

American Magnetics, Inc.



P.O. Box 2509, 112 Flint Road, Oak Ridge, TN 37831-2509
Phone: (423) 482-1056 Fax: (423) 482-5472
Internet: <http://www.usit.net/ami> E-mail: amagi@usit.net

AMI HELIUM VAPOR COOLED CURRENT LEADS

Installation, Operation and Maintenance Instructions

I. INTRODUCTION

The American Magnetics, Inc. (AMI) helium vapor cooled current leads are designed to introduce high currents into liquid helium environments with a minimum of liquid helium loss. This is accomplished by using the heat capacity of the cold helium boil-off gas to cool the current leads.

II. SPECIFICATIONS

- A. Table 1 lists the specifications and shows dimensional references for AMI standard vapor cooled current leads. Dimensional references in Table 1 are shown on Figure 1. Custom designed or special order current leads may have dimensions and specifications that vary from those listed. However, the remainder of the information in these Installation, Operation and Maintenance Instructions is applicable.
- B. A voltage drop of 0.2 volts per lead at the rated current is typical.
- C. A pressure drop of approximately 2mm of mercury (0.03 psi) is developed through the leads at the rated current.
- D. Operating temperature range is 300K to 4.2K.

III. INSTALLATION

- A. Carefully remove the current leads from the shipping carton and ensure all packaging material is removed.
- B. Ensure that the vapor passages do not have any foreign material lodged in them. Check the passage-ways by blowing dry compressed air through the passage-ways.

***NOTE:** Compressed air with high moisture content may cause water vapor to collect in the passage-ways which may subsequently freeze and cause blockage.*



Model Number	L-50	L-75	L-100	L-150	L-200	L-250	L-500	L-1000	L-2000	L-3000	L-5000
Amperes	50	75	100	150	200	250	500	1000	2000	3000	5000
~Helium consumption, liters/hr., (pair of leads)	0.18	0.25	0.37	0.48	0.64	0.8	1.6	3.2	6.4	9.6	16
Type (see figures above)	A	A	A	A	A	A	A	B	B	B	B
D I M E N S I O N S I N C H E S	A	1/4	1/4	1/4	1/4	3/8	3/8	1/2	1/2	1/2	3/4
	B	1-1/2	1-1/2	1-1/2	1-1/2	2	2	3	3	3	3-3/4
	C	1	1	1	1	1-1/4	1-1/4	1-1/2	2	2-1/2	3
	D								1	1	1-1/2
	E	9/32	9/32	9/32	9/32	9/32	9/32	9/16	9/32	7/16	7/16
	F	3/8	3/8	3/8	3/8	1/2	3/4	3/4	3/4	3/4	1
	G	3/8	3/8	3/8	3/8	1/2	1/2	1/2	7/8	1-1/8	1-1/4
	H	1/4	1/4	1/4	1/4	3/8	1/2	1/2	1/2	3/4	1
	I								2-1/4	2-1/2	2-5/8
	J								1-3/4	2	2-1/8
	K	1/4 NPT	1/4 NPT	1/4 NPT	1/4 NPT	3/8 NPT	3/8 NPT	1/2 NPT	1	1-1/4	1-3/8
	L	7/8	7/8	7/8	7/8	1	1	1-3/16	5/8	5/8	5/8
	M	9/16	9/16	9/16	9/16	9/16	9/16	3/4	3/8	3/8	3/8
	N								9/32	9/32	9/32
	O	1/4	1/4	1/4	1/4	3/8	3/8	1/2	3/4	1	1-1/8
	R					0.201	0.201	0.201	9/32	13/32	17/32
	S	1	1	1	1	1	1	1	1-1/2	1-1/2	1-1/2
	T	1/16	1/16	1/16	1/16	1/8	1/8	1/8	1/4	1/4	1/4
	U					1/4	1/4	1/4	1/2	1/2	1/2
	V	16-5/8	16-5/8	16-5/8	16-5/8	16-5/8	16-5/8	17-1/2	19-1/2	19-1/2	19-1/2
W	Adjust.	Adjust.	Adjust.	Adjust.	Adjust.	Adjust.	Adjust.	1-1/2	2	2	
X	1/4	1/4	1/4	1/4	3/8	3/8	1/2	3/4	1	1-1/8	

TABLE 1
HELIUM VAPOR COOLED CURRENT LEAD SPECIFICATIONS

*Helium consumption is for a pair of leads when energized at operating current. Helium consumption is approximately equal to 1.6×10^{-3} liter per hour per lead. Helium consumption at zero current is approximately 40% of operating consumption.

