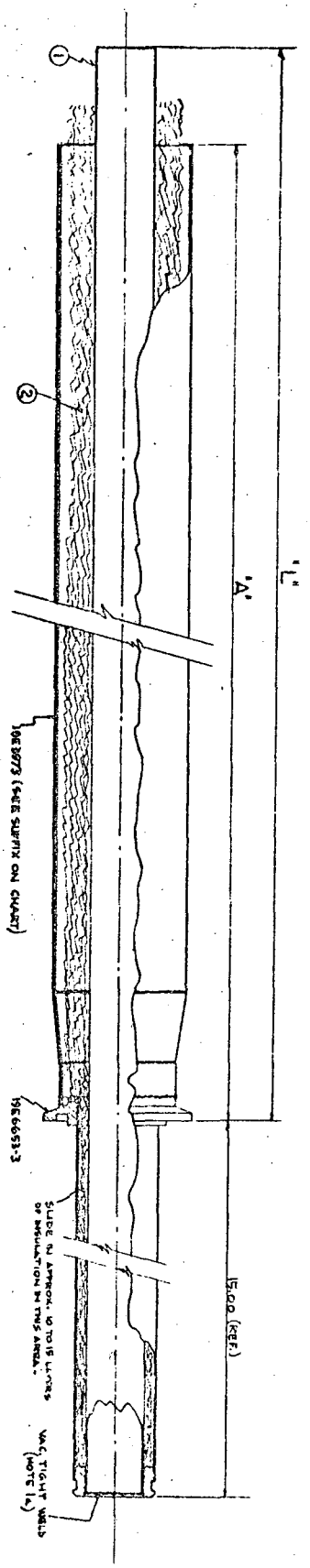
347 OUET

18N6653

A	14	5-5-78	TM WALL THICKNESS CHANGED TO .028"	18-25	P				
			T2 DIMENSION ADDED TO CHART						

FEMALE BAYONET SUB-ASSEMBLY





MALE BAYONET SUB-ASSEMBLY

19E4994
19E4964

BAYONETS CONDUCTION HEAT LEAK.

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

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

(T_M) $A \cong D\pi t = (1.25-.02)\,\pi\,(.02)\,6.452 = .499\ cm^2$

(T_F) $A = (1.5-.02)\,\pi\,(.02)\,6.452 = .6\ cm^2$

$L \cong 13.00'' = 33.02$ cm.

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

1 1/4 BAYONET UNIT

(T_M) $A = (1.75-.028)\,\pi\,(.028)\,6.452 = .977\ cm^2$

(T_F) $A = (2.00-.02)\,\pi\,(.02)\,6.452 = .803\ cm^2$

$L = 15.00'' = 38.1$ cm.

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

* ENG.N. 3140-01 M241

BAYONET TUBES STABILITY -

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

1) (T_M) 1.75" O.D. X .028 W., 15.00" LG

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

ROARK P. 354

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

$$= \frac{.807(28\times10^6).028^2}{15(.875)}\sqrt[4]{1.33\left(\frac{.028}{.875}\right)^2} = \quad (.192)$$

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

2) (T_M) 1.25" O.D. X .020 W., 13.00" LG.

$$P'_{CRIT.} = \frac{.807(28\times10^6).020^2}{13(.625)}\sqrt[4]{1.33\left(\frac{.02}{.625}\right)^2} = \underline{213}\ \text{PSI} \quad (.192)$$

TUBE UNDER EXTERNAL PRESSURE (ATMOSPHERIC 14.7 PSI):

3) (T_F) 2.00" O.D. X .020 W., 15.00" LG.

$$P'_{CRIT.} = \frac{.807(28\times10^6).02^2}{15(1.0)}\sqrt[4]{1.33\left(\frac{.02}{1}\right)^2} = \underline{91.5}\ \text{PSI} \quad (.15)$$

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

YIELD STRESS $P = \frac{2SI}{D}$

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

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

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

$A = D\pi t = (.5 - .035)\pi(.035)6{,}452 = .33 \text{ cm}^2$

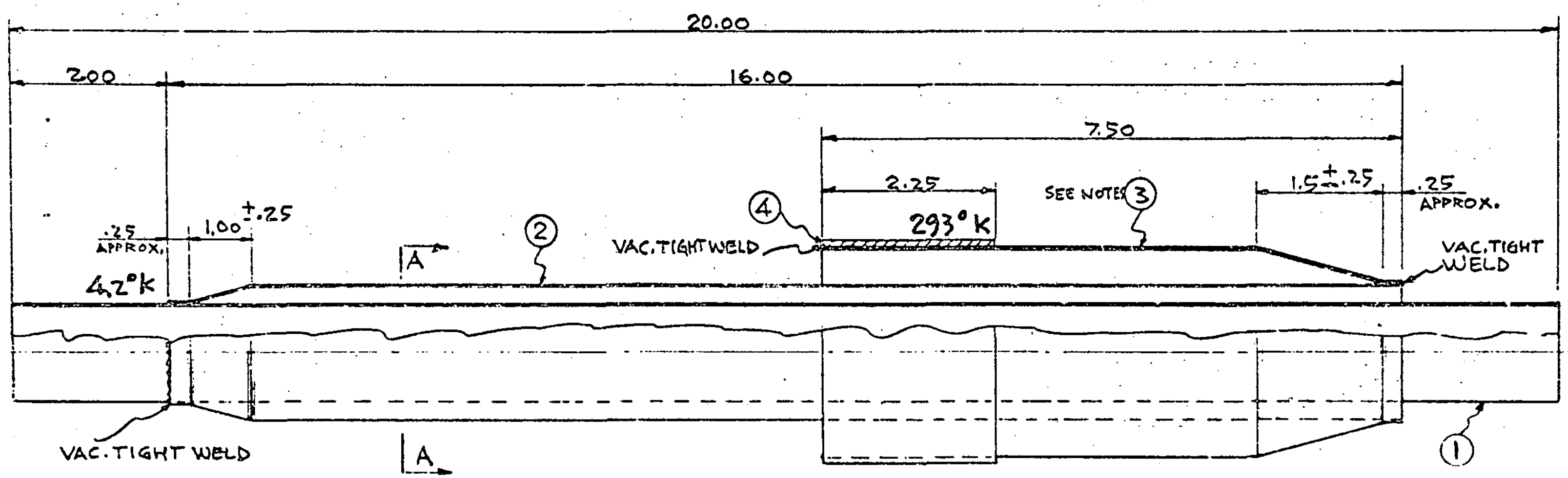
$L \cong 40.00" = 101.6 \text{ cm}.$

$$Q = \frac{A}{L}\int_{4.2°}^{293°} k\,dT =$$

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

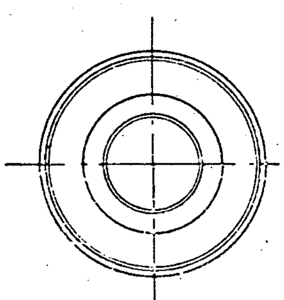
VACUUM BARRIER -

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.083W.) 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 -



SECTION A-A

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	TOLERANCE ±.06 AND NOTES
SHOP ORDERS	IDENTIFIC. METHOD: TAG
DRAWN BY	J. Carrieri, DATE 8-21-78
LAWRENCE BERKELEY LABORATORY	UNIVERSITY OF CALIFORNIA - BERKELEY
	NBSTF-TFTR
	H_e TRANSFER LINES
	DISTRIB. BOX 1 1/4 LINE VAC. BARRIER
DWG TYPE	D
SCALE	FULL
USED/FILED	H
DESIGN ACCT NO.	4749-12
CATEGORY CODE	80-02-00
DWG NO	19E 3393

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.

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

$L \cong 16.00" = 40.64\ cm.$

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

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

1 1/4 LINE BARRIER:

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

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

$L \cong 16.00" = 40.64\ cm.$

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

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

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

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

$$= \frac{.807\,(28\times10^6)(.036)^2}{7.25(1.35)}\sqrt[4]{1.33\left(\frac{.036}{1.35}\right)^2} =$$

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

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 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 1/4 " " .552(4) (P.20)		2.21
	12.93	33.20

TOTAL HEAT LEAK = 12.93 + 33.20 ≅ 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 -

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

236 FT. OF LINES CONSISTING OF 20FT. 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:	
S/S 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
S/S 1 1/4 & 3/4 ANNULAR CORRUGATED HOSE	225
56" WIDE, 11000 FT.^{2} ALUMINIZ. MYLAR	216
MYLAR ADESIVE TAPE	98
* TOTAL	$ 21,419.

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

* FIELD INSTALLATION & FIELD TESTING NOT INCLUDED.

LAWRENCE BERKELEY LABORATORY - UNIVERSITY OF CALIFORNIA ENGINEERING NOTE	CODE TF0200	SERIAL M5356	PAGE 24 OF 27
AUTHOR JOHN CARRIERI	DEPARTMENT MECHANICAL	LOCATION BERKELEY	DATE APRIL 27-1979

DISTRIBUTION BOX FABRICATION & MATERIAL COST:

FABRICATION 661.5 M.HRS @ 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 ≅	$ 19,280

NOTE: BOX VACUUM SYSTEM NOT INCLUDED.

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

FABRICATION 125.5 M.HRS. @ 24.4/hr.	$ 3063
STORES STOCK MATERIAL	107
CONNECTING BOX COST ≅	$ 3,170

BAYONET ASSEMBLIES COST:

FABRICATION 293 M.HRS. @ 24.4/hr.	$ 7150
STORES STOCK MATERIAL	143
PURCHASED MATERIAL:	
(8) "CRYENCO" PURCHASED BAYONET UNITS (MALE & FEMALE)	2334
TOTAL	$ 9,627

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

J.C.'19 3-29-19

TFTR 80-02-00 He TRANSFER LINES

DWGS LIST

(OBSOLETE)	18N	5926	LN COOLED DISTRIB. BOX ASSEMBLY
	18N	5934	TRANSF. LINES LAYOUT (PRELIM.)
A	"	5946	He DEWAR TRANSF. LINES & BAYONET ASSEMB
	"	6653	TRANSF. LINES BAYONET (PURCH. DWG.)
	"	6674	" " SCHEMATIC
	"	6681	He LINE ANNULAR SUPPORT BALL
	"	6691	" VAC. SEAL-OFF VALVE
	19E	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 1¼ BAYONET FL.
	"	2961	" " ¾ " "
	"	2971	DISTRIB. BOX FEED THRU
	"	2981	" " " " WASHER
	"	2992	" " VALVE BROKEN STEM BRKT
	19E	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 ¾ LINE VAC. BARRIER
	"	3393	" " 1¼ " " "
	19E	3903	TRANSF. LINES DISTR. BOX CASING
	"	3913	" " " " ¾ FEM. BAYONET
	"	3923	" " " " 1¼ " "
	"	3933	" " 45° ELBOW FL.

19E	3943	TRANSF. LINES 45° ELBOW CASING (GROOVE INFL.)
"	3953	" " " " " (PLAIN FL.)
"	3963	" " 3/4 BAYONET OUTER TUBE
"	3973	" " 1 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 " "
A "	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 1/4 FEM. BAYONET SUB-ASSEMBLY
"	4974	3/4 " " " "
"	4984	3/4 MALE " " "
"	4994	1 1/4 " " " "
19E	0322	SUPER INSUL. PREPARATION & USE SPECS.
"	0333	SUPPLY LINE ELBOWS
"	0344	INJECTOR REMOVABLE LINE SECTION ASSY
"	0354	" " " " SUPPORT FRA
"	0364	LIQUIF. MALE BAYONET SUB-ASSEMBLY
"	0374	HORIZONTAL RETURN 1 1/4 LINE & ELBOW SUB-A
"	0384	" " 3/4 " " "

DRWG LIST

19 E	0394	VERTICAL (RETURN) 1¼ LINES SUB-ASSEMBLY
"	0404	" (SUPPLY) ¾ " "
"	0414	TARGET He SUPPLY & RETURN LINES BAYONET ASS'Y
"	0422	" " " " INTEMED. BRKT
"	0432	" " " " UPPER "
19 E	0612	He RETURN FLEX. LINE AT DEWAR CONNEC. 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
035343
035344
035592
035633
035634
035687
035688
035755
035868
035958
036044
036105
036188
036206
036207
036210
036211
036262
036346

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. VAL
95119A2	METAL BELLOWS
95158A2	" "

TECHNICAL INFORMATION DEPARTMENT
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