Muon Cryosystem Design Note #13

Addendum

SUBSYSTEM: ☐ CDM ☐ CVM ☒ Cryoplant

TITLE: CDM Built 400 Liter Liquid Helium Dewar

AUTHOR: R.I.Dachniwskyj

DATE: March 3, 1986

DATE OF ADDENDUM: May 27, 1986

This addendum contains the Manufacturer's Data Report, test results, and mill certification sheets for the 400-L liquid helium dewar.

Reviewed by:

[signature] 6/3/86

Name Date

FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
(Alternative Form for Single Chamber, Completely Shop-Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

1. Manufactured and certified by Robinson Mfg. Company 2210 So. Delaware St. Denver, Colorado 80223 (Name and address of manufacturer)

2. Manufactured for C.D.M. Machining & Fabrication 4950 Niagara St. Commerce City, Colo. 80022 (Name and address of purchaser)

3. Location of installation Unknown (Name and address)

4. Type Horiz. (Horiz. or vert., tank) | I-6 (Mfgr's serial No.) | NA (CRN) | D1991 (Drawing No.) | NA (Nat'l. Bd. No.) | 1986 (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 1983 (Year)

to Summer 1985 (Addenda (Date)) | NA (Code Case Nos.) | Helium Duwar (Special Service per UG-120(d))

6. Shell: SA 240 304 SS (Matl. (Spec. No., Grade)) | .375 (Nom. Thk. (in.)) | NA (Corr. Allow. (in.)) | 3Ft. (Inside Diameter) | 6 Ft. 4 inches (Length (overall) (ft. & in.))

7. Seams: DBL Butt (Long. (Welded, Dbl., Sngl., Lap, Butt)) | NA (R.T. (Spot or Full)) | .7 (Eff. (%)) | NA (H.T. Temp. (°F)) | NA (Time (hr)) | 1 DBL Butt / 1 Single Butt (Girth (Welded, Dbl., Sngl., Lap, Butt)) | NA (R.T. (Spot, Partial, or Full)) | 1 (No. of Courses)

8. Heads: (a) Matl. SA 240 304 SS (Spec. No., Grade) (b) Matl. SA 240 304 SS (Spec. No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top	.375	NA	80 %	10 %	NA	NA	NA	NA	Concave
(b)	Bottom	.375	NA	80 %	10 %	NA	NA	NA	NA	Concave

If removable, bolts used (describe other fastenings) 6 ea. 1/2-13 SA 276 304 SS (Matl., Spec. No., Gr., Size, No.)

9. MAWP 100 psi at max. temp. NA °F
Min. temp. (when less than -20°F) -452 °F. Hydro., ~~Pneu.~~ test pressure 150 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No	Diam or Size	Type	Matl	Nom Thk	Reinforcement Matl	How Attached	Location
Drain	1	1/4"	Socket Weld	SA 276	3000#	None	Weld	Bottom
Outlet	1	1 1/2"	Coup.	SA 182	3000#	None	Weld	Top side
Vent	1	1/4"	Coup.	SA 182	3000#	None	Weld	Top side
Inlet	1	1"	Coup.	SA 182	3000#	None	Weld	Top side
Outlet	1	1/2"	Coup.	SA 182	3000#	None	Weld	Top side

11. Supports: Skirt None (Yes or no) Lugs None (No.) Legs None (No.) Other None (Describe) Attached NA (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: (Name of part, item number, Mfgr's. name and identifying stamp)

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 12110 expires May 6, 19 89.

Date MAY 28 1986 Co. name Robinson Mfg. Company (Manufacturer) Signed Jesse M. Robinson (Representative)

CERTIFICATE OF SHOP INSPECTION

Vessel constructed by Robinson Mfg. Company at 2210 So. Delaware St. Denver, Co. 80223

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Colo. and employed by HSBI & I Co.

have inspected the component described in this Manufacturer's Data Report on MAY 28 1986, 19 ____, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date MAY 28 1986 Signed Wm. B. [illegible] (Authorized Inspector) Commissions COLO/354 (Nat'l Board (incl. endorsements), State, Prov. and No.)

(12/82) This form (E00117) may be obtained from the Order Dept., ASME, 345 E. 47th St., New York, N.Y. 10017

CDM MACHINING & FABRICATING CORP.
8570 VALENTIA STREET • COMMERCE CITY, COLORADO 80022 • Phone: 289-5678

May 29, 1986

FERMI NATIONAL ACCELERATOR LAB
P.O. Box 500
Batavia, IL 60510

ATTN: Dick Mau

Dear Dick:

This is to certify that the Inner Shell on the LH_e Dewar on Fermi P.O. #904680, CDM SO #A762, was cold shocked with LN_2 before the leak check test was done.

Thank you.

Sincerely,

Richard J. Jaeger

Richard J. Jaeger

'86 JUN -3 A10:38
RECEIVED
FERMILAB
CONTRACTS

CDM MACHINING & FABRICATING CORP.
4950 Niagara Street • COMMERCE CITY, COLORADO 80022 • Phone: 287-0187

S.O. A762 Specification

Part No. A762 -1 Test Helium Leak Test

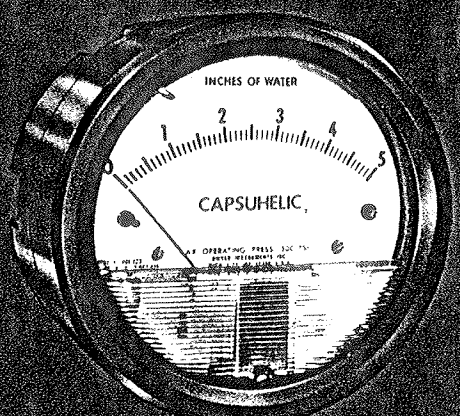
ITEM TESTED	DETEPMINATION OF MINIMUM DETECTABLE LEAK					Date Time	Meter Reading Before Helium Probe	Meter Reading With Helium Probe	Perf. By
		Calib. (.02 X Leak	) ÷	(Response-	Bckgnd) = MDL				
Inner Shell		3.5×10^{-8}	2.6	.9	4.1×10^{-10}	4-11-86 2:30			
D1991						4-11-86 2:55	.9	.6	[illegible]
Shield		3.5×10^{-8}	2.2	.48	4.07×10^{-10}	4-21-86 5:10			
D1990						4-21-86 5:40	.49	.48	[illegible]
Outer Shell		3.5×10^{-8}	1.2	.17	6.80×10^{-10}	5-8-86 1:15			
D1990						5-8-86 1:50	.5	.4	5-8-86
		3.5×10^{-8}	1.1	.15	7.37×10^{-10}				[illegible]

Dwyer

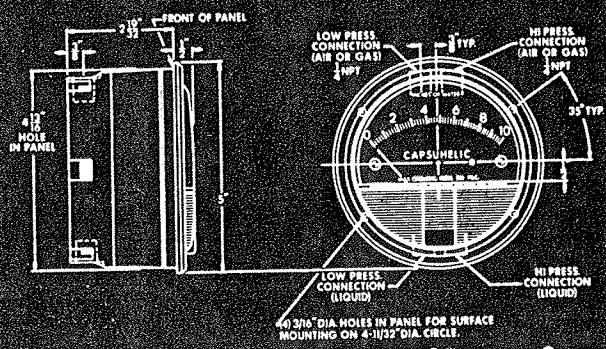
SERIES 4000

Capsuhelic® Differential Pressure Gages

For air or compatible gases or liquids. Measures pressure, vacuum or differential. Accurate to 2% of full scale. Suitable for internal pressures to 500 psig.



Capsuhelic® Pressure Gage has a large, easy-to-read 4" dial.



Dimensions, Series 4000 Capsuhelic® Pressure Gages.

The Capsuhelic® gage is designed to give fast, accurate indication of differential pressures. The gage may be used as a readout device when measuring flowing fluids, pressure drop across filters, liquid levels in storage tanks and many other applications involving pressure, vacuum or differential pressure.

Using the basic design of Dwyer's time-proven Magnehelic® gage, the Capsuhelic® contains a simple, frictionless movement that permits full scale readings as low as 0.5 inch water column. The pressure being measured is held within a capsule which is an integral part of the gage. This containment of the pressure permits the use of the gage on system pressures of up to 500 psig, even when differentials to be read are less than 0.1 inch W.C.

The diaphragm-actuated Capsuhelic® gage requires no filling liquid which might limit its outdoor applications. Zero and range adjustments are made from outside the gage, and there is no need to disassemble the gage in normal service.

PHYSICAL DATA

Ambient temperature range: 32° to 200° F.

Pressure Rating: Maximum operating pressure 500 psig.

Standard Ranges: See facing page.

Accuracy: Plus or minus 2% of full scale at 70° F. (3% on –0 range).

Housing: Die cast aluminum with Teflon® impregnated hard coat anodizing, standard. Optional forged brass housing is recommended for water or water based fluids. For highly corrosive gases or liquids, consult factory before ordering.

For other fluids and for special diaphragms, contact the factory.

Exterior Finish: Baked dark gray hammerloid.

Connections: ¼" NPT high and low pressure taps, duplicated — one pair top for air and gas, and one pair bottom for liquids.

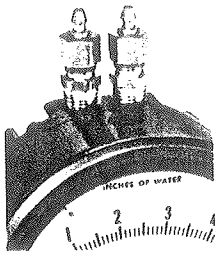
Standard Accessories: Two ¼" NPT plugs for duplicate pressure taps, four flush mounting adapters with screws and four surface mounting screws.

Dimensions: 5" diameter x 3 3/32" length.

Weight: 3 lbs., 3 oz. aluminum case; 7 lbs., 13 oz. brass case.

