PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-III-87-138 Date November 3, 1987

This preliminary notification constitutes EARLY notice of events of POSSIBLE safety or public interest significance. The information is as initially received without verification or evaluation, and is basically all that is known by the Region III staff on this date.

Facility: Cleveland Electric Illuminating Company
Perry
Perry, OH 44081

Docket No. 50-440

Licensee Emergency Classification:
____ Notification of an Unusual Event
____ Alert
____ Site Area Emergency
____ General Emergency
_X_ Not Applicable

Subject: SHUTDOWN BECAUSE OF EXCESSIVE MSIV CLOSURE TIMES

At 1:38 p.m. (EST) on November 3, 1987, the licensee initiated an orderly reactor shutdown from 83 percent power after two Main Steam Isolation Valves (MISVs) failed to close during testing within the required Technical Specification limits. The remaining six MSIVs closed within the 3 to 5 second requirement. There are two valves in sequences on each of the four Main Steam Lines, one valve inside the reactor containment and one valve outside the containment. The valves that did not meet the closure time were both on the "D" steam line -- the inboard valve closed in 18 seconds and the outboard valve had not closed within the two minutes after the control switch was in the close position. The tests were observed by the Resident Inspectors.

Subsequent tests of the two valves resulted in closure times within the Technical Specification limit.

During testing on October 29, three valves did not meet the closure limit -- the two valves on the "D" line and the outboard valve on the "B" line. Subsequent cycling of the valves provided acceptable time responses.

An Augmented Inspection Team (AIT) is being dispatched to the plant site to review the circumstances and possible causes of the MSIV closure problems. The team will consist of the resident inspectors and personnel from Region III (Chicago) and the Office of Nuclear Reactor Regulation. A Region III Supervisor will head the team.

Region III will issue a Confirmatory Action Letter to the licensee documenting the licensee's agreement not to resume operation of the plant without concurrence of the Regional Administrator.

The State of Ohio will be notified.

Region III was informed of the test results and shutdown at 1:15 p.m. (EST) by the licensee. This information is current as of 2:30 p.m. (EST).

CONTACT: R. Knop (FTS 388-5547) M. Ring (FTS 388-5602)

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B/83

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

Docket No. 50-440
Docket No. 50-441

The Cleveland Electric Illuminating
Company
ATTN: Mr. Murray R. Edelman
Vice President
Nuclear Group
Post Office Box 5000
Cleveland, OH 44101

Gentlemen:

This letter confirms the telephone conversation on November 3, 1987, between Mr. Greenman and others of this office and Mr. A. Kaplan of your staff regarding the Main Steam Isolation Valve (MSIV) failures occurring at the Perry Nuclear Power Plant Unit 1 on November 3, 1987. With regard to the matters discussed, we understand that you will:

1. Take those actions necessary to ensure that complete documentary evidence of the "as found" condition of equipment being inspected is maintained.

2. Provide a step by step troubleshooting program to establish the root cause of the MSIVs failure to meet acceptance criteria.

3. Not disturb any components that offer a potential for being the root cause including power sources, switches, solenoids, and the air system directly feeding the MISVs until that action is approved by the NRC AIT team leader.

4. Except as dictated by plant safety, advise the NRC AIT Leader prior to conducting any troubleshooting activities. Such notification should be provided soon enough to allow time for the team leader to assign an inspector to observe activities.

5. Submit to NRC Region III a formal report of your findings and conclusions within 30 days of receipt of this letter.

We also understand that Perry Nuclear Power Plant Unit 1 will not be made critical without the concurrence of the Region III Regional Administrator or his designee.

~~871207 0041~~ (113PP)

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Please let me know immediately if your understanding differs from that set out above.

Sincerely,

A. Bert Davis
Regional Administrator

cc: F. R. Stead, Manager, Perry Plant Technical Department
M. D. Lyster, Manager, Perry Plant Operations Department
Ms. E. M. Buzzelli, General Supervising Engineer, Licensing and Compliance Section
DCD/DCB (RIDS)
Licensing Fee Management Branch
Resident Inspector, RIII
Harold W. Kohn, Ohio EPA
Terry J. Lodge, Esq.
James W. Harris, State of Ohio
Robert M. Quillin, Ohio Department of Health
State of Ohio, Public Utilities Commission
R. Cooper, EDO
W. Lanning, NRR
F. Miraglia, NRR
G. Holahan, NRR
M. Virgilio, NRR
J. Partlow, NRR
K. Connaughton, SRI
J. Strasma, RIII

DAILY REPORT REGION III

DATE: 11-02-87

LICENSEE/FACILITY	NOTIFICATION/SUBJECT
CLEVELAND ELECTRIC ILLUMINATING CO./ PERRY UNIT 1	SRI-PC/ EXCESSIVE MAIN STEAM ISOLATION VALVE (MSIV) STROKE TIMES
EVENT	EVENT NO. 10515 (UPDATE)