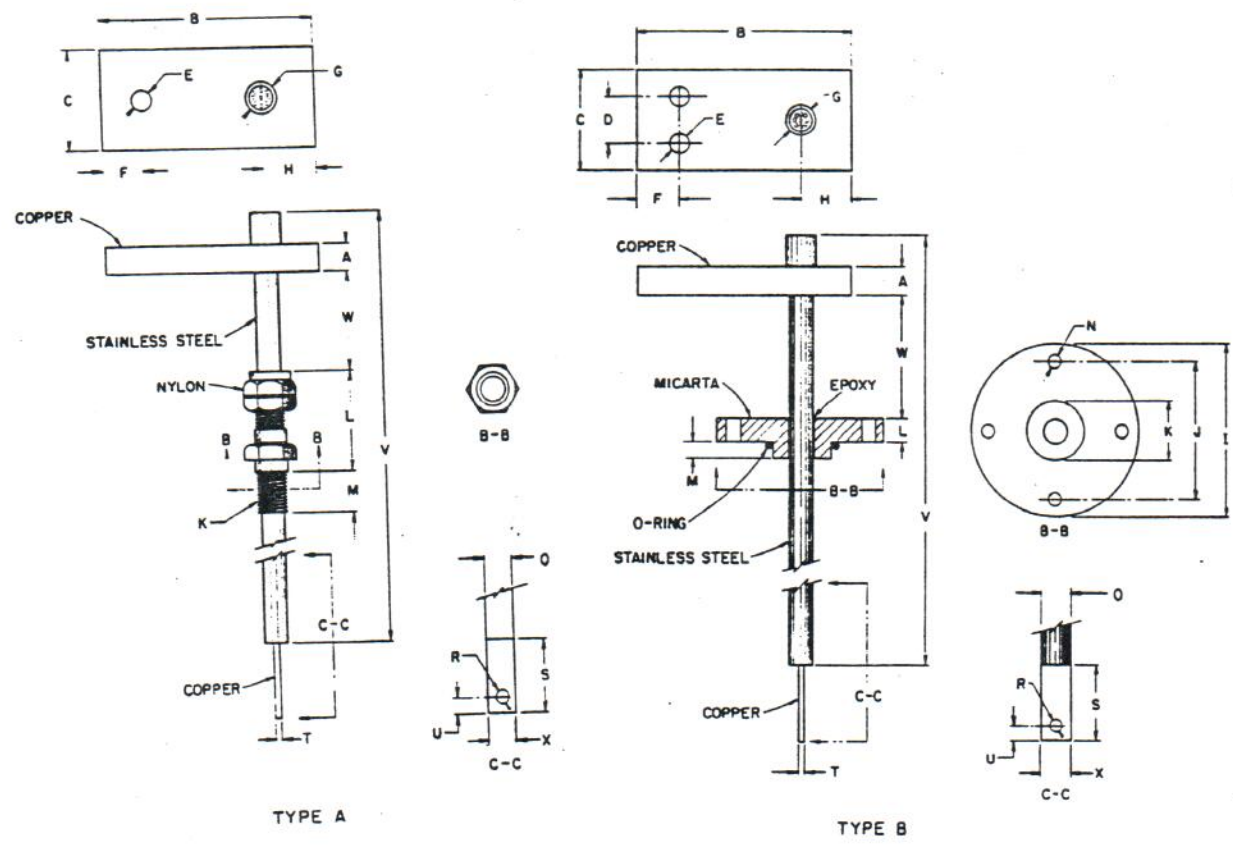


FIGURE 1
DIMENSION REFERENCES OF STANDARD
HELIUM VAPOR COOLED CURRENT LEADS



- C. Position the current leads into the helium dewar and secure them in position either with nylon bushings or by bolting through the micarta flange.

CAUTION: Ensure that the bottom of the vapor tube is positioned above the maximum liquid helium level. A liquid helium level above the bottom of the vapor tube will result in excessive helium loss until the level stabilizes below the end of the vapor tube.

- D. Electrical connections to the bottom current lug should be made by bolting and soldering. Solder electrical connections with ordinary eutectic lead-tin or other low melting point solder.

CAUTION: A heat sink should be provided between the electrical connection and the vapor tube to keep the temperature below 400oF. The vapor tube is constructed with a lead-silver solder that melts at 430oF. Temperatures above 430o could result in damage to the vapor tube filaments.

NOTE: It is desirable to make as good an electrical connection as possible between the current lead connection flange and the load. A poor electrical connection may cause excessive helium loss.

NOTE: AMI can provide a 24 inch bus bar extension that will operate in either the superconducting or resistive mode. However, it should be noted that the use of a bus bar extension may cause the helium consumption to increase.

- E. Electrical connections should be made by bolting or clamping cables, with proper terminations, to the top current lug.

CAUTION: Be sure all power supplies are de-energized before making or breaking electrical connection.

- F. During cooldown, helium gas should be vented through the vapor cooled current leads. A short length of rubber tubing pointed downwards will create a helium gas trap and prevent the re-introduction of air into the system.



IV. OPERATION

The helium vapor cooled current leads are a passive system component. They are ready to carry the current to the load when properly installed. Upon initial operation and periodically thereafter the helium gas flow through the current leads should be checked and the flow balanced (i.e. equalized). Flow is adjusted by restricting, by any suitable means, the higher gas flow. All normal gas flow from the dewar should be vented through the current leads. An overpressure valve should be provided on the dewar to vent large amounts of helium gas that may be generated in an abnormal event (e.g. superconducting magnet quench).

***CAUTION:** When vapor cooled current leads are used with inductive loads such as superconducting magnets, special care should be taken to avoid thermal damage to the current leads. Gas blockage can result in overheating, deterioration or even complete burn-out of the current leads. The resulting inductive voltages in the load are dangerous and special care must be taken to ensure the magnet is completely discharged to avoid equipment damage and electrical shock.*

After gas flow has been initially balanced a frequent visual check for frost on the current lead is sufficient to assure safe operation. Alternatively, the voltage across each lead (from the top of the lead to the appropriate magnet terminal) may be monitored to avoid operating with an overheated condition.

***CAUTION:** If your experiment requires current reversing it is recommended that the AMI Model 610 current reversing switch be purchased. Manual disconnecting and switching of current leads is NOT recommended because of the potentially fatal voltages involved.*

V. MAINTENANCE

Periodically check and adjust the helium gas vapor flow through the leads to ensure they are balanced.

VI. TROUBLESHOOTING

If the vapor cooled current leads are properly installed and operated within the specification limits they will provide years of trouble free service. The leads are sealed, passive units and repair, other than by factory authorized personnel, is not recommended.



VII. WARRANTY

All products manufactured by AMI are warranted to be free of defects in materials and workmanship and to perform as specified for a period of one year from date of shipment. In the event of a failure occurring during normal use, AMI, at its option, will repair or replace all products or components that fail under warranty, and such repair or replacement shall constitute a fulfillment of all AMI liabilities with respect to its products. All warranty repairs are F.O.B. Oak Ridge, Tennessee.

VIII. RETURN AUTHORIZATION

Items to be returned to AMI for repair (warranty or otherwise) require a return authorization number to ensure your order will receive the proper attention. Please call an AMI representative at (423) 482-1056 for a return authorization before shipping any item back to us.



Fili ROSSI SRL - MILAN - ITALY
ELECTROPLATING EQUIPMENT

- | | |
|---|---|
| * Opaque deposits (for lucid bath): | - lack of brightner
- excess of brightner |
| * Opaque deposits in the high density of current zones: | - high density of current |
| * Opaque deposits in the low density of current and insufficient penetration zones: | - pollution by extraneous metals
- low density of current
- organic particles in suspension |
| * The deposit becomes opaque after passivation: | - the passivation bath is exhausted |
| * Lack of deposit: | - too strong pickling
- pollution by chromium (VI) |
| * Excessive development of hydrogen: | - high density of current
- low zinc content |
| * Bad metallic penetration: | - zinc excess |

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June 20, 1997

Dear Mr. Piero Valente,

Enclosed are 3 copies of all certification documents for the custom 5000 ampere vapor cooled current leads, as required by your specification. The current leads are being shipped 6/20/97 by Burlington Air Express, Airbill #300619734, and should arrive in Chiasso, Switzerland by 6/27/97.

Regarding a technical issue, you should be careful when welding to the flange on the lower end of the current lead. You need to make sure that during welding that you do not overheat the flange. If you overheat the flange, then the solder used inside the current lead will melt. It is recommended that you keep the current lead tube less than 177°C during welding to prevent the solder from melting. The melting point of the solder is 220°C.

If you have any questions, please do not hesitate to contact us. Thank you for choosing AMI current leads for your project. We wish you much success in your work.

Sincerely,

A handwritten signature in cursive script that reads "Paul Arakawa".

Paul E. Arakawa

cc: K. Schaefer
K. Efferson

cc/enc: Job file #4851

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COPY

CERTIFICATION DOCUMENTATION
FOR
ANSALDO CUSTOM 5000 AMPERE
VAPOR COOLED CURRENT LEADS
P.O. 12/97-8671/1/96

June 20, 1997

American Magnetics, Inc.



P.O. Box 2509, 112 Flint Road, Oak Ridge, TN 37831-2509
Phone: (423) 482-1056 Fax: (423) 482-5472
Internet: <http://www.usit.net/ami> E-mail: amagi@usit.net

CERTIFICATE OF COMPLIANCE

Customer: Ansaldo

Date: 6/13/97

Customer Purchase Order: 12/97-8671/1/96

Date of PO: 2/10/97

Product: 5000 A Custom Vapor Cooled Current Lead

Qty. Shipped: 2 ea.

It is hereby certified that the products listed below, supplied on the above referenced purchase order, have been measured to the following values and are acceptable to specification requirements, as stated in AMI Quotation No. 961218-V4851. Insulation resistance tested at 0.7kV c.c. for one minute in air @ room temperature.

Serial No.	Insulation Resistance
7G0610A	> 500 Mohms
7G0610B	> 500 Mohms

Charles H. Hargis
Quality Assurance

American Magnetics, Inc.



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CERTIFICATE OF COMPLIANCE

Customer: Ansaldo

Date: 6/13/97

Customer Purchase Order: 12/97-8671/1/96

Date of PO: 2/10/97

Product: 5000 A Custom Vapor Cooled Current Lead

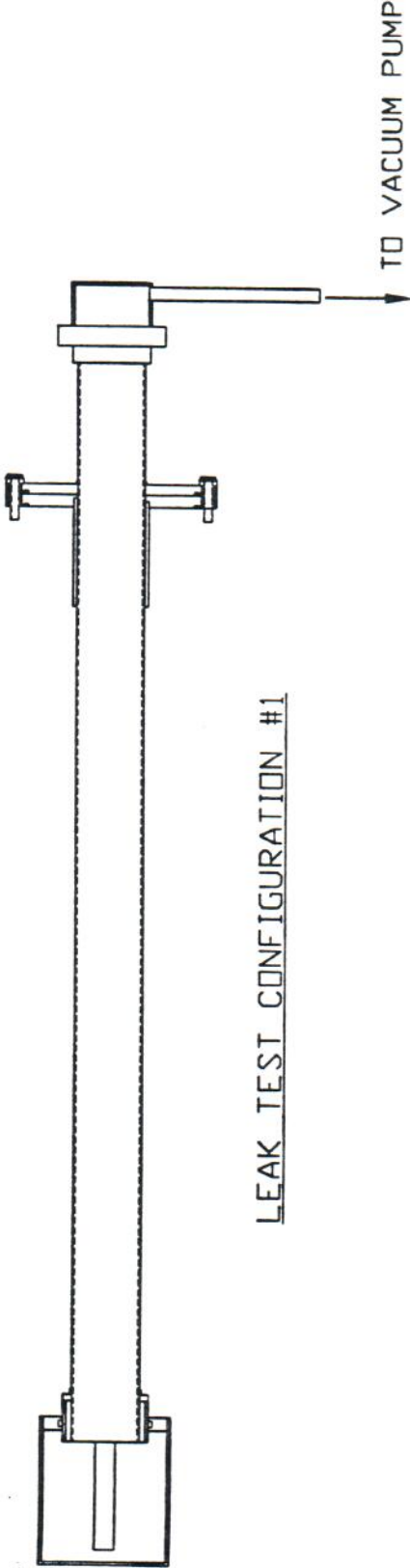
Qty. Shipped: 2 ea.

It is hereby certified that the products listed below, supplied on the above referenced purchase order, have been measured and are acceptable to specification requirements as stated in AMI Quotation No. 961218-V4851. Both leads were tested as indicated on AMI Sketch No. SK4851D, and were found to be within the following specifications:

Max. helium leakage toward air : 10E-7 mbar l/s

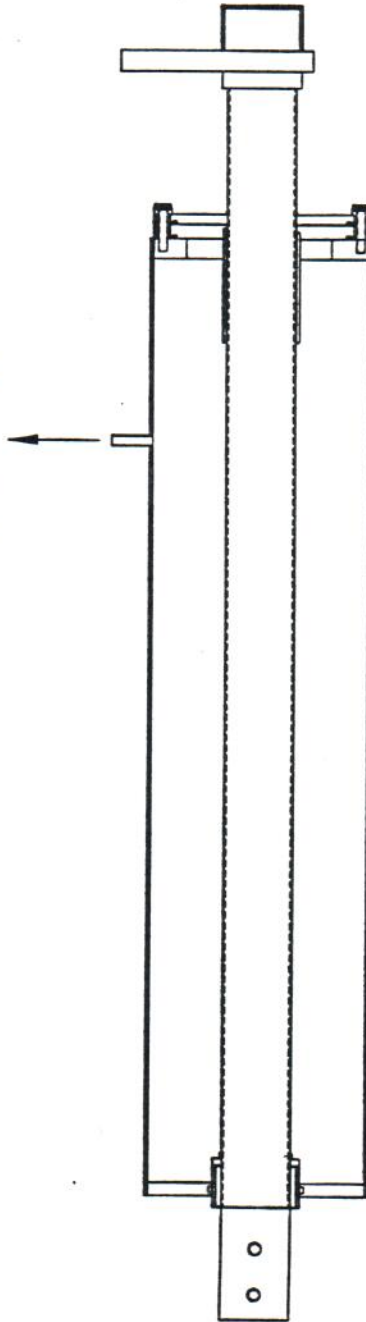
Max. helium leakage toward vacuum : 10E-9 mbar l/s

Charles H. Hargis
Quality Assurance



LEAK TEST CONFIGURATION #1

TO VACUUM PUMP



LEAK TEST CONFIGURATION #2

AMI
 SKETCH
 SK4851D
 JOB# 4851
 PEA
 05/22/97

5000 AMP CURRENT LEAD

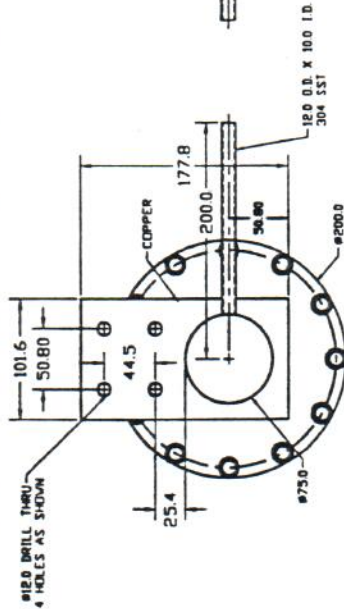
NOTES:

1. ALL LEAK TEST IN ACCORDANCE WITH APPLICABLE ASME CODE.
2. ALL WELDS SHALL BE DYE PENETRANT TESTED IN ACCORDANCE WITH APPLICABLE ASME CODE.

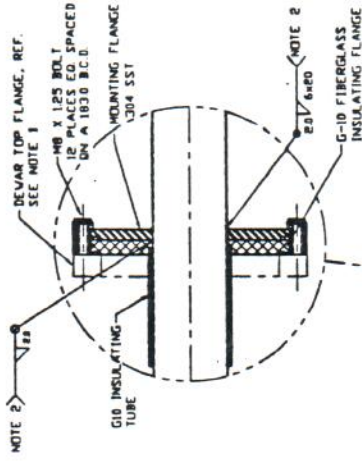
AMERICAN MAGNETICS, INC.
Number of Pages: 1
To: Piero VALENTE
ANSALDO
Fax Number: 011-39 1 06 55 64 85
From: Paul E. Arakawa
Date: May 22, 1997

NOTES:

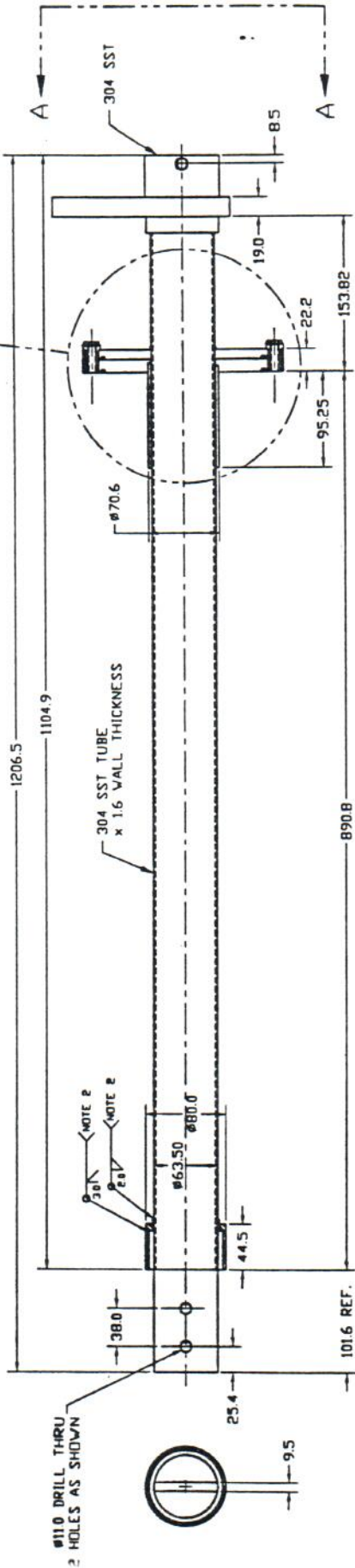
1. DEVAR TOP FLANGE TO HAVE A 200 MM OUTSIDE DIAMETER PER CUSTOMER.
2. ALL WELDS TO BE VACUUM TIGHT AND TESTED IN ACCORDANCE WITH AMI QUOTATION NO. 961218-V4851.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHER WISE NOTED.
4. CHAMFER G-10 TUBE & FLANGE TO ALLOW RELIEF WITH WELD ON MOUNTING FLANGE.




TOP VIEW A-A
LEFT HAND LEAD ASSEMBLY



TOP VIEW A-A
RIGHT HAND LEAD ASSEMBLY



5000 AMP CUSTOM VCCL
 REQ'D: ONE LEFT HAND ASSEMBLY
 REQ'D: ONE RIGHT HAND ASSEMBLY

AMERICAN MAGNETICS, INC.  ANSAL DO 5000 AMP CUSTOM VCCL CUSTOMER DRAWING	
TOLERANCES UNLESS OTHERWISE SPECIFIED X DECIMALS +/- 0.8 MM XX DECIMALS +/- 0.3 MM ANGLES +/- 10°	DATE: 5/02/97 DRAWN BY: PEA CHECKED BY: [Blank] SCALE: 1/2 D 97-4851-2281
ALL DIMENSIONS IN MM UNLESS OTHERWISE SPECIFIED	

PATHWAY

HELIUM LEAK TEST REPORT

NO.	REV.
HLT-1	(3) 6/1/80
DATE	PAGE
	OF

CUSTOMER American Magnetics, Inc. PATHWAY NO. _____
CUSTOMER P.O. _____ SPEC. REQ'TS. Cust

UNIT I.D.	DWG. & REV. NO.	LEAK RATE	ACCEPT	REJECT	DATE/INSPECTOR/LEVEL
760610A-4851		1×10^{-7}	✓		JUN 13 1997
760610A-4851		1×10^{-7}	✓		JUN 13 1997

REMARKS: Ref. PO. # 25297

MASS SPECTROMETER LEAK DETECTOR
SN: BDBAD 8004018 TRAVELER OPERATION NO. _____

THE ABOVE LISTED ITEMS WERE TESTED IN ACCORDANCE WITH PATHWAY BELLOWS HELIUM LEAK TEST PROCEDURE HLT 2 AND ARE ACCEPTABLE TO REFERENCED SPECIFICATION REQUIREMENTS.

Cal W. Loy
QUALITY ASSURANCE ENGINEER/QUALITY CONTROL SUPERVISOR



UNLESS OTHERWISE SPECIFIED, MATERIAL IS STEEL

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PATHWAY

LIVID PENETRANT EXAMINATION REPORT

NO.	REV./DATE
DATE	PAGE
	OF

CUSTOMER American Magnetics, Inc PATHWAY NO. _____
 CUSTOMER P.O. _____ SPEC REQTS. Cust

UNIT I.D.	DRAWING & REV #	AREA OF INSPECTION	WELDER SYMBOL	WPS NO.	ACCEPT	REJECT	DATE/INSPECTOR/LEN
7G0610A	4851	P.T. Inspect 6 welds Per Dwg Note: Spec.			✓		JUN 13 1997
7G0610B	4851	P.T. Inspect 6 welds Per Dwg Note: Spec.			✓		JUN 13 1997

TRAVELER OPERATION/REMARKS: Ref. P.O.# 25297

TIN/BATCH #	Penetrant Material Manufactures Certifications are on file at Pathway Bellows, Inc. The materials listed meet the contamination limits of: <input checked="" type="checkbox"/> ASME Sect V, Article 6 <input type="checkbox"/> NAVSEA 250-1500-1 <input type="checkbox"/> Other _____
PENETRANT <u>96C07K</u>	
DEVELOPER <u>97B07K</u>	
CLEANER <u>96M02K</u>	

THE ABOVE LISTED ITEMS WERE EXAMINED IN ACCORDANCE WITH PATHWAY BELLOW'S LIQUID PENETRANT PROCEDURE 2 Rev 26 AND ARE ACCEPTABLE TO REFERENCED SPECIFICATION REQUIREMENTS.

Cal W. Roy
 QUALITY ASSURANCE ENGINEER/QUALITY CONTROL SUPERVISOR



CONFIDENTIAL INFORMATION - IF PATHWAY BELLOW'S, INC. UNLESS PERMISSION IS GRANTED. WRITING
 COPYING OF THIS MATERIAL IS STRICTLY PROHIBITED.

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AMERICAN MAGNETICS, INC.

P.O. BOX 3809

113 FLINT ROAD

OAK RIDGE, TN. 37831-2509

VOICE 423-482-1056 FAX 423-482-5472

FACSIMILE TRANSMITTAL SHEET

TO: Piero VALENTE	FROM: Paul E. Arakawa
COMPANY: ANSALDO	DATE: June 19, 1997
FAX NUMBER: (11-39) 1 06 55 64 85	TOTAL NO. OF PAGES INCLUDING COVER: 2
PHONE NUMBER:	SENDER'S REFERENCE NUMBER: ANS-97-002
REF: APPROVAL REQUEST	YOUR REFERENCE NUMBER:

URGENT FOR REVIEW PLEASE COMMENT PLEASE REPLY INFORMATION

NOTES/COMMENTS:

Dear Piero,

I enjoyed talking to you and the other gentleman (I did not get his name) by telephone on 6/18/97. I am providing clarification of the helium leak test which we performed on your 5000 ampere vapor cooled current leads.

We tested both leads, serial numbers 7G0610A and 7G0610B, as indicated on AMI sketch number SK4851D. In the actual test, we evacuated the leads to 1×10^{-7} mbar l/s and then introduced helium gas around the canister. The helium spectrometer, with a sensitivity of 1×10^{-9} mbar l/s, detected no leaks, as tested in configuration #1 or configuration #2 shown on the above referenced sketch.

We also certify that the leads were manufactured in according to AMI drawing number 97-4851-2281, with the following exceptions, one of which was verbally approved by you during our telephone conversation of 6/18/97.

Current Lead Serial No. 760610A

Specified Dimension (mm)	Actual Dimension (mm)
890.8	889.8
153.82	153.11

Current Lead Serial No. 760610B


Specified Dimension (mm)	Actual Dimension (mm)
890.8	889.8
153.82	152.32

Please respond to your approval/disapproval of the exception to the 153.82 mm dimension. Once we have this final approval we will ship immediately.

Please let me know if you need additional information.

Sincerely,


Paul E. Arakawa

<p>Ansaldo Energia s.p.a. GENOVA (ITALIA)</p>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">ANSALDO</div> TELEFAX N° ++ 39 10 6556485	Data: 20/06/97 date: N. fax: Fogli n. :3 Pages no. :
DESTINATARIO TO	Societa' : SCHAEFER Company : c.c. AMI Sig. : Mrs. SCHAEFER : c.c. P. ARAKAWA Fax n. : 0041 31 7476470 Fax no. : c.c. 001 423 4825472	
MITTENTE FROM	Sig. : P. VALENTE Mr. Ufficio : PMA/CRSP Office Tel. n. : 010/6556722 Phone No.	
OGGETTO SUBJECT	CURRENT LEADS BaBar your offer No. 8671/1/96 AMI fax June 19,1997	
	<p>Dear Paul,</p> <p>if you had a sensitivity of 1×10^{-9} mbar l/s, it means that you can appreciate a leak of 1×10^{-9} mbar l/s. If you wrote that there was no leakage it means that you are within contract specification:</p> <p>Max helium leakage toward air = 10^{-7} mbar l/s Max helium leakage toward vacuum = 10^{-9} mbar l/s</p> <p>If that is true, I give you the final approval, but please send me a new leak test certification specifying the above written value.</p> <p>For the dimensional point of view we also accept what written in the fax attached.</p> <p>I remember you if you can advice us when the current leads should arrive to CHIASSO (CH).</p> <p style="text-align: right;">P. Valente </p>	



Sandvik Steel Canada
 425 McCartney Street,
 ARNPRIOR, Ontario K7S 3P3 Tel: 613-623-8501 Fax: (Admin) 613-623-7243

CERTIFIED MATERIAL TEST REPORT

WORK ORDER
 000003979

SHIP TO:
 S A M E

CUSTOMER:
 SANDVIK STEEL COMPANY
 982 GRIFFIN FORD ROAD
 CLARKS SUMMIT, PA 18411
 U.S.A.

SPECIFICATION
 ASTM A213-94B/A269-94A, ASME SA213 95 ED.
 CPI T-2.3.35 REV 0
 ATL659552 ✓
 SA30051

CUSTOMER ORDER & ITEM
 097780 01

TAG1 TUBE SALES
 FOREST PARK

WORK ORDER/HEAT NO.
 *1 19895 437970 *1 19896 437970
 *1 19897 437970 *2 19898 437970

MATERIAL
 TP304/TP304L Seamless Stainless Steel Tube

3/2" x .035" avg/wall

* = Test Lot

Heat No.	C	Si	Mn	P	S	Cr	Ni	Mo	Co	Cu	N
437970	.005	.40	1.37	.025	.004	18.37	10.68	.30	.080	.210	.046
437970	.010	.35	1.38	.024	.006	18.27	10.74	.29	.078	.213	.044

Melt Source - Sandvik, Sweden
 Melt Method - Electric Furnace

PRODUCT ANALYSIS

MECHANICAL TESTS

TEST	UTS	0.2% YS	El. 1 on 2	Hardness
1.	91,000 90,000	39,000 39,000	60 60	74 76
2.	87,000 90,000	37,000 37,000	60 60	72 72

Eddy Current Examination - Acceptable
 Alloy Verification - Acceptable
 Flare Test - Acceptable
 Flattening Test - Acceptable
 Seamless, Cold Finished, Bright Annealed & Quenched
 No weld repair has been performed on this material
 Traceability to test lot is through Work Order Number line-marked on tubes.

This material was manufactured by Sandvik Steel Canada in Canada and meets the requirements of MARTA origin.

This material has not come in contact with mercury or mercury-containing compounds.

This certification affirms that the contents of the report are correct and accurate and that all test results and operations performed by Sandvik Steel Canada or our subcontractors are in compliance with the material specification. The material is manufactured according to a quality system, approved and registered to ISO 9002.

Fraser, Superintendent Quality Systems and NDE/dh

TEST REPORTS

FEB 10 1997

ACCEPTABLE

BY: *[Signature]*

TELEDYNE RODNEY METALS

SCOTTDALE PLANT
 PO BOX 302, SCOTTDALE, PA 15683
 TEL# 412-887-9700 FAX# 412-887-9686

TEST CERTIFICATE NO. 1824

PURCHASE ORDER
 CRP 6-59134

TUBESALES
 PROSPECT PLAIN RD
 CRANBURY NJ

OUR ORDER NO. D5482 PAGE 1 of 2

TUBESALES
 175 TUREWAY
 FOREST PARK GA

LOT NUMBER D5482 * O.D. 1.2500 * SIZE WALL .035 * I.D. * GRADE 321 * HEAT NUMBER AS2403 ✓ * ORDERED QUANTITY 1000 FT * SHIPPED QUANTITY 740 FT * TEMPER ANNEALED * SMLS WLD 31 PCS * TEST REPORTS

FEB 25 1997

SPECIFICATIONS

ACCEPTABLE

MIL-T-8808B/8606C AMEN 2AMS 55576/5570M

BY *[Signature]*

CHEMISTRY PROPERTIES

ELEMENT: C	.07	Mn	1.37	P	.024	S	.50	Si	17.20	Cr	9.20	Ni	.020	Cu	.27	Mo	.29	Ti	.55	Fe	REM.
------------	-----	----	------	---	------	---	-----	----	-------	----	------	----	------	----	-----	----	-----	----	-----	----	------

MECHANICAL PROPERTIES

.2% OFFSET Y.S. --- U.T.S. ---
 PSI 93,320
 94,590
 95,200

ELONGATION IN 2 INCHES 54.00
 50.00

FLATTENING OK SURFACE CONDITION OK SURFACE FINISH OK SURFACE HYDROSTATIC OK

FLARING OK GRAIN SIZE B FLANGE OK MICROSCOPIC OK INTERGRANULAR CORROSION OK PASSIVATION OK

HEAT TREATMENT: ALL MATERIAL SUPPLIED ON THIS ORDER WAS SUBJECT TO A FINAL SOLUTION BRIGHT ANNEALING HEAT TREATMENT IN A CONTINUOUS FURNACE. THE MATERIAL WAS HELD AT A TEMPERATURE OF 1900 DEGREES F FOR A SUFFICIENT TIME TO INSURE COMPLETE SOLUTION OF THE CARBIDES IN THE MATRIX. FOLLOWED IMMEDIATELY BY QUENCHING TO BELOW 800 DEGREES F IN LESS THAN THREE MINUTES. QUENCHING WAS ACCOMPLISHED VIA THE CONTACT H2 ATMOSPHERE AND NON-CONTACT CIRCULATING COOLING WATER (PER TRM PROCEDURE AF-2, REV. 13, DTD 6-16-95.)

NO WELD REPAIR WAS PERFORMED ON THIS PRODUCT

100% VISUAL AND DIMENSIONAL INSPECTION AND INSPECTIONS, THIS MATERIAL DID NOT COME IN DIRECT CONTACT WITH MERCURY OR ANY OF ITS COMPOUNDS, NOR WITH ANY SINGLE BOUNDARY CONTAINMENT.

ALL MATERIAL SUPPLIED WITH THIS SHIPMENT ARE IN FULL COMPLIANCE WITH ALL PURCHASE ORDER AND ORDER SPECIFICATION REQUIREMENTS. THE TEST REPORTS REPRESENT THE ACTUAL ATTRIBUTES OF THE ITEMS FURNISHED AND THAT THE TEST RESULTS ARE IN FULL COMPLIANCE WITH ALL APPLICABLE SPECIFICATION AND ORDER REQUIREMENTS. WHEN TWO OR MORE SPECIFICATIONS ARE INCLUDED IN PURCHASE ORDERS REQUIRING SIMILAR TESTING TO DIFFERING REQUIREMENTS, TELEDYNE RODNEY METALS PERFORMS TESTING TO THE MORE STRINGENT REQUIREMENT.

A. M. L. *[Signature]* 2/20/97
 AUTHORIZED SIGNATURE DATE

The above are true and correct results of tests on samples of the material. Solid results meet



International Copper Company

MATERIAL CERTIFICATION
COPPER MILL PRODUCTS

CUSTOMER ORDER NO. 25166	INVOICE NO. 1-90357	INVOICE DATE 4/22/97
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CUSTOMER American Magnetic Inc. P. O. Box 2509 Oakridge, Tn. 37831	SHIPPED TO Same 112 Flint Road
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MATERIAL	Alloy 110 Copper Bar to ASTM-B-187
1 pc	3/8" X 2-1/2" Bar X 48"
1 pc	3/4" X 4" Bar X 24"
1 pc	3" Dia. Rod X 24"

This is to certify that this material was manufactured pursuant to the requirements of the following SPECIFICATION: ASTM-B-187

ORDER DATA				
QUANTITY	MILL LOT NO.	SIZE	DATE SHIPPED	
48"		3/8" X 2-1/2"	4/22/97	
24"		3/4" X 4"	4/22/97	
24"		3" Dia.	4/22/97	

MECHANICAL PROPERTIES AND TESTS				
ROCKWELL HARDNESS	AVERAGE GRAIN SIZE, mm.	TENSILE STRENGTH PSI	YIELD STRENGTH	ELONGATION % IN _____
BEND TEST IN DEGREES	MERCUROUS NITRATE TEST	EXPANSION TEST _____ %	FLATTENING TEST	OTHER

CHEMICAL ANALYSIS							
COPPER %	ZINC	LEAD	TIN	IRON	SILICON	MANGANESE	OTHER

SUBSCRIBED AND SWORN TO BEFORE ME

THIS _____ DAY OF _____ 19____

NOTARY PUBLIC

By Dewey E. Cato, Jr.

AUTHORIZED SIGNATURE



Certification of Materials

**AMERICAN MAGNETICS INC.
112 FLINT ROAD**

OAK RIDGE TN 37831

DATE 04/22/97

YOUR ORDER NO. P/O # 25166

TULL INVOICE NO. 0168874

Material

26568 1/2 304 HRAP S/S PLATE

Certification

We certify that the ORDER ITEM described on this document was shipped in accordance with your order. The producer of the material has certified to us that it was produced in accordance with the following specifications:

**ASTM-A240, ASME-SA240, CONDITION A,
AMS-5513, UNS-S-30400**


QUALITY MANAGER

Tull Metals

**PO BOX 4725
NORCROSS**

GA 30091-4725

770-368-4200

ATLANTIC PLASTICS AND SUPPLY CO.

721 DREW AVENUE, N.C. • ROANOKE, VA 24012 • (540) 366-2323 • FAX: (540) 366-7151

CERTIFICATE OF COMPLIANCE

TO: American Magnetics DATE: 5-6-97
112 Hunt Rd.
Oak Ridge, TN 37830

PART NUMBER: _____

PURCHASE ORDER #: 25197

MATERIAL: 2 1/2 x 3 G-10 tube

SPEC: L-P-509A

SIGNATURE: Wanda Jolly

TITLE: office manager

ATLANTIC PLASTICS AND SUPPLY CO.

721 DREW AVENUE, N.C. • ROANOKE, VA 24012 • (540) 366-2323 • FAX: (540) 366-7151

CERTIFICATE OF COMPLIANCE

TO: American Magnetics DATE: 5-6-97

112 Flint Rd.

Oak Ridge, TN 37830

PART NUMBER: _____

PURCHASE ORDER #: 25197

MATERIAL: 1/2 x 1/2 x 24 G-10

SPEC: mil - i - 24768 / 2 GEE

SIGNATURE: Maria Golly

TITLE: office manager