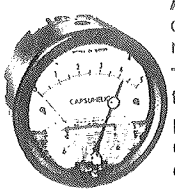
Teflon® is a trademark registered by DuPont.

BLEED FITTINGS



The use of the Capsuhelic® gage in liquid service requires that all entrapped gas be vented from the sensing lines and the interior of the gage. To make it easy and safe to bleed this gas from the gage, use Dwyer A-314 bleed fittings. Loosening the nut on each fitting will allow the gas to escape. As soon as liquid appears in the drain line, tightening the nut will reseal the gage.

OPTIONS AND ACCESSORIES

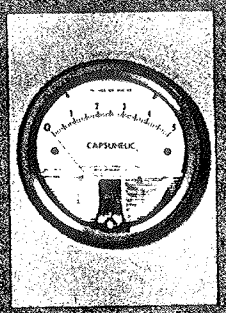


Adjustable signal flag — Integral with plastic gage cover; has external reset screw. Available for all ranges. Can be ordered with gage or separately.

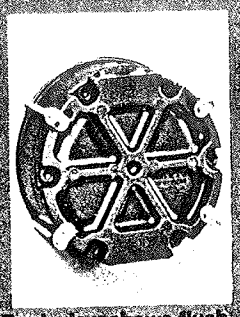
Transparent overlays — Furnished in red and green to highlight and emphasize critical pressures.

Portable units — Combine carrying case with any Capsuhelic® gage. Includes two sections of hose complete with fittings.

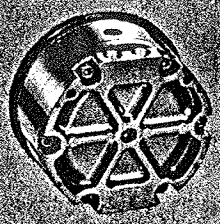
Forged brass case — For applications involving water or water based liquids. To order, add suffix "B" after 4000 series number.



Flush mounted in panel.



Back view shows flush mounting adapters.



Back view for surface mounting.

MOUNTING

Capsuhelic® gages may be flush mounted in a panel or surface mounted. They can be mounted in any plane, making them ideal for portable as well as stationary applications. For flush mounting, a 4 3/16" diameter cutout in panel is required. Optional A-610 kit allows gage to be easily attached to any 1¼"-2" horizontal or vertical pipe. Installation is same as Magnehelic gage shown on page 6.

Straightforward design assures maintenance-free performance

Bezel provides flange for flush mounting in panel.

"O" ring seal for cover assures dust tight integrity of case.

Clear SAN plastic window is highly resistant to breakage. Provides undistorted viewing of pointer and scale.

Precision scale, litho-printed on aluminum, is accurate and easy to read.

Red tipped pointer of heat treated aluminum tubing is easy to see. It is rigidly mounted on helix shaft.

Pointer stops of molded rubber prevent pointer over-travel without damage.

Samarium cobalt magnet mounted at end of range spring rotates helix without mechanical linkages.

"Wishbone" assembly provides mounting for helix, helix bearings and pointer shaft.

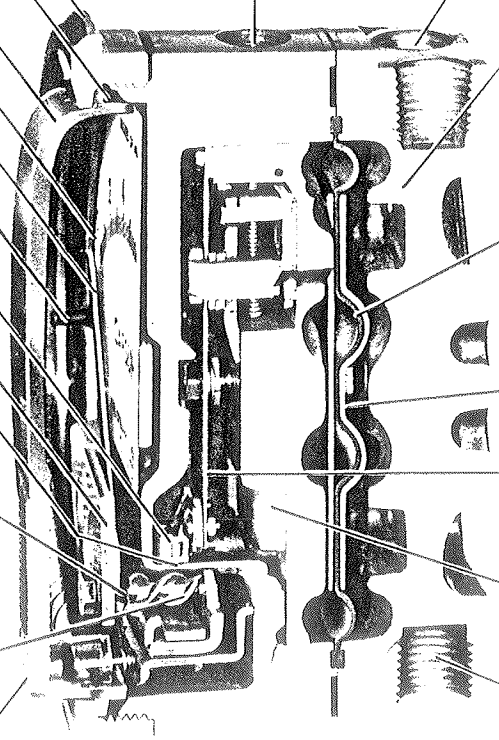
Thin wall magnetic "window" is well braced and of minimum area for maximum pressure capability.

Sapphire bearings for helix are shock-resistant mounted. They provide virtually friction-free rotation for helix. Rotation is damped with high viscosity silicone fluid.

Helix is precision milled from an alloy of high magnetic permeability, deburred and annealed in a hydrogen atmosphere for best magnetic qualities. Mounted in sapphire bearings, helix rotates to align with magnetic field of magnet and transmit pressure indication to pointer.

Zero adjustment screw is conveniently located in plastic cover, accessible without removing cover. "O" ring seal provides dust seal.

Range spring calibration is screw adjusted. Rate adjust and rate adjust lock are coaxial and are factory set and sealed.



Patent No. 4,011,759

Top low pressure connection (for *Air or Gas*) connects to chamber in back of diaphragm. High pressure air or gas port (cut away; not shown) connects with chamber in front of diaphragm through passageways in case.

Precision made case is offered in two materials. Standard is die cast aluminum coated inside with Teflon® for resistance to most oils and similar fluids. Optional forged brass case is recommended when using water or water based liquids. One case size for all pressure ranges — can be either surface or flush mounted.

Buna-N rubber diaphragm with integrally molded "O" ring is sealed between the case and backplate. Diaphragm motion is restricted to prevent damage due to over-pressure. Double convolution allows choice of effective areas to suit range at time of assembly.

Diaphragm support plate of stainless steel minimizes position or attitude sensitivity.

Calibrated range spring is a flat leaf of stainless steel. Small amplitude of motion assures consistency and long life. It reacts to pressure on diaphragm. Live length factory adjusted for calibration.

Range spring mounting plate provides mounting for rate adjust screw and for the calibration range spring and magnet assembly.

Bottom high pressure connection *(for Liquids)* connects to chamber in front of diaphragm. Low pressure liquid connection (not visible) connects with chamber in back of diaphragm through passageways in case.

SERIES 4000 CAPSUHELIC® — MODELS AND RANGES

Scales reading directly in flow, heights, etc., are also available.

Model Number	Range, Inches of Water	Minor Div.
4000-0	0-.50	.01
4001	0-1.0	.02
4002	0-2.0	.05
4003	0-3.0	.10
~~4004~~	~~0-4.0~~	~~.10~~
4005	0-5.0	.10
~~4006~~	~~0-6.0~~	~~.20~~
4008	0-8.0	.20
4010	0-10	.20
4015	0-15	.50
4020	0-20	.50
4025	0-25	.50
4030	0-30	1.0
4040	0-40	1.0
4050	0-50	1.0
4060	0-60	2.0
4080	0-80	2.0
4100	0-100	2.0
4150	0-150	5.0
4200	0-200	5.0
4300	0-300	10.0
4400	0-400	10.0
4500	0-500	10.0

Model Number	Range, Zero Center Inches of Water	Minor Div.
4301	.5-0-.5	.02
4302	1-0-1	.05
4304	2-0-2	.10
4310	5-0-5	.20
4320	10-0-10	.50
~~4330~~	~~15-0-15~~	1.0

Model Number	Range, Metric Scales CM of Water	Minor Div. CM
4000-1CM	0-1	.02
4000-2CM	0-2	.05
4000-5CM	0-5	.10
4000-8CM	0-8	.20
4000-10CM	0-10	.20
4000-15CM	0-15	.50
4000-20CM	0-20	.50
4000-25CM	0-25	.50
4000-30CM	0-30	1.0
4000-40CM	0-40	1.0
4000-50CM	0-50	1.0
4000-80CM	0-80	2.0
4000-100CM	0-100	2.0
4000-150CM	0-150	5.0
4000-200CM	0-200	5.0
4000-250CM	0-250	5.0
4000-300CM	0-300	10.0

Model Number	Range, Zero Center, Metric, CM of Water	Minor Div. CM
4300-4CM	2-0-2	.10
4300-10CM	5-0-5	.20
4300-20CM	10-0-10	.50
4300-30CM	15-0-15	1.0

Model Number	Range, Metric Scales MM of Water	Minor Div. MM
4000-15MM	0-15	.50
4000-20MM	0-20	.50
4000-25MM	0-25	.50
4000-30MM	0-30	1.0
4000-40MM	0-40	1.0
4000-50MM	0-50	1.0
4000-80MM	0-80	2.0
4000-100MM	0-100	2.0
4000-150MM	0-150	5.0
4000-200MM	0-200	5.0
4000-250MM	0-250	5.0
4000-300MM	0-300	10.0

Special Purpose Ranges

Scale No. 4401
Square Root
Specify Range

Scale No. 4402
Blank Scale
Specify Range

SERIES 43000 CAPSU-PHOTOHELIC® SWITCH/GAGE

Models and Ranges

(See description, pgs. 12 & 13) When ordering Capsu-Photohelic models, use this range table, BUT instead of first digit Model No. "4", use number "43". For example: 43000-0 rather than 4000-0. Also specify desired range.

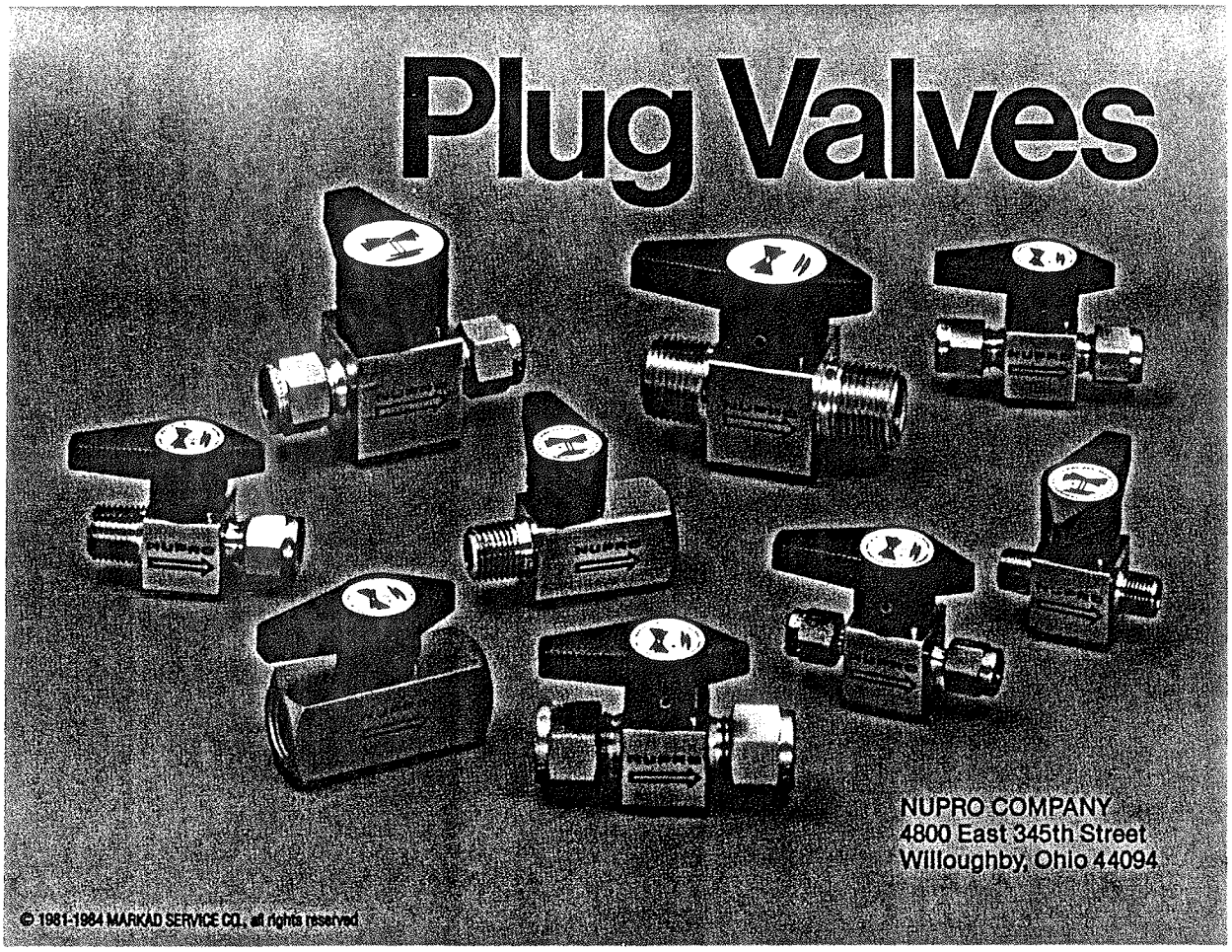
Model Number	Range PSIG	Minor Div. PSIG
4201	0-1	.02
4202	0-2	.05
4203	0-3	.10
4204	0-4	.10
4205	0-5	.10
4210	0-10	.20
4215	0-15	.50
4220	0-20	.50

Suggested Specifications

A differential pressure gage for measuring (state purpose) shall be installed. Gage shall be the diaphragm-actuated dial type 5" O.D., with white dial, black figures and graduations and pointer zero adjustment. Gage shall be Dwyer Instruments, Inc. CAPSUHELIC®, Series 4000, (OR CAPSU-PHOTOHELIC®, Series 43000), Model No._____ reading to_____" water column, in_____" divisions.

NUPRO®

Plug Valves



NUPRO COMPANY
4800 East 345th Street
Willoughby, Ohio 44094

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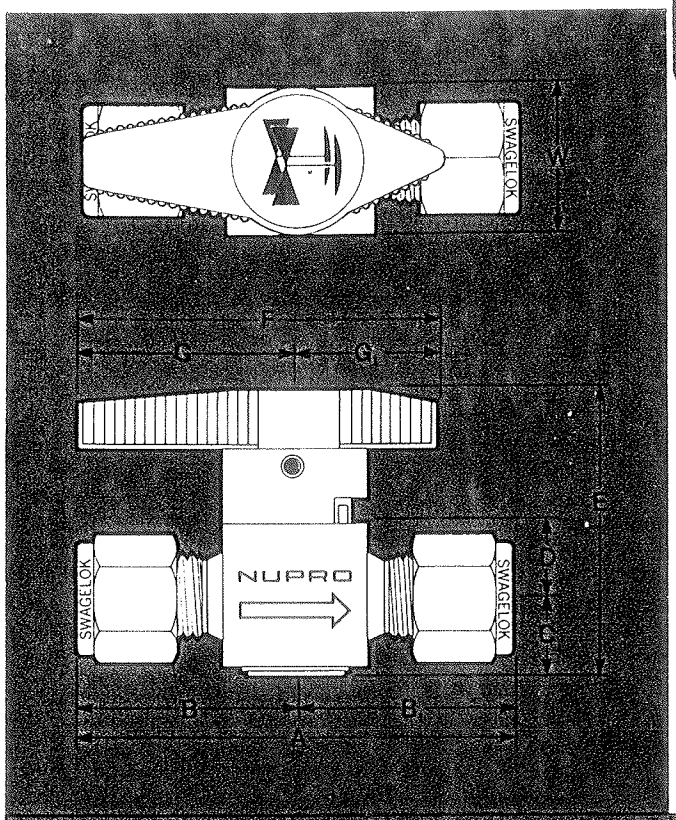
TABLE OF DIMENSIONS



TECHNICAL DATA

Valve Series	Standard Material	Pressure Rating* @70°F (21°C)	Temperature Rating
P4T	Brass & 316SS	3000 PSI (20,600 kPa)	−10° to 400°F (−23° to 204°C) with Viton seals
P6T	Brass	2000 PSI (13,700 kPa)	
	316SS	3000 PSI (20,600 kPa)	

*If reverse flow occurs, differential pressure is limited to 150 PSI (1000 kPa) max. (On/Off service only)

FLOW CAPACITY DATA

Catalog Number	CV	Pressure Drop to Atmosphere (ΔP) PSI					
		Air SCFM @70°F (21°C)			Water GPM @70°F (21°C)		
		10	50	100	10	50	100
-2P4T	0.2	2.77	7.65	13.36	.63	1.41	2.00
-2P4T2	1.0	13.84	38.25	67.81	3.16	7.07	10.00
-2P4T4	1.0	13.84	38.25	67.81	3.16	7.07	10.00
-4P4T	2.4	33.21	91.80	162.74	7.59	16.97	24.00
-4P4T1	1.4	19.51	53.93	95.61	4.46	9.97	14.10
-4P4T2	0.9	12.45	34.42	61.03	2.85	6.36	9.00
-4P4T4	0.9	12.45	34.42	61.03	2.85	6.36	9.00
-4P4T5	0.9	12.45	34.42	61.03	2.85	6.36	9.00
-6P4T	1.1	15.22	42.08	74.59	3.48	7.78	11.00
-6P4T-MM	2.3	31.83	87.98	155.96	7.27	16.26	23.00
-4P6T4	3.6	49.82	137.70	244.12	11.38	25.46	36.00
-6P6T	7.0	96.87	267.75	474.67	22.14	49.50	70.00
-8P6T	4.0	55.35	153.00	271.24	12.65	28.28	40.00
-8P6T2	2.3	31.83	87.98	155.96	7.27	16.26	23.00
-8P6T4	2.3	31.83	87.98	155.96	7.27	16.26	23.00
-10P6T-MM	5.7	78.88	218.03	386.52	18.02	40.30	57.00
-12P6T-MM	4.3	59.50	164.48	291.58	13.60	30.41	43.00

PLUG VALVES			END CONNECTIONS		DIMENSIONS ②									
Catalog Number ①	Plug Orifice in.	Plug Orifice mm	Inlet	Outlet	A	B	B_1	C	D	E	F	G	G_1	W
-2P4T	0.172 ③	4.4	⅛ SWAGELOK	⅛ SWAGELOK	2	1	1	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-2P4T2	0.172	4.4	⅛ Male NPT	⅛ Male NPT	1 17/32	49/64	49/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-2P4T4	0.172	4.4	⅛ Female NPT	⅛ Female NPT	1 25/32	57/64	57/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P4T	0.172	4.4	¼ SWAGELOK	¼ SWAGELOK	2 3/16	1 3/32	1 3/32	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P4T1	0.172	4.4	¼ Male NPT	¼ SWAGELOK	2 1/16	61/64	1 7/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P4T2	0.172	4.4	¼ Male NPT	¼ Male NPT	1 29/32	61/64	61/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P4T4	0.172	4.4	¼ Female NPT	¼ Female NPT	2 3/32	1 3/64	1 3/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P4T5	0.172	4.4	¼ Male NPT	¼ Female NPT	2	61/64	1 3/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-6P4T	0.172	4.4	⅜ SWAGELOK	⅜ SWAGELOK	2 11/32	1 11/64	1 11/64	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-6P4T-MM	0.172	4.4	6mm SWAGELOK	6mm SWAGELOK	2 3/16	1 3/32	1 3/32	15/32	3/8	1 17/32	1 7/8	1 5/32	23/32	3/4
-4P6T4	0.281	7.2	¼ Female NPT	¼ Female NPT	2 3/8	1 3/16	1 3/16	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-6P6T	0.281	7.2	⅜ SWAGELOK	⅜ SWAGELOK	2 11/16	1 11/32	1 11/32	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-8P6T	0.281	7.2	½ SWAGELOK	½ SWAGELOK	2 7/8	1 7/16	1 7/16	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-8P6T2	0.281	7.2	½ Male NPT	½ Male NPT	2 21/32	1 21/64	1 21/64	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-8P6T4	0.281	7.2	½ Female NPT	½ Female NPT	2 7/8	1 7/16	1 7/16	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-10P6T-MM	0.281	7.2	10mm SWAGELOK	10mm SWAGELOK	2 11/16	1 11/32	1 11/32	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8
-12P6T-MM	0.281	7.2	12mm SWAGELOK	12mm SWAGELOK	2 7/8	1 7/16	1 7/16	21/32	9/16	2 1/8	2 1/2	1 1/2	1	1 1/8

① For a complete ordering number, add B for brass or SS for 316 stainless steel as a prefix to the catalog number. Example: SS-4P4T, B-4P4T2.
② Dimensions shown with **SWAGELOK** nuts finger-tight, when applicable. ③ Body orifice 0.093" (2.4mm).

Materials Research & Engineering, Inc.
4747 Sugarloaf Road
Boulder, Colorado 80302
(303) 442-4242

May 13, 1986

Mr. Bob Cunico
Robinson Manufacturing Co.
2210 South Delaware Street
Denver, Colorado 80223

Dear Bob,

Enclosed are the results for the charpy impact tests that we conducted, at near 4 degrees Kelvin as per ASTM E-23. The table indicates the results of the impact energy required to fracture the two groups of specimens. Two of the specimens, in group 1, had shifted in the apparatus during impact. However, I intentionally had you machine a couple of extras for each orientation to account for this possibility. For the more important results, being the lower Charpy impact values in group number 2, all five tests were valid.

The invoice for the mechanical testing performed is enclosed, along with a description of our laboratory capabilities. We can provide you with very competitive estimates, in the future, for any type of mechanical test that you may have in mind, and at all temperatures, from cryogenic to high the melting point of steels. We thank you for providing this opportunity to work with you.

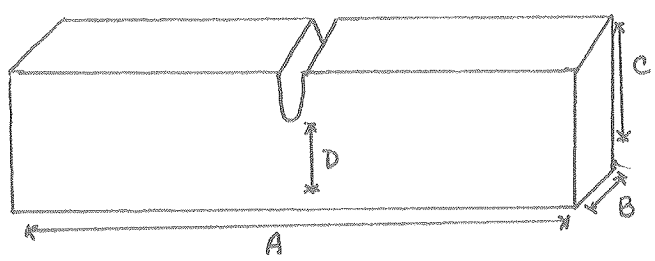
Sincerely Yours,

John M. Arvidson

enclosures (4)

CHARPY IMPACT SPECIMEN* MEASUREMENTS FOR ROBINSON MANUFACTURING CO.

Specimen	A	B	C	D	Impact Energy ft-lb
1-1	2.12**	0.3930	0.3384	0.1969	--
1-2	2.12	0.3953	0.3387	0.1994	49.5
1-3	2.10	0.3970	0.3345	0.1945	45.0
1-4	2.10	0.3940	0.3403	0.2015	48.0
1-5	2.08	0.3939	0.3388	0.1983	$\bar{X}$ = 47.5
2-1	2.05	0.3332	0.4018	0.1975	42.0
2-2	2.08	0.3365	0.4001	0.1997	46.0
2-3	2.18	0.3329	0.3990	0.1996	47.0
2-4	2.14	0.3338	0.3969	0.1987	40.0
2-5	2.10	0.3340	0.3971	0.1978	41.0
					$\bar{X}$ = 43.2



Welded 304 Stainless Steel with 316L filler wire.*

All measurements done in inches.**

Jesse McRobinson
Robinson MFG. Co.

IC # 1010

IC # 101090

MATERIAL TEST REPORT
PLYMOUTH TUBE COMPANY
ELLWOOD IVINS PLANT
HORSHAM, PA. 19044

OCT 22 1985

Shipped to KILSBY-ROBERTS CO., DENVER, CO 80239 Date Shipped

Customer's Order No. 51-95922 Mill Order No. 62-10110 Size: .250" OD X .028" AV WALL

Special Markings Grade: 304 WELDED

SPECIFICATION AND SPECIAL REQUIREMENTS:

ASTM A-269 / A-249 / A-554

KILSBY - ROBERTS
CERTIFICATION OF COMPLIANCE
We certify that this shipment of material conforms to the applicable specifications shown on this purchase order.
Customer CDM Machining & Fab Corp
Cust. P.O. 9130
K-R S.O. 51-5136911
Qty. 24 ft 0 in
Date 04-8-86

Lot No.	O.D.	I.D. or Wall	Shape	Area Sq. Ins.	Yield Strength Lbs. PSI	Tensile Strength Lbs. PSI	Elong. %2ins.	Rockwell Hardness	Heat No.
10105	.252	.029	R	.020	40,000	90,000	50%	B-71	341194
10110A	.250	.030	R	.021	35,714	85,714	56%	B-64	341194

Heat No.	C	Mn	P	S	Si	Cr	Mo	Ni	Cu	Co	Fe	N		
341194	.039	1.37	.030	.015	.56	18.07	.12	8.41	.17	.15		.055		
CHECK	.043	1.37	.029	.015	.56	18.06	.12	8.43	.17	.15		.058		
CHECK														
CHECK														

THE FOLLOWING TESTS AND/OR CAPABILITIES MEET SPECIFICATION REQUIREMENTS AS INDICATED BELOW:

FLARE TEST	N/A	GRAIN SIZE	N/A	HYDRO TEST	N/A
FLAT TEST	OK	CORROSION TEST	N/A	EDDY CURRENT TEST	OK
FLANGE TEST	OK	BEND TEST	N/A	PASSIVATION TEST	N/A
REVERSE FLAT TEST	OK	REVERSE BEND TEST	N/A	ULTRASONIC TEST	N/A

P.O. 9130
S.O. A762
RW 4-8-86

THIS IS TO CERTIFY THAT THE CONTENTS OF THIS REPORT ARE CORRECT AS CONTAINED IN THE RECORDS OF PLYMOUTH TUBE COMPANY.

QUALITY CONTROL M. Williams

DAVIS PIPE
and METAL
FABRICATORS

PHONE 615-323-2171

BIRCH STREET
P. O. BOX 565
BLOUNTVILLE, TENN. 37617

CERTIFICATION OF TEST AND CHEMICAL ANALYSES

SOLD TO: STAINLESS TUBLAR
DENVER, COLO.

SHIP TO:

SHOP ORDER NO. 5577B	SPECIFICATIONS A-312
CUST. P.O. NO. 4652	
DATE SHIPPED	TAG #

REVERSE TEST	FLARING TEST	HYDROSTATIC TEST BELOW
FLAT TEST OK		AIR PRESSURE TEST
REVERSE FLAT	FLANGE TEST	NONDESTRUCTIVE ELECTRIC TEST

OTHER SPECIFIED TESTS:
OTHER SPECIFIED REQUIREMENTS: ANNEALED AT 1950 F
OTHER DATA: **PICKLED AND PASSIVATED**

MECHANICAL PROPERTIES

ITEM	TYPE	IPS.	SCH.	HARDNESS	YIELD	TENSILE	% ELONG.	
1	304	8	5	RB 86	51,700	90,600	50	375 psi
2	304	16	10	RB 84	52,700	87,000	55	350 psi

CHEMICAL ANALYSIS

ITEM	HEAT	C	MN	P	S	SI	CR	NI	MO	CU	CO	N
1	93593	.061	1.76	.030	.016	.55	18.34	8.21	.16	.27	.09	.078
2	72685	.022	1.66	.029	.011	.60	18.08	8.88	.24	.33	.13	.087

P.O. 8981
S.O. A762
RW 3-11-86

WE CERTIFY THAT THE CHEMICAL, PHYSICAL OR MECHANICAL TESTS REPORTED HEREIN ARE CORRECT AS SHOWN ON OUR RECORDS.

DAVIS PIPE & METAL FABRICATORS
Dannie Bartley
TESTING SUPERVISOR

MANUFACTURER OF ALLOY PIPE & WELD FITTINGS

TEST CERTIFICATE

DATE: February 28, 1986

TO: CDM Machining
4950 Niagara St.
Commerce City, CO 80022

P.O.: 8981

SHIPPING ORDER #:

MATERIAL: S/S

STAINLESS TUBULAR PRODUCTS CORP.
1825 W. CASPIAN PLACE
ENGLEWOOD, COLORADO 80110
(303) 936-7151 • (303) 936-7213

					CHEMICAL ANALYSIS								
Item	Heat No.	Description	Alloy	Quantity	C	Si	Mn	P	S	Ni	Cr	Mo	Other
1	75149	1/4" 3M Half Coupling	T304	1	0.07	0.52	1.03	0.031	0.019	8.22	18.35		
2													
3													
4													
5													

TENSILE PROPERTIES						MECHANICAL TESTS						
Item	Yield	Tensile	Unit	Elong.	Red. of Area	Hardness	Flattening	Flaring	Hydrostatic	Surface	Corrosion	Spec
1	42,600	88,100		60.0	76.0							A 182
2												
3												
4												
5												

We certify that the above data is as furnished by the producing mill or supplier.

P.O. 8981
SO. 1762
2-28-86

STAINLESS TUBULAR PRODUCTS CORP.

Janet M. Simpson

TEST CERTIFICATE

DATE: 2-13-86

TO: CDM Machining
4950 ~~8~~ Niagara
Commerce City, CO 80022

P.O.: 8981

SHIPPING ORDER #:

MATERIAL: S/S pipe and fittings as indicated below

STAINLESS TUBULAR PRODUCTS CORP.
1825 W. CASPIAN PLACE
ENGLEWOOD, COLORADO 80110
(303) 936-7151 • (303) 936-7213

					CHEMICAL ANALYSIS								
Item	Heat No.	Description	Alloy	Quantity	C	Si	Mn	P	S	Ni	Cr	Mo	Other
1	75176	1/2" 3000# Scrd Half Coup	T304	1	0.07	0.55	1.08	0.030	0.017	8.10	18.27		
2	26391	1" 3000# Scrd Half Coup	T304	1	0.06	0.34	1.13	0.038	0.025	8.58	18.23		
3	605617	1 1/2" 3M Scrd Half Coup	T304	1	0.06	0.45	1.70	0.034	0.021	9.03	18.12		
4													
5													

TENSILE PROPERTIES						MECHANICAL TESTS						
Item	Yield	Tensile	Unit	Elong.	Red. of Area	Hardness	Flattening	Flaring	Hydrostatic	Surface	Corrosion	Spec
1	44,000	96,500	PSI	59.0	69.0							A182
2	42,600	92,400	PSI	61.0	72.0							A182
3	36,900	89,400	PSI*	57.0	76.0							A182
4												
5												

We certify that the above data is as furnished by the producing mill or supplier.

P.O. 8981
S.O. A762
RW
2-28-86

STAINLESS TUBULAR PRODUCTS CORP.
Janet M. Simpson

tru-edge® heads
BRIGHTON CORPORATION
ESTABLISHED 1914

STEEL PLATE FABRICATORS ASSOCIATION Founded 1933

11861 MOSTELLER ROAD
SHARONVILLE, OHIO 45241
TELEPHONE 513-771-2400
TELETYPE 810-464-8177
TELEX 21-4412
CABLE "BRICOP"

C D M MACHINING & FAB
4950 NIAGARA ST
COMMERCE CITY, CO 80022

ATTENTION : QUALITY CONTROL MANAGER

REFERENCE : CUSTOMER P/O 8956
BRIGHTON S/O 2-16219

GENTLEMEN :

ATTACHED ARE COPIES OF MILL TEST REPORTS FOR THE FOLLOWING MATERIAL PROVIDED ON YOUR REFERENCED PURCHASE ORDER.

LABOR & MATERIAL
2-304-S/S 80-10 HEAD 36.0000 OD 0.3750 THICK
28.0000 RD. 3.7500 ICR. WITH 1.5000 SF.

HEAT NUMBER

F5157936553

F5157936553

ALL HEADS WERE COLD FORMED AND ARE IN COMPLIANCE WITH REGULATION UG - 81 AND UG - 79 AS STATED IN SECTION VIII DIVISION I OF THE ASME BOILER AND PRESSURE VESSEL CODE.

IF YOU HAVE ANY FURTHER QUESTIONS, PLEASE CONTACT ME.

VERY TRULY YOURS,

BRIGHTON CORPORATION

C. Keith

CARL KEITH

2/21/86

P.O. 8956
S.O. A762
RCV 2-27-86

Ingersoll Steel

Division of Avesta Inc.

Certificate of Analysis and Tests

ITEM NO.	MFG CLASS	TYPE	FIN	DESCRIPTION
2	304		1	.375 X 96.0000 X 240.0000 RANDOM

ASME SA-240-80 83 SUM ADD ASTM A-240-83C
QQS-766C

PLATES & TEST PCS SOLUTION ANNEALED @ 1950 DEGREES FARENHEIT MINIMUM
THEN WATER COOLED OR RAPIDLY COOLED BY AIR
HOT ROLLED, ANNEALED & PICKLED (HRAP)

QUANTITY ORDERED | SHIPMENTS

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-17-86
Signature Judy Schultz

MECHANICAL AND OTHER TESTS

HEAT NUMBER	HARDNESS RB	PIECES	YIELD STRENGTH LBS PER SQ IN.	TENSILE STRENGTH LBS PER SQ IN.	ELONG % IN 2"	BEND	RED AREA %	INTERGRANULAR CORROSION	GRAIN SIZE			REMARKS:
~~90468~~	~~84~~	~~1~~	~~42500~~	~~84100~~	~~57.5~~	~~OK~~	~~63.5~~	~~OK~~		~~02-2A~~		LENGTH 316
85019	82	2	42400	83700	58.0	OK	64.0	OK		01-1B		LENGTH 317,308

CHEMICAL COMPOSITION

HEAT NO	C	Mn	P	S	Si	Cr	Ni	Co	Cu	Mo	N	Cb/Ta	Ti	V	W	Ce
~~90468~~	~~.040~~	~~1.540~~	~~.028~~	~~.006~~	~~.390~~	~~18.240~~	~~8.120~~	~~.170~~	~~.220~~	~~.260~~	~~.093~~					
85019	.040	1.510	.029	.004	.350	18.210	8.090	.140	.250	.240	.086					

gersoll Steel
vision of Avesta Inc.
O Box 370
New Castle, Indiana 47362

STATE OF INDIANA
COUNTY OF HENRY

By Cindy Orr

Subscribed And Sworn To Before Me This 24 Day Of MA 1985

Harold W. Shaw
HAROLD W. SHAW NOTARY PUBLIC
My Commission Expires Dec. 27, 1985

P.O. 8979
S.O. A762
RW 2-17-86

tru-edge® heads
BRIGHTON CORPORATION
ESTABLISHED 1914

STEEL PLATE FABRICATORS ASSOCIATION
Founded 1933

11861 MOSTELLER ROAD
SHARONVILLE, OHIO 45241
TELEPHONE 513-771-2400
TELETYPE 810-464-8177
TELEX 21-4412
CABLE "BRICOP"

C D M MACHINING & FAB
4950 NIAGARA ST
COMMERCE CITY, CO 80022

ATTENTION : QUALITY CONTROL MANAGER

REFERENCE : CUSTOMER P/O 8956
BRIGHTON S/O 2-16220

GENTLEMEN :

ATTACHED ARE COPIES OF MILL TEST REPORTS FOR THE FOLLOWING MATERIAL PROVIDED ON YOUR REFERENCED PURCHASE ORDER.

LABOR & MATERIAL
2-304-S/S A.S.M.E. HEAD 42.0000 OD 0.1875 THICK
42.0000 RD. 3.0000 ICR. WITH 1.5000 SF.

HEAT NUMBER

F51210-13086

F51210-13086

ALL HEADS WERE COLD FORMED AND ARE IN COMPLIANCE WITH REGULATION UG - 81 AND UG - 79 AS STATED IN SECTION VIII DIVISION I OF THE ASME BOILER AND PRESSURE VESSEL CODE.

IF YOU HAVE ANY FURTHER QUESTIONS, PLEASE CONTACT ME.

VERY TRULY YOURS,

BRIGHTON CORPORATION

C. Keith

CARL KEITH

2/21/86

P.O. 8956
S.O. A762
RW 2-27-86

P.O. Box 1975
Baltimore, Maryland 21203

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

THINK FIRST . . . THINK EASTERN

CUSTOMER COPY

CERTIFIED MATERIAL TEST REPORT
We certify that all of the test results and the statements of performed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

J E Bongardt
QUALITY CONTROL DEPARTMENT

MANIFEST NO. 5285
DATE 23 01/XXX/86
CUST. NO. 2910

SHIP TO: BRIGHTON CORP
11861 MOSTELLER RD
CINCINNATI OH 45241

MAIL TO: DIRECT
EASTERN STAINLESS STEEL CO
P.O. BOX 1975
BALTIMORE MD 21203

MILL ORDER NO.	CUSTOMER ORDER NO.	LOC.	SHIPPED VIA	SHIP MODE	B/L NUMBER	CAR NUMBER		RLS-DT
B61000	61000	NP	HORIZON	T	9381		COLLECT ☐	/ /

ITEM	HEAT NO.	COIL NO.	M.P.O. NO.	GAUGE	SIZE	FINISH CODE	DESCRIPTION	COUPON	W-LOC	BNDL CODE	PLATES COILS SHEETS	GROSS	TARE	NET	PK	GP	FA	WS
WW 60	F51579		36553	0.3750	84.0000 X 85.0000	17	304 HRAP		RD12		1	818		818	0	12	A 28	Y 6

SO# 16219(2)

SPECS ASTM A240-84A ASME SA240 SECT II S85 ADD

FREE FROM KNOWN CONTACT WITH MERCURY

MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
F51579	304	.048	1.68	.027	.016	.54	18.13	8.10	.18			.33	.19	.075

CORROSION TEST CODES
A. ASTM A262-'A'
B. ASTM A262-'B'
C. ASTM A262-'C'
D. ASTM A262-'E'
E. QQS-766(CUS04)

TRANSVERSE OR FRONT								LONGITUDINAL OR BACK								CORROSION TEST		MAG. PERM.	SOLUTION ANNEAL	
HEAT NO.	M.P.O.	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	GR	C	CODE	RESULT	TEST	TIME MINUTES	TEMP. °F
F51579	36553	91.8	47.0	60	HB163	G	63							5		EA	SAT			

P.O. 8956
S.O. A762
Rec 2-27-86

TENSILE & YIELD X 1,000

CAUTION: PROCESSING THAT MAKES FUMES, DUST, OR SOLUTIONS MAY CAUSE RESPIRATORY DISEASE. PLEASE REFER TO MATERIAL SAFETY DATA SHEET.

P.O. Box 1975
Baltimore, Maryland 21203

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

THINK FIRST . . . THINK EASTERN

CUSTOMER COPY

CERTIFIED MATERIAL TEST REPORT
We certify that all of the test results and the statements of performed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

J E Bongardt
QUALITY CONTROL DEPARTMENT

MANIFEST NO. 1403

DATE ~~XXXXXXXX~~ 08/30/85

CUST. NO. 1334

SHIP TO: BRIGHTON CORP
11861 MOSTELLER RD
CINCINNATI OH 45241

MAIL TO: BRIGHTON CORP
11861 MOSTELLER RD
CINCINNATI OH 45241

DIRECT

MILL ORDER NO.	CUSTOMER ORDER NO.	LOC.	SHIPPED VIA	SHIP MODE	B/L NUMBER	CAR NUMBER		RLS-DT
S52203	A11697	SH	GEORGE	C	5961		COLLECT ☐	08/26/85

ITEM	HEAT NO.	COIL NO.	M.P.O. NO.	GAUGE	SIZE	FINISH CODE	DESCRIPTION	COUPON	W-LOC	BNDL CODE	PLATES COILS SHEETS	GROSS	TARE	NET	PK	GP	FA	WS
WW 03	F51210		13086	0.1875	60.0000 X 160.0000	15	304 HRAP				5	2860		2860		08	29 A	85 Y

DO NOT SHIP ITEM PARTIALS

SPECS ASTM A240-83 ASME SA240 SECT II W84 ADD

FREE FROM KNOWN CONTACT WITH MERCURY

MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
F51210	304	.053	1.67	.023	.014	.47	18.10	8.08	.22			.30	.15	.077

CORROSION TEST CODES
A. ASTM A262-'A'
B. ASTM A262-'B'
C. ASTM A262-'C'
D. ASTM A262-'E'
E. QQS-766(CUS04)

TRANSVERSE OR FRONT								LONGITUDINAL OR BACK								CORROSION TEST		MAG. PERM.	SOLUTION ANNEAL	
HEAT NO.	M.P.O.	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	TENSILE PSI	YIELD	ELONG	HARDNESS	BEND	R/A	GR	'C	CODE	RESULT	TEST	TIME MINUTES	TEMP. °F
F51210	13086	90.3	42.7	57	B 82		61													

2-27-86 P.O. 8956 S.O. A762 Rcv

RECEIVED
SEP 4 1985

TENSILE & YIELD X 1,000

Ingersoll Steel
Division of Avesta Inc.

Certificate of Analysis and Tests

4284

ORDER NUMBER
59555 1

SOLD TO
AVESTA INC.
[illegible] EAST
SUITE 710
[illegible]

SHIP TO — SAME UNLESS NOTED OTHERWISE
AVESTA INC.
INGERSOLL STEEL DIV.
% HEIGHTS BONDED WAREHOUSE
90 HIRSCH
HOUSTON TX 77020

CUSTOMER CODE: 416004
DATE: APR. 11, 1985

Avesta (Esco) #6311606

CUSTOMER ORDER NO. & DATE	ROUTING	WHEN WANTED	TERMS
4/10/85			

ITEM NO.	HEAT CLASS	PIECES	IN.	DESCRIPTION	QUANTITY ORDERED WEIGHT	QUANTITY ORDERED PIECES	SHIPMENTS PIECES	SHIPMENTS WEIGHT
1	304	1		.187 X 96.0000 X 240.0000 MIN R/L				
				ASME SA-240-80 83 SUM ADD ASTM A-240-83C				
				[illegible]				
				[illegible]				
				[illegible] SOLUTION ANNEALED @ 1950 DEGREES FARENHEIT MINIMUM				
THEN WATER COOLED OR RAPIDLY COOLED BY AIR								
				[illegible]				

ESCO CORPORATION
Customer Name
Customer Order No.
Sales Order No.
Marked

MECHANICAL AND OTHER TESTS

HEAT NUMBER	HARDNESS RB	PIECES	YIELD STRENGTH LBS. PER SQ. IN.	TENSILE STRENGTH LBS. PER SQ. IN.	ELONG % IN 2"	BEND	RED AREA %	INTERGRANULAR CORROSION	GRAIN SIZE	REMARKS:
90132	77	1	40300	81700	56.5	OK	60.5	OK	01-1C	LENGTH 277
34450	86		40700	80900	50	OK	59.0	OK	03-3A	LENGTH 255-240

CHEMICAL COMPOSITION

HEAT NO.	C	Mn	P	S	Si	Cr	Ni	Co	Cu	Mo	N	Cb/Ta	Ti	V	W	Ce
90132	.057	1.290	.033	.017	.400	18.200	8.290	.150	.420	.330	.082					
34450	.044	1.460	.030	.009	.160	18.120	8.330	.110	.140	.160	.099					

Ingersoll Steel
Division of Avesta Inc.
P.O. Box 370

3-6-86 Rec'd
P.O. 9032

STATE OF INDIANA
COUNTY OF HENRY

By [signature]

P.O. Box 19.
Baltimore, Maryland 21203

strip

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

THINK FIRST . . . THINK EASTERN

CERTIFIED MATERIAL TEST REPORT
We certify that all of the test results and the statements of performed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

J E Bongardt
QUALITY CONTROL DEPARTMENT

MANIFEST NO. 1827
DATE 05/30/85
CUST. NO. 3005

SHIP TO: ESCO CORPORATION
5185 MILLER ST
WHEAT RIDGE CO 80033

MAIL TO: ESCO CORPORATION
5185 MILLER ST
WHEAT RIDGE CO 80033

MILL ORDER NO.	CUSTOMER ORDER NO.	LOC.	SHIPPED VIA	SHIP MODE	B/L NUMBER	CAR NUMBER		RLS-DT
550624	6311482	PC	DAVIS TRANSPORT	1	3172		COLLECT ☐	[illegible]

ITEM	HEAT NO.	COIL NO.	M.P.O. NO.	GAUGE	SIZE	FINISH CODE	DESCRIPTION	COUPON	W
08	50249		39029	0.2500	2.5000 X 14[illegible].0000	14	304 BRAP		4[illegible]

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-17-86
Signature Judy Schultz

SPECS ASTM A240-82C ASME SA240 SECT II 83 ED (EXC MKG)

REF FROM KNOWN CONTACT WITH MERCURY

MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
50249	304	.055	1.61	.019	.019	.40	18.18	8.18	.23			.21	.14	.082

CORROSION TEST CODES
A. ASTM A262-'A'
B. ASTM A262-'B'
C. ASTM A262-'C'
D. ASTM A262-'E'
E. QQS-766(CUS04)

TRANSVERSE OR FRONT								LONGITUDINAL OR BACK								CORROSION TEST		MAG. PERM.	SOLUTION ANNEAL	
HEAT NO.	M.P.O.	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	GR	C	CODE	RESULT	TEST	TIME MINUTES	TEMP. °F
50249	39029	92.0	45.0	52	HB167	G	60	92.4	45.6	52	HB167	G	60	7		AL	SAT			

P.O. 8979
S.O. A262
RW 2-17-86

TENSILE & YIELD X 1,000

P.O. Box 1975
Baltimore, Maryland 21203
Telephone: (301) 288-2000

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

CERTIFIED MATERIAL TEST REPORT

suits and the ...ments of per-formed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

MANIFEST NO. 6977

DATE 073185

SHIP TO: ESCO CORPORATION
5185 MILLER ST
WHEAT RIDGE CO80033

MAIL TO: ESCO CORPORATION
5185 MILLER STREET
WHEAT RIDGE, CO. 80033

J. E. Bogardt
QUALITY CONTROL DEPARTMENT
07/31/85

SALES ORDER: 557460 | CUSTOMER'S P.O. NO.: 6311328 | M— 2 | S— 1 | O—

ITEM	HEAT NO.	M.P.O.	TYPE	FINISH	GAUGE	WIDTH / O.D.	LENGTH / I.D.	PIECES	GROSS	NET
06	F50721	12097	304	NO. 1	0.3750	3.0000	144.0000	21	1,036	1,030

MATERIAL SPECIFICATIONS AND REQUIREMENTS

SPECS ASTM A240-82C ASME SA240 SECT II 83 ED (EXC MKG)
FREE FROM KNOWN CONTACT WITH MERCURY
MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
F50721	304	.050	1.63	.027	.007	.42	18.17	8.12	.67			.22	.16	.084

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-21-86
Signature Judy Schultz

P.O. 8979
S.O. 4762
Rec'd 2-17-86

CORROSION TEST CODES

CODE	DESCRIPTION
A.	ASTM A262-PRACTICE 'A' (OXALIC)
B.	ASTM A262-PRACTICE 'B' (STREICHER)
C.	ASTM A262-PRACTICE 'C' (HUEY)
D.	ASTM A262-PRACTICE 'E' (CUCUS04)
E.	QQS - 766 (CUS04)

		TRANSVERSE OR FRONT						LONGITUDINAL OR BACK								CORROSION TEST		MAG.PERM.	SOLUTION ANNEAL	
HEAT NO.	M.P.O.	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	GR	C	CODE	RESULT	TEST	TIME MINUTES	TEMP. °F
F50721	12097	91.3	45.7	54	HB167		63													

TENSIL AND YIELD X 1000

Ingersoll Steel

Division of Avesta Inc.

Certificate of Analysis and Tests

ITEM NO.	MFG. CLASS	TYPE	FIN	DESCRIPTION	QUANTITY ORDERED WEIGHT	QUANTITY ORDERED PIECES	SHIPMENTS PIECES	SHIPMENTS WEIGHT	DA
2	304		1	.375 X 96.0000 X 240.0000 RANDOM					
				ASME SA-240-80 83 SUM ADD ASTM A-240-83C					
				QQS-766C					

PLATES & TEST PCS SOLUTION ANNEALED @ 1950 DEGREES FARENHEIT MINIMUM
THEN WATER COOLED OR RAPIDLY COOLED BY AIR
HOT ROLLED, ANNEALED & PICKLED (HRAP)

MECHANICAL AND OTHER TESTS

HEAT NUMBER	HARDNESS RB	PIECES	YIELD STRENGTH LBS. PER SQ. IN.	TENSILE STRENGTH LBS. PER SQ. IN.	ELONG % IN 2"	BEND	RED AREA %	INTERGRANULAR CORROSION	GRAIN SIZE			REMARKS:
~~90468~~	~~84~~	~~1~~	~~42500~~	~~84100~~	~~59.5~~	~~OK~~	~~63.5~~	~~OK~~		~~02-2A~~		~~LENGTH 316~~
85019	82	2	42400	83700	58.0	OK	64.0	OK		01-1B		LENGTH 317,308

CHEMICAL COMPOSITION

HEAT NO.	C	Mn	P	S	Si	Cr	Ni	Co	Cu	Mo	N	Cb/Ta	Ti	V	W	Ce
~~90468~~	~~.040~~	~~1.540~~	~~.028~~	~~.006~~	~~.390~~	~~18.240~~	~~8.120~~	~~.170~~	~~.320~~	~~.260~~	~~.093~~					
85019	.040	1.510	.029	.004	.350	18.210	8.090	.140	.250	.240	.086					

Ingersoll Steel
Division of Avesta Inc.
P.O. Box 370
New Castle, Indiana 47362

STATE OF INDIANA
COUNTY OF HENRY

By Cindy Orr

Subscribed And Sworn To Before Me This 24 Day Of MA 1985

Harold W. Shaw
HAROLD W. SHAW NOTARY PUBLIC
My Commission Expires Dec. 27, 1985

ESCO CORPORATION
Customer Name CDM
Customer Order No. 9032
Sales Order No. 6375360
Date Mailed 3-5-86
Signature Judy Schultz

P.O. 9032
S.O. A762
RW
3-6-86

Manufacturing & Inspection Plan

PAGE	OF	W. A. NO.	PLANNED BY/DATE	Q. C. ENGINEER/DATE	RELEASED BY/DATE
1	1	A762	RW 2-12-86		

QUANTITY	PART NO.	REV. LTR.	PART NAME	NEXT ASSY. NO.
1	A1995	A	Reinforcement	D1991

OPER. NO.	DEPT.	REC'D DATE	MANUFACTURING OPERATIONS / OPERATIONAL DESCRIPTION	PERF. BY	DATE PERF.	INSP. OPER. NO.	INSPECTION OPERATIONS / INSPECTION DESCRIPTION	INSP. BY
			3/8 Pl., A240 304 S.S.				P.O. 8979 RLSD BY DATE	RW 2-27-86
10			Mach. Per Dwg	T. D.	3/5/86	10	Inspect Dim.	RW 3-7-86

1/2 plate

7530.

Division of Avesta Inc.

Certificate of Analysis and Tests

SOLD TO

AVESTA STAINLESS INC.
721 UNION BLVD.
P.O. BOX 269
TOTOWA, NJ

SHIP TO — SAME UNLESS NOTED OTHERWISE

ESCO CORPORATION
5185 MILLER STREET
WHEAT RIDGE CO 80033

ORDER NUMBER 16765 1

CUSTOMER CODE 416000

DATE DEC.02,1985

CUSTOMER ORDER NO & DATE	ROUTING	WHEN WANTED	TERMS
6312004 11/19/85			

ITEM NO.	MFG. CLASS	TYPE	FIN	DESCRIPTION
1	304		1	.500 X 94.0000 X 247.0000 EXACT ASME SA-240-80 83ED,S84 ADD ASTM A-240-84A QWS-766C PLATES & TEST PCS SOLUTION ANNEALED @ 1950 DEGREES FARENHEIT MINIMUM. THEN WATER COOLED OR RAPIDLY COOLED BY AIR HOT ROLLED, ANNEALED & PICKLED (HRAP)

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-17-86
Signature Judy Schultz

MECHANICAL AND OTHER TESTS

HEAT NUMBER	HARDNESS RB	PIECES	YIELD STRENGTH LBS PER SQ IN.	TENSILE STRENGTH LBS. PER SQ IN.	ELONG % IN 2"	BEND	RED AREA %	INTERGRANULAR CORROSION	GRAIN SIZE			REMARKS:
75301	83	1	44695	84337	63.0	OK	62.5	OK		02-28		

CHEMICAL COMPOSITION

HEAT NO.	C	Mn	P	S	Si	Cr	Ni	Co	Cu	Mo	N	Cb/Ta	Ti	V	W	Ce	FE
75301	.040	1.780	.029	.015	.550	18.260	8.190	.140	.320	.270	.087						

P.O. 8979
A762
Rec'd
2-17-86

Ingersoll Steel
Division of Avesta Inc.
P.O. Box 370
New Castle, Indiana 47362

STATE OF INDIANA
COUNTY OF HENRY

By Cindy Orr

Subscribed And Sworn To Before Me This 2 Day Of DECEMBER, 1985

Harold W. Shaw
HAROLD W. SHAW NOTARY PUBLIC

Manufacturing & Inspection Plan

PAGE 1 OF 1

W. A. NO. A762

PLANNED BY/DATE RW 2-12-86

Q. C. ENGINEER/DATE

RELEASED BY/DATE

QUANTITY	PART NO.	REV. LTR.	PART NAME	NEXT ASSY. NO.
1	A1993	A	Shield Adapter	D1991

OPER. NO.	DEPT.	REC'D DATE	MANUFACTURING OPERATIONS / OPERATIONAL DESCRIPTION	PERF. BY	DATE PERF.	INSP. OPER. NO.	INSPECTION OPERATIONS / INSPECTION DESCRIPTION	INSP. BY
			1/2 Pl., A240, 304 S.S.				P.O. 8979 RLSD BY DATE	RW 2-27-86
10			Mach. Per Dwg	T.D.	3/3/86	10	Inspect Dim.	RW 3-8-86

Certificate No 24L2208-066

Messers TOYO MENKA KAISHA, LTD.

P. O. NO. NA-853280

NAR STAINLESS STEEL
ST TITANIUM

HEAD OFFICE: NO. 8-2, HONSHIO-CHO, SHINJUKU-KU, TOKYO, JAPAN
TELEPHONE: TOKYO (03) 358-2511

Date. SEP 22, 1984 84 AABS 1541 07

Specification & Type	ASTM A240 TP304	Condition & Finish	NO.1

No	Case No	Shape & Size ※1 unit inch:" feet:' ■:space U:up L:	Quantity	Weight LBS	Inspection No or Heat No
1	K00007	B 1 X 96. X 240.	1	6826	24LH484A
		TOTAL	1	6826	

Notes
※1 Shape
A :Coil
B :Sheet Plate
E :Circle
F :Ring
K :Square Bar
M :Flat Bar
H :Foil
R :Round Bar
S :Square Billet
T :Round Billet
U :Angle
V :Unequal Angle
W :Flange
I :Ingot
J :Slab

※2 LC
L :Ladle
C :Check

※3 Element
CC :Cb+Ta+Ti
GG :Other Element Each
HH :Other Element Total
Remain :Remainder

※4 Position
T :Top
M :Middle
B :Bottom
S :Soft
H :Hard

※5 Direction
T :Transverse
L :Longitudinal

※6 Test Item
1Y :1.0%Offset Yield Strength
2Y :0.02%Offset Yield Strength
HY :High Temperature Yield Strength
HT :High Temperature Tensile Strength
HE :High Temperature [illegible]
ER :[illegible]
GS :Grain Size
FC :Ferrite Content
NB :Nickel Balance
MP :Magnetic Permeability
NM :Non-Metallic Inclusion Test

※7 Heat Treatment
Q :Quenching
T :Tempering
S :Stabilizing Treatment

	Chemical Composition in %												Tensile Test				Hardness Test	Bend Test	※6	※6
	C	Si	Mn	P	S	Cr	Ni	N			※3		Yield Strength 0.2% off Set	Tensile Strength	Elongation	Reduction of Area				
	X100	×100	×100	×1000	×1000	×100	×100	X100					KSI	KSI	%	%	HB			
MIN						1800	800						30	75	40					
MAX	8	100	200	45	30	2000	1050	10									202			
1	5	40	118	31	5	1832	841	2					35	88	60		149			

P.O. 8979
S.O. 4762
Rcd 2-17-86

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-17-86
Signature Judy Schultz

Dimensional & Visual Examination SATISFACTORY

Remarks Corresponding Spec. ASME.SA-240/SA-167, QQ-S-766c

We hereby certify that the material described herein has been manufactured and tested satisfactorily in accordance with the requirements of the above specification.

NIPPON STAINLESS STEEL CO., LTD
KASHIMA WORKS
H. Ohno
Manager of Quality Assurance Section

Manufacturing & Inspection Plan

PAGE 1 OF 1

W. A. NO. A762

PLANNED BY/DATE RW 2-12-86

Q. C. ENGINEER/DATE

RELEASED BY/DATE

QUANTITY	PART NO.	REV. LTR.	PART NAME	NEXT ASSY. NO.
1	B1992	A	Top Flange	D1991

OPER. NO.	DEPT.	REC'D DATE	MANUFACTURING OPERATIONS / OPERATIONAL DESCRIPTION	PERF. BY	DATE PERF.	INSP. OPER. NO.	INSPECTION OPERATIONS / INSPECTION DESCRIPTION	INSP. BY
			7/8 Pl., A240, 304 S.S.				P.O. 8979 RLSD BY DATE	RW 2-27-86
10			Mach. Per Dwg	T.D.	3/4/86	10	Inspect Dim.	RW 3-7-86

P.O. Box 1975
Baltimore, Maryland 21203
Telephone: (301) 288-2000

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

CERTIFIED MATERIAL TEST REPORT

sults and t. statements of performed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

MANIFEST NO. 8247

DATE 031584

SHIP TO: ESCO CORP
5185 MILLER ST.
WHEAT RIDGE

CO80033

MAIL TO: ESCO CORPORATION
5185 MILLER STREET
WHEAT RIDGE, CO.

80033

J E Bongardt
QUALITY CONTROL DEPARTMENT
03/15/84

SALES ORDER: 831600 CUSTOMER'S P.O. NO.: 6319102 M- 2 S-1 O-

ITEM	HEAT NO.	M.P.O.	TYPE	FINISH	GAUGE	WIDTH / O.D.	LENGTH / I.D.	PIECES	GROSS	NET
02	V34163	20519	304L	NO. 1	1.2500	72.0000	130.0000	1	3,445	3,445

MATERIAL SPECIFICATIONS AND REQUIREMENTS

SPECS ASTM A240-81A ASME SA240-S82 QQS-766C AMEND 6 COND A
MATERIAL FREE FROM MERCURY CONTAMINATION MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
V34163	304L	.012	1.54	.023	.017	.51	18.19	8.67	.23			.24	.13	.094

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8979
Sales Order No. 6374936
Date Mailed 2-17-86
Signature Judy Schultz

CORROSION TEST CODES

CODE	DESCRIPTION
A.	ASTM A262-PRACTICE 'A' (OXALIC)
B.	ASTM A262-PRACTICE 'B' (STREICHER
C.	ASTM A262-PRACTICE 'C' (HUEY)
D.	ASTM A262-PRACTICE 'E' (CUCUS04)
E.	QQS - 766 (CUS04)

HEAT NO.	M.P.O.	TRANSVERSE OR FRONT TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	LONGITUDINAL OR BACK TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	GR	C	CORROSION TEST CODE	RESULT	MAG.PERM. TEST	SOLUTION ANNEAL TIME MINUTES	TEMP. °F
34163	20519	81900	43900	60	HB150	G	69									[illegible]	SAT			

P.O. 8979
S.O. A762
RW
2-17-86

P.O. Box 1975
Baltimore, Maryland 21203

EASTERN STAINLESS STEEL COMPANY

DIVISION OF Eastmet CORPORATION

THINK FIRST . . . THINK EASTERN

CERTIFIED MATERIAL TEST REPORT
We certify that all of the test results and the statements of performed operations recorded here are in compliance with the ordered material specifications and the applicable material requirements.

J E Bonnett
QUALITY CONTROL MANAGER

MANIFEST NO. 1775
DATE 05/30/85
CUST. NO. 3055

SHIP TO: ESCO CORPORATION
5185 MILLER ST
WHEAT RIDGE CO 80033

MAIL TO: ESCO CORPORATION
5185 MILLER ST
WHEAT RIDGE CO 80033

MILL ORDER NO.	CUSTOMER ORDER NO.	LOC.	SHIPPED VIA	SHIP MODE	B/L NUMBER	CAR NUMBER		RLS-DT
S58624	6311482	FC	DAVIS TRANSPORT	T	3172		COLLECT ☐	05/27/85

ITEM	HEAT NO.	COIL NO.	M.P.O. NO.	GAUGE	SIZE	FINISH CODE	DESCRIPTION	COUPON	W-LOC	BNDL CODE	PLATES COILS SHEETS	GROSS	TARE	NET	PK	GP	FA	WS
3M 06	F40935	✓	39160	0.2500	1.5000 X 145.0000	14	304 HRAP		5C		64	1020	6	1014	052485		T	Y
3M 05	F50049	✓	39443	0.2500	1.2500 X 145.0000	14	304 HRAP		4C		34	468	8	460	052985		T	Y
3M 07	F50173	✓	39025	0.2500	2.0000 X 144.0000	14	304 HRAP		4C		48	998	4	994	052985		T	Y
3M 07	F50173	✓	39025	0.2500	2.0000 X 144.0000	14	304 HRAP		4C		48	1004	4	1000	052985		T	Y
3M 07	F50173	✓	39025	0.2500	2.0000 X 144.0000	14	304 HRAP		4C		48	998	4	994	052985		T	Y
											242	4488	26	4462				

SPECS ASTM A240-82C ASME SA240 SECT II 83 ED (EXC MKG)

FREE FROM KNOWN CONTACT WITH MERCURY

MINIMUM SOLUTION ANNEALING TEMPERATURE 1900 F

HEAT NO.	TYPE	C %	MN %	P %	S %	SI %	CR %	NI %	CU %	TI %	CB+TA %	MO %	CO %	N %
F40935	304	.059	1.61	.021	.019	.38	18.10	8.14	.21			.24	.14	.079
F50049	304	.056	1.65	.025	.007	.53	18.15	8.09	.24			.33	.15	.079
F50173	304	.048	1.64	.024	.011	.45	18.15	8.07	.20			.30	.13	.084
F50173	304	.048	1.64	.024	.011	.45	18.15	8.07	.20			.30	.13	.084
F50173	304	.048	1.64	.024	.011	.45	18.15	8.07	.20			.30	.13	.084

CORROSION TEST CODES

A. ASTM A262-'A'
B. ASTM A262-'B'
C. ASTM A262-'C'
D. ASTM A262-'E'
E. QQS-766(CUS04)

HEAT NO.	TRANSVERSE OR FRONT M.P.O.	TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	LONGITUDINAL OR BACK TENSILE PSI	YIELD PSI	ELONG %	HARDNESS	BEND	R/A %	GR	C	CORROSION TEST CODE	RESULT	MAG. PERM. TEST	SOLUTION ANNEAL TIME MINUTES	TEMP. °F
F40935	39160	93.4	45.2	54	HB172	G	63	94.1	46.0	54	HB167	G	63			E	SAT			
F50049	39443	93.1	46.0	56	HB153	G	63	93.0	46.1	56	HB157	G	63			E	SAT			
F50173	39025	97.9	52.8	48	HB176	G	63	96.9	52.2	48	HB173	G	63	7		AE	SAT			
F50173	39025	97.9	52.8	48	HB176	G	63	96.9	52.2	48	HB173	G	63	7		AE	SAT			
F50173	39025	97.9	52.8	48	HB176	G	63	96.9	52.2	48	HB173	G	63	7		AE	SAT			

P.O. 8422

INSPECTION CERTIFICATE

Messrs: MITSUI & CO., LTD. 492075 Date. DEC. 15. 1984 Packing List No; 12-0139

Contract No; T3029-11 (AA490127 ...) Customer No; Condition; SOLUTION TREATED & COLD DRAWN (COILED)

No.	Type of Steel	Heat No.	Size(INCH)	Length(FEET)	P'cs	Weight(LBS)	Body Hardness (HB)
			Quantity				
AF1-AF11	AISIT304	AX227	DIA. 1/2	12-14	2536	23051	229-241
AH1-AH3		49204	DIA. 1/4	12-14	3218	7045	187
AJ1-AJ2		AX226	DIA. 3/8	12-14	950	4828	217-229
			TOTAL	16 BUNDLES	6704	34954	

Chemical Composition

Items / Unit / Specification / Heat No.	C	Si	Mn	P	S	CU	NI	CR	MO	N		
Unit	%100	%100	%100	%1000	%1000	%100	%100	%100	%100	%100	%	%
Specification	MAX 8	MAX 100	MAX 200	MAX 40	MAX 30	MAX .75	800-1050	1800-2000	MAX 75	MAX 10		
AX227	5	40	174	32	21	45	829	1860	17	10		
49204	5	28	171	31	24	48	831	1886	14	9		
AX226	6	29	187	31	19	45	831	1882	22	8		

Mechanical Properties(Type of Specimen)

Heat No.	YS	Tensile Strength	Elongation	Reduction of Area	Hardness	Impact Value	SIZE
Unit	KSI	KSI	%	%			INCH
Specification	MIN 45	90-125	MIN 30	MIN 40			
AX227	64	106	43	71			1/2
49204	70	112	36	67			1/4
AX226	65	107	46	72			3/8

Hardenability (End Quenching Method)

Heat No.			
AX227	6-13-85	P.O. 8422 3.0.49252	
49204			
AX226			

ESCO CORPORATION
Customer Name CDM
Customer Order No. 8422
Sales Order No. 6369305
Date Mailed 6-12-85
Signature Judy Schulz

Remarks:

MACRO-STRUCTURE TEST	MICRO-STRUCTURE TEST
GOOD	GOOD
GOOD	GOOD
GOOD	GOOD

TO BE CONTINUED.

Hoshizaki Plant.

Chief of Quality Assurance Section

T. Higuchi

It is hereby certified that the above results are true and correct in every detail.

Daido Steel Co. Ltd.

Manufacturing & Inspection Plan

PAGE 1 OF 1

W. A. NO. A762

PLANNED BY/DATE RW 2-12-86

Q. C. ENGINEER/DATE

RELEASED BY/DATE

QUANTITY	PART NO.	REV. LTR.	PART NAME	NEXT ASSY. NO.
1	B1152-2		Weld Adapter	D1991

OPER. NO.	DEPT.	REC'D DATE	MANUFACTURING OPERATIONS / OPERATIONAL DESCRIPTION	PERF. BY	DATE PERF.	INSP. OPER. NO.	INSPECTION OPERATIONS / INSPECTION DESCRIPTION	RLSD BY DATE	INSP. BY
			1/2 ø Bar, A276, 304 S.S.				P.O. 8422		RW 2-27-86
10			Mach. Per Dwg	[illegible]	3/5/86	10	Inspect Dim.		RW 3-7-86