ON OCTOBER 29, 1987, WHILE OPERATING AT APPROXIMATELY 75% POWER, THE MSIVs WERE INDIVIDUALLY FAST-CLOSURE TESTED. VALVES 1B21-F022D, 1B21-F028D, AND 1B21-F028B EXHIBITED EXCESSIVE STROKE TIMES. SUBSEQUENT FAST-CLOSURE TESTS WERE PERFORMED AND THE VALVES PERFORMED SATISFACTORILY. THE VALVES WERE DECLARED OPERABLE FOLLOWING THE SUCCESSFUL FAST-CLOSURE TESTS. THE LICENSEE BELIEVES THAT THE EXCESSIVE INITIAL STROKE TIMES MAY HAVE BEEN DUE TO IMPURITIES IN THE VALVE ACTUATOR PILOT AIR SYSTEM AND THAT THE IMPURITIES WERE DISLODGED DURING VALVE OPERATION. BASED UPON DISCUSSIONS BETWEEN LICENSEE, NRC REGION III, AND NRR MANAGEMENT PERSONNEL HELD ON OCTOBER 30, 1987, THE LICENSEE WILL PERFORM ADDITIONAL FAST-CLOSURE TESTS ON THE SUBJECT VALVES TO CONFIRM THEIR OPERABILITY SHORTLY BEFORE THE PERFORMANCE OF THE FULL REACTOR ISOLATION STARTUP TEST. THE FULL REACTOR ISOLATION STARTUP TEST IS CURRENTLY SCHEDULED TO BE PERFORMED ON NOVEMBER 6, 1987. THE FULL REACTOR ISOLATION IS THE LAST TEST IN THE LICENSEE'S STARTUP TEST PROGRAM. WHILE SHUT DOWN FOLLOWING THE STARTUP TEST THE LICENSEE WILL EXAMINE THE MSIVs AND MSIV ACTUATORS TO FURTHER ESTABLISH THE ROOT CAUSE OF THE EXCESSIVE STROKE TIMES EXPERIENCED ON OCTOBER 29, 1987.

REGIONAL FOLLOWUP: THE RESIDENT INSPECTORS WILL WITNESS MSIV FAST-CLOSURE TESTING TO BE CONDUCTED PRIOR TO THE FULL REACTOR ISOLATION STARTUP TEST AND WILL INFORM NRC REGION III AND NRR MANAGEMENT OF THE TEST RESULTS.

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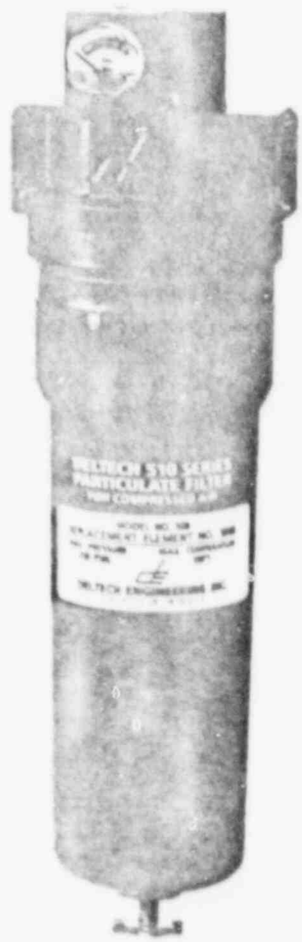
DELTECH

PARTICULATE COMPRESSED AIR FILTERS

510 SERIES



B175

Deltech 510 Series Filters remove the dirt and the problems from your compressed air.

Dust, dirt, rust, pipe scale and other particulates are introduced into your compressed air either at the air intake or by the system itself. These particulates cause excessive wear in moving parts, clog small orifices in precision instruments and controls, and contaminate products and processes. In short, they slow down production and step up maintenance.

Filtration is the simplest way to remove troublesome particulates from your compressed air. And, of the many different types of particulate filters available today, none can equal the overall performance and cost-effectiveness of the Deltech 510 Series Filter.

This high efficiency particulate filter for compressed air and natural gas provides nominal 3-micron filtration with a lower in-service pressure drop and a greater dirt-removing capacity than any other particulate filter now on the market.

Available in 14 models, the 510 Series offers air flow capacities up to 15,000 scfm at 100 psig and 100°F. Maximum operating temperature for all models is 150°F. Maximum operating pressure is 250 psig for all units through Model 520, and 150 psig for larger models.

Applications

You can use the 510 Series Filter to get cleaner air and better compressed air operations in any compressed air system that's likely to have particulate contamination. You can install it, for example, downstream of a desiccant dryer, to capture desiccant dust; after a nonlubricated compressor, to remove Teflon or carbon particles produced as the compressor wears; and as a prefilter to a refrigerated dryer, to keep dust and dirt from fouling the heat exchanger.

Features/Benefits

Lower Maintenance

• Replaceable element with its extended surface area removes more dirt for longer periods of time than any other particulate filter. This means fewer element replacements for less maintenance and lower operating cost.

• Differential pressure gauge with red/green zones on the dial face eliminates guesswork. Indicator in the red zone signals element replacement. Gauge is standard on Model 511 and larger.

• Element and materials are compatible with most compressor lubricants, except phosphate ester base types.

• Element core can withstand pressure surges up to 100 psi differential in Models 503 through 518 (Models 519 through 526, 60 psi). Element collapse is minimized.

Lower Pressure Drop

• Extended surface area of element results in lower pressure drop, and therefore lower compressor power consumption.

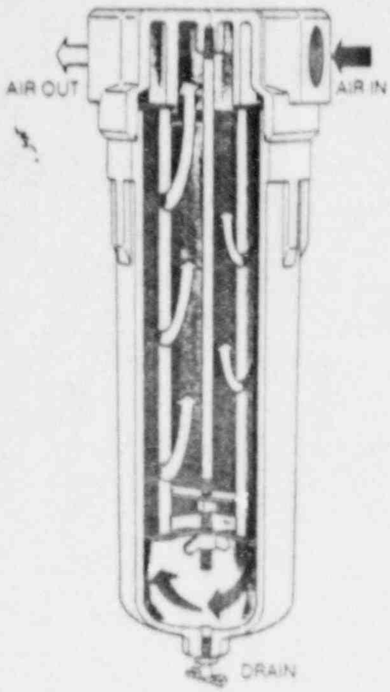
Fully Tested

• Each filter and indicator housing is pressure tested to 1½ times maximum operating pressure.

FILTER SIZING CHART

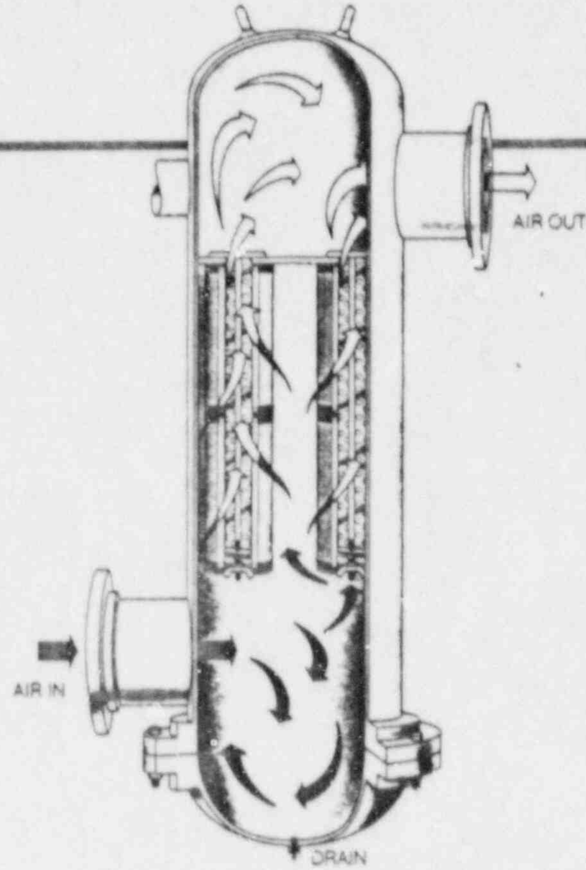
503	9	12	16	19	23	26	29	33	37	40	43	49	58	66	75	91
505	32	40	45	50	55	60	65	70	75	80	83	89	100	110	120	140
508	80	94	108	120	130	140	150	158	165	175	180	195	210	235	255	300
511	175	200	230	260	280	300	320	340	360	375	395	420	475	520	555	650
512	200	250	290	320	330	380	410	440	470	500	530	580	650	725	800	950
518	400	500	580	640	700	760	820	880	940	1000	1060	1160	1300	1450	1600	1900

Note: Initial pressure drop at inlet air pr[illegible] and maximum air flow is 1 psi.



Models 503-518

- Pleated element provides greater surface area, collects more dirt, with lower pressure drop.
- Element material is neither wound nor felt-type... it cannot release fiber particles into outlet air stream.
- Element is replaced in line by removing vessel bottom... no need to break piping connections.
- Element is nondirectional... it cannot be installed incorrectly.
- Large volume sump holds dirt separated mechanically by filter housing. Reduced dirt load on element reduces pressure drop, extends element life.



Models 519-526

How to Size Your Particulate Filter

Sizing a Deltech 510 Series Filter for top performance in your application is simple. Just determine the flow rate and pressure of the air to be filtered and select the appropriate model from the filter sizing chart.

Example:
Select a particulate filter to remove desiccant dust downstream of a heat reactivated compressed air dryer. The dryer delivers 490 scfm at 100 psig for the operation of pneumatic hand tools.

Model Selection:
In the filter sizing chart, read across to the column for 100 psig inlet air pressure. Read down this column and select a filter capable of handling the required flow. Select Model 512, which can handle up to 500 scfm at the specified operating pressure and 1 psi initial pressure drop.

Effect of Pressure Drop on Filter Sizing

Maximum air flow rates in the filter sizing chart are based on an initial pressure drop of 1 psi. However, in any given filter a change in flow will cause a change in pressure drop across the filter: the higher the flow, the higher the pressure drop. The operating range of each 510 Series Filter is broad enough to permit a wide range of flows without loss in filtration efficiency. To accurately size your filter for a pressure drop other than 1 psi, the air flow to be filtered must be adjusted using the following factors.

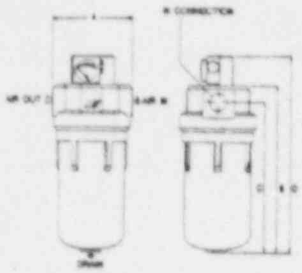
Initial Pressure Drop (psi)	Flow Adjustment Factor
0.5	1.45
1.0	1.0
1.5	0.83
2.0	0.69

In the filter sizing example above, the selected filter Model 512 is rated at 1 psi initial pressure drop. If the application can tolerate a 2-psi pressure drop, the flow to be filtered can be adjusted for an equivalent 1-psi pressure drop as follows:

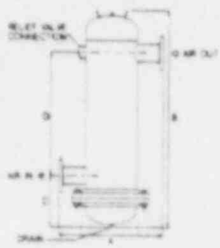
Adjusted Flow = Required Flow at Pressure × Flow Factor
= 490 scfm × 0.69
= 338 scfm

Using the filter sizing chart, for a 338 scfm adjusted flow select Model 511. In this case, the higher acceptable pressure drop lets you select a smaller filter.

Specifications



Models 503 through 518



Models 519 through 526

503	3.5	7.3	6.6	11.2	½		Manual				4
505	3.5	12.2	11.5	16.1	½		Manual				5
508	4.5	12.9	12.0	16.8	1		Manual				6
511	6.1	—	21.0	26.4	1½		Manual				15
512	6.1	—	28.9	34.3	2		Manual				20
518	8.5	—	39.5	45.7	3		Manual				135

Note: For disassembly of housing and element replacement, 510 Series filters must be installed with sufficient clearance below the lowest portion of any drain valves or piping. Models 503 through 518 require clearance equal to dimension C. Models 519 through 526 require a 30-inch clearance.

MATERIALS & CONSTRUCTION

Vessel top	Cast aluminum alloy	ASME code welded, flanged P.V.Q. steel
Vessel bottom*	Cast aluminum alloy	ASME code welded, flanged P.V.Q. steel
Bolts	—	SA193, Grade B7
Nuts	—	SA194, Grade 2H
Surface finish	Painted	Painted
O-Rings	Buna N	—
Gasket	—	Woven ring-type
Support core**	Perforated carbon steel	Perforated carbon steel
Element Filter media End caps	 Pleated paper Polymeric elastomer	 Pleated paper Polymeric elastomer

*Model 518 vessel bottom welded P.V.Q. steel

**Not required in Models 503 and 505

Maximum operating temperature: All models, 150°F

Maximum operating pressure: Models 503 through 520, 250 psig • Models 521 through 526, 150 psig

DELTECH ENGINEERING, INC.

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DELTECH

COMPRESSED AIR FILTERS
810 SERIES

The Deltech 810 Series Filter for cost-effective improvements in your compressed air operations

Filtration is the simplest way to remove the common contaminants . . . oil, dirt and water . . . from compressed air. Unfortunately, this simple solution is often overlooked until the contaminants slow down high-speed air tools, clog precision pneumatic instruments and controls, or cause product spoilage, process interruption, excessive maintenance, downtime or even a complete plant shutdown.

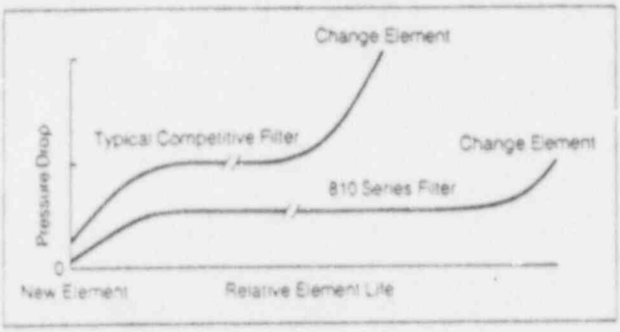
There are a number of filters on the market that are designed to eliminate the troublesome, costly problems caused by compressed air contaminants. Some of these filters work better than others. But there is no compressed air filter available today that can match the overall performance and cost benefits provided by the Deltech 810 Series Filter for compressed air. Compare these key factors with any other compressed air filter you are now using or considering for your operations.

Lower Installed Cost
The Deltech 810 Series Filter operates at high efficiency without a prefilter. It can even handle slugs of water. Other filters require a prefilter or a dryer or both. Prefilters, plus their associated piping, fittings and labor, increase installed cost and result in appreciable pressure drop over the complete filtering system.

Lower Operating Cost
Element replacement in typical competitive filters is recommended at 10 psi pressure drop. In the standard 100 psig air system, a 10 psi pressure drop requires a 5% increase in compressor power consumption. Tests indicate (see chart) that under equivalent service conditions the 810 Series Filter operates at a much lower pressure drop, and therefore lower compressor power usage.

High Efficiency
Actual in-service comparisons show that the filtration efficiency of the 810 Series Filter is unsurpassed by any of the leading competitive filters tested. The 810 Series has a theoretical efficiency greater than 99.9999+%, and is capable of removing particles as small as 0.01 micron.

Lower Maintenance Cost
Up to 99+% (by weight) of incoming contaminants are removed by the 810 Series Filter before the compressed air reaches the uniquely constructed element. This "pre-cleaning" is a major factor in providing an element life approximately twice that of competitive filters (see chart). This results in less maintenance and lower replacement cost.



Compressed Air Contaminants

Where They Come From
Compressed air contaminants can enter the system at the compressor intake or be introduced into the air stream by the system itself. Water and water vapor, dirt, oil and exhaust fumes are some of the contaminants that are commonly drawn in at the compressor intake. Lubricating oil and metal particles from wear come from lubricated compressors; carbon or Teflon particles, from oil-free compressors; rust and pipe scale, from the pipeline.

What They Can Do
Power Air — Water, oil and solid particles form a sludge which gums up air-operated drills, motors, chucks, presses, automatic feeds and other

pneumatic devices, causes rust and corrosion and reduces tool life and efficiency.

Process Air—Contaminants in compressed air used for process can seriously affect the quality of ingredients or products, and in some applications, can even produce undesirable chemical reactions.

Instrument Air—Even minute traces of oil, dirt and moisture will clog orifices of air-operated precision instruments and controls. When this happens, their ability to initiate, modulate, terminate or otherwise direct machines and processes is impaired and costly malfunctions can occur.

How the Deltech 810 Series Filter Removes Contaminants

The 810 Series design utilizes both impingement and centrifugal action to remove up to 99% of all particles, oil droplets and even slugs of water before the air ever reaches the filter element. These contaminants drop to the bottom of the filter for discharge through a drain valve (an automatic type is recommended). The "pre-cleaned" air then passes through the uniquely graded multi-media layers of the element which remove decreasingly smaller particles, mists and droplets, with maximum efficiency and low pressure drop. A specially designed and constructed inner drain layer captures the liquid mists, which fall to the bottom of the filter for easy removal through a manual drain or an automatic drain, depending on model.

Air leaving the 810 Series Filter is clean and free of harmful oil, suitable for use wherever high quality compressed air is required.

A pressure drop indicator,* mounted on the filter, senses pressure drop across the filter. For greatest operating cost efficiency, the filter element should be replaced before pressure drop becomes excessive and robs your air system of critical compressed air power. Green/red zones on the dial face of the pressure gauge let you check at a glance the condition of the filter element. When the indicator reaches the red zone, it's time to change the element.

*Standard on Models 815 through 829

How to Select Your 810 Series Filter

Selecting a Deltech 810 Series Filter for top performance in your application is simple. Merely determine the flow rate and pressure of the air to be filtered, and select the appropriate filter from the model selection chart.

Important: Do not select filter by pipe size.

Since compressed air pressure varies from system to system, the volume after compression depends on the pressure—the higher the pressure, the smaller the volume. For example, one standard cubic foot of air compressed to 125 psig occupies only 0.1 cubic foot. Therefore, the common method of specifying air flow rate for sizing almost all equipment in a compressed air system is standard cubic feet per minute (scfm). This refers to the volume the air occupies at standard conditions (68°F, 14.7 psia and 36% RH).

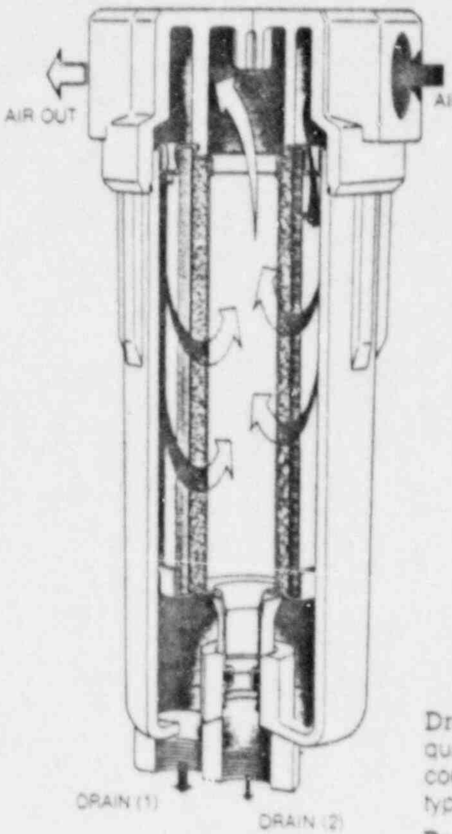
Example: For an air system with a 40 hp compressor, select an 810 Series Filter to remove oil, liquid water and solid particles from 155 scfm compressed air at 110 psig.

In the Model Selection Chart, read across to the column for 110 psig inlet air pressure. Read down this column and select a filter capable of handling the required flow. Select Model 815.

The operating range of each Deltech 810 Series Filter is broad enough so that it covers a wide range of flow rates and pressures without loss in performance. However, prolonged operation above the maximum inlet air flow should be avoided.

MODEL SELECTION CHART

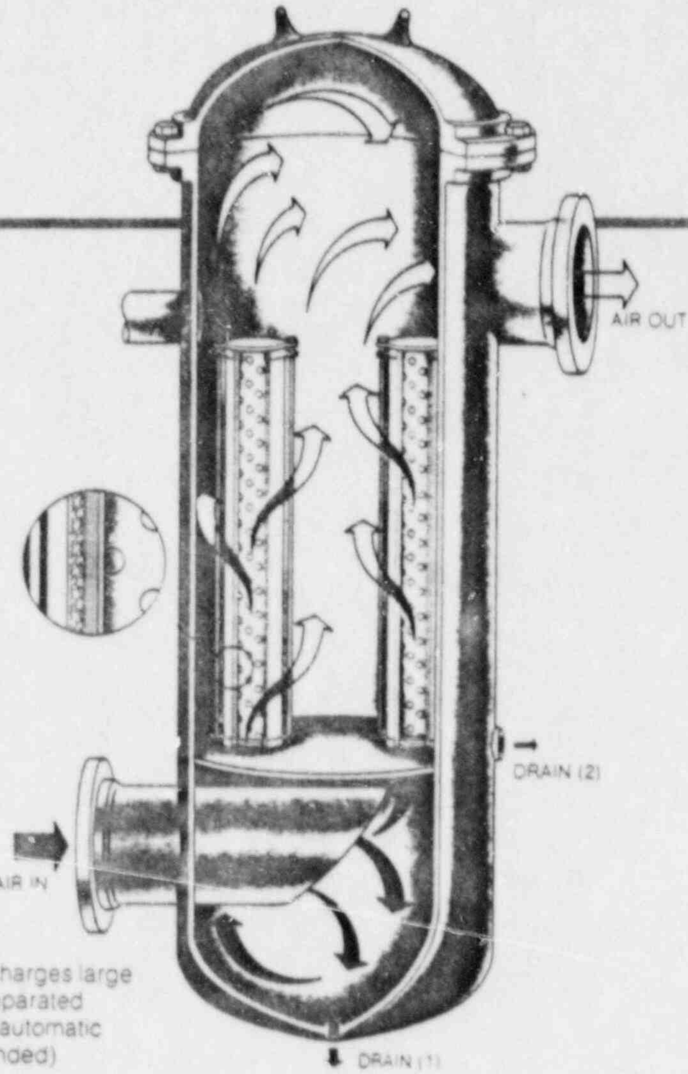
MODEL	INLET AIR PRESSURE (psig)															
	10	20	30	40	50	60	70	80	90	100	110	125	150	175	200	250
	MAXIMUM INLET AIR FLOW (scfm)															
811	3	5	6	7	8	10	11	12	14	15	16	18	22	25	28	34
812	6	9	12	14	17	19	22	25	27	30	33	37	43	50	56	69
813	13	18	23	29	34	39	44	50	55	60	65	73	86	100	113	135
814	22	30	39	48	56	65	74	83	91	100	108	120	140	165	185	225
815	34	48	62	76	90	104	118	130	145	160	170	195	230	255	300	365
816	54	75	97	119	140	160	180	205	225	250	270	305	360	415	470	570
817	86	120	155	190	225	260	290	330	365	400	430	485	575	665	750	910
818	108	150	195	235	280	325	365	410	455	500	540	610	715	830	940	1140
819	160	225	290	355	420	485	550	615	685	750	810	910	1075	1245	1410	1700
820	215	300	385	475	560	650	735	825	910	1000	1085	1215	1435			
821	320	450	580	710	845	975	1100	1235	1460	1500	1625	1825	2150			
822	430	600	775	950	1125	1295	1470	1650	1825	2000	2160	2430	2870			
823	645	905	1165	1425	1690	1945	2200	2470	2740	3000	3250	3650	4310			
824	860	1205	1555	1900	2250	2590	2940	3300	3650	4000	4330	4870	5750			
825	1075	1505	1945	2370	2810	3240	3670	4120	4570	5000	5420	6090	7190			
826	1610	2260	2910	3560	4220	4870	5510	6190	6850	7500	8130	9140	10,700			
827	2150	3010	3890	4750	5630	6490	7350	8250	9140	10,000	10,800	12,100	14,300			
828	2680	3770	4860	5940	7040	8120	9190	10,300	11,400	12,500	13,500	15,200	17,900			
829	3220	4520	5830	7130	8450	9740	11,000	12,300	13,700	15,000	16,200	18,200	21,500			



Models 811 through 819

Drain (1) discharges large quantities of separated contaminants (automatic type recommended)

Drain (2) discharges oil (manual type supplied with 811-819)



Models 820 through 829

Low Pressure Drop

- Initial pressure drop at standard conditions is only 0.4 psi
- "Pre-cleaning" of air significantly reduces contaminant loading of element
- Remaining contaminants are captured, in progressively smaller sizes, as air passes through graded layers of multi-media element
- Reduced resistance to air flow through element means lower pressure drop, more compressed air power at point of use

Long Element Life

- Uniquely constructed element has service life approximately twice that of competitive filters

Lube-Resistant Materials

- Compatible with petroleum base or synthetic lubricants

Maintenance/Safety Alert

- Gauge indicates time to change element
- Filter bowl "hisses," if loosened while under pressure, to alert worker of danger (Models 819 and smaller)
- ASME code-designed vessel (Model 820 and larger)

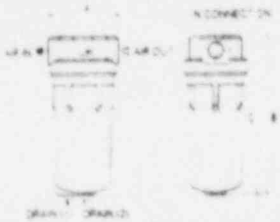
No Prefilter Required

- Impingement and centrifugal action remove up to 99% of large particles, oil droplets and slugs of water

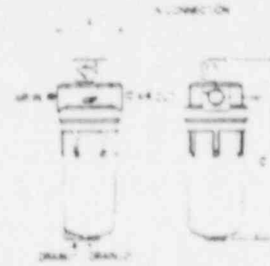
No Contaminant "Blow Through"

- Drain layer captures liquid mists, which fall to sump for removal
- Element core withstands pressure surges up to 100 psi differential in Models 811 through 819 (Models 820 through 829 30 psi)

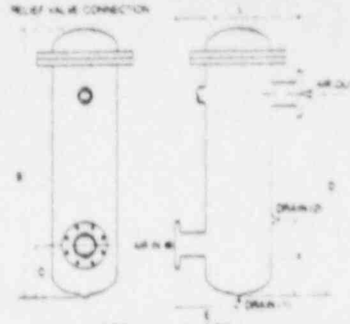
Specifications



Models 811 through 814



Models 815 through 819



Models 820 through 829

MODEL	DIMENSIONS (inches)						CONNECTIONS (inches)						APPROX. SHIPPING WEIGHT (lbs)
							In/Out		Drain (1)	Drain (2)	Relief Valve		
	A	B	C	D	E	F	NPT	Flange	NPT	NPT	NPT	Flange	
811	3.5	7.8*	7.1				½		¼	Drain cock			4
812	3.5	11.2*	10.5				½		¼	Drain cock			5
813	4.5	14.5*	13.6				1		¼	Drain cock			10
814	4.5	20.6*	19.7				1		¼	Drain cock			12
815	6.1	25.8	22.7				1½		¼	Drain cock			15
816	6.1	35.8	32.7				1½		¼	Drain cock			20
817	6.1	52.5	49.4				2		¼	Drain cock			30
818	8.5	45.6	41.7				3		¼	Drain cock			105
819	8.5	63.5	59.6				3		¼	Drain cock			135
820	22.8	73.0	8.6	61.0	11.4	12.9		3	¼	¾	1½		450
821	24.8	76.0	9.6	63.0	12.4	14.4		4	¼	¾	2		575
822	26.0	82.0	11.0	67.0	13.0	17.3		6	¼	¾	2		725
823	30.0	84.0	12.0	68.0	15.0	18.3		6	¼	¾	2½		940
824	34.0	91.0	14.0	72.4	17.0	21.8		8	¼	¾	3		1175
825	38.0	94.0	15.0	73.4	19.0	22.8		8	¼	¾	3		1475
826	42.0	100.0	17.0	78.1	21.0	26.4		10	¼	¾		4	1650
827	46.0	102.0	17.6	78.6	23.0	27.0		10	¼	¾		4	1850
828	52.0	110.0	20.0	83.1	26.0	30.4		12	¼	¾		4	2475
829	58.0	114.0	21.6	84.6	29.0	32.0		12	¼	¾		6	3200

Note: 810 Series filters must be installed with sufficient clearance for disassembly of housing and element replacement. Models 811 through 819 require a 5-inch clearance below the lowest portion of any drain valves or piping. Models 820 through 829 require a 42-inch clearance above the top of the filter.

* Add 1.7 in. for optional differential pressure gauge.

MATERIALS & CONSTRUCTION

COMPONENT	MODEL	
	811-819	820-829
Vessel top	Cast aluminum alloy	ASME code welded, flanged P.V.Q. steel
Vessel bottom	Cast aluminum alloy*	ASME code welded, flanged P.V.Q. steel
Bolts	—	SA193, Grade B7
Nuts	—	SA194, Grade 2H
Surface finish	Painted	Painted
O-Rings	Buna N	—
Gasket	—	Woven ring-type
Element		
Filter media	Glass fiber	Glass fiber
End caps	Stainless steel	Stainless steel
Support core	Perforated carbon steel	Perforated carbon steel

*Models 818 and 819 vessel bottom welded steel.

Maximum operating temperature: 150°F

Maximum recommended filtration temperature: 120°F

Maximum pressure: Models 811 through 819: 250 psig • Models 820 through 829: 150 psig

DELTECH ENGINEERING, INC.

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INSTALLATION, OPERATING
AND
MAINTENANCE MANUAL
FOR
DELTECH 510 SERIES
PARTICULATE FILTERS

RECEIVED
SEP 26 1985
PNPP DOCUMENT CONTROL

To register your Deltech Filter and validate the warranty, the card enclosed in this manual must be completed and mailed to Deltech.

MODEL 508

THIS INSTRUCTION MANUAL MUST BE READ BEFORE INSTALLATION OF EQUIPMENT AND BY ANYONE WHO WORKS WITH THIS EQUIPMENT.

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LIST OF FIGURES

WARRANTY

DELTECH ENGINEERING, INC. (DELTECH) MAKES NO WARRANTY OF MERCHANTABILITY AND NO WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE, NOR DOES IT MAKE ANY WARRANTY, EXPRESS OR IMPLIED, OF ANY NATURE WHATSOEVER WITH RESPECT TO PRODUCTS SOLD BY DELTECH OR THE USE THEREOF EXCEPT AS IS SPECIFICALLY SET FORTH ON THE FACE HEREOF EVEN THOUGH IT MAY HAVE BEEN NEGLIGENT. DELTECH SHALL IN NO EVENT BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PENAL DAMAGES. DELTECH MAKES NO WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, TO "CONSUMERS" AS THAT TERM IS DEFINED IN SEC. 101 OF PUBLIC LAW 93-637, THE MAGNUSON-MOSS WARRANTY-FEDERAL TRADE COMMISSION IMPROVEMENT ACT.

Deltech Engineering, Inc. (Deltech) warrants to its customers, and to no others, that those products manufactured and sold by Deltech to such customers shall, when properly applied, maintained, and operated under normal conditions, be free from defect in material and workmanship.

Upon claim to Deltech this warranty applies when such defect appears in Deltech manufactured filters and purifiers within twelve months of service and which are returned to and received by Deltech or, in the case of dryers, reported to Deltech within twelve months of service but not longer than twenty months from the date of shipment.

Upon claim to Deltech this warranty applies to defects in Deltech manufactured parts or components if such defects appear in such manufactured parts or components which are returned to and received by Deltech within twelve months of date of sale by Deltech.

Any claim made pursuant to this warranty shall be conditioned upon Deltech inspection of product upon which claim is made and Deltech determination that there was a defect in material or workmanship. Those claiming under this warranty shall, at Deltech's option, have one of the following remedies against Deltech in substitution for all other remedies or rights. The right (a) to repayment, or if not paid, to credit of the purchase price, or (b) to replacement of said goods, or (c) to repair of said goods, and in any event Deltech's maximum monetary liability hereunder shall be to refund, if paid, otherwise to credit, for that part of the product which is subject to the defect on which the claim is based.

Deltech products repaired or replaced pursuant to this warranty shall be warrented for the unexpired portion of the warranty applying to the original product. Any technical advice furnished before or after delivery in regard to the use or application of Deltech products is furnished without charge and on the basis that it represents Deltech's best judgment under the circumstances but that it is used at the recipient's sole risk.

Validation of this warranty is contingent upon adherence to the stated payment terms for any and all invoices relating to the purchase of the unit.

INTRODUCTION

Deltech 510 Series Particulate Filters are designed to remove, when used in accordance with these instructions, rust, scale and other particulates and liquid contaminants from compressed air. Consult the factory for suitability of these filters for any other compressed gas or gas mixture.

To ensure effective use and continuing good performance of the 510 Series Filter, persons concerned with the installation, use and maintenance of the filter must carefully follow the instructions given in this manual.

SAFETY

Deltech 510 Series Filters are designed and built with safety as a prime consideration. Each filter is tested to 1-1/2 times its maximum operating pressure prior to shipment from the factory.

Do not allow the transparent lens of the differential pressure gauge to come in contact with methanol, gasoline, xylene, toluene; synthetic or fire-retardant lubricants (chlorinated hydrocarbons, phosphate esters); lacquer, aromatic or chlorinated hydrocarbon solvents; acetone or other ketones. These materials cause the lens to dissolve or stress crack and may result in equipment failure and serious personal injury.

The use of replacement parts or elements other than those supplied by Deltech may cause failure of the filter or serious personal injury. Therefore, Deltech Engineering, Inc. bears no responsibility for the consequences of the use of equipment in which nonapproved parts are used.

Do not use the filter at pressures or temperatures which exceed the maximum pressure and temperature shown on the filter label. Models 519 through 525 are supplied with a connection for the attachment of a pressure relief valve (See Figure 1). Before these filters are placed in service, the customer must install a pressure relief device in accordance with paragraphs UG-125 through UG-136 of the ASME Boiler and Pressure Vessel Code, Section VIII - Division 1.

Compressed air can be dangerous. Safety precautions must be observed in the use of compressed air and compressed air equipment. Before changing the element or doing any work on this equipment be sure the internal pressure has been completely vented to the atmosphere.

RECEIVING & INSPECTION

Immediately upon receipt of your Deltech 510 Series Filter, carefully inspect it for any damage that may have occurred during shipping. If there is any sign of damage do not install or attempt to repair the filter as this may invalidate the warranty. Contact the factory (302-328-1345) for action to be taken.

Since the filter is shipped F.O.B. Factory, the carrier is responsible for any damage incurred during shipping. Such damage is not covered by the filter warranty. To receive compensation for damage, file a claim with the carrier. Deltech will assist in every way possible to rectify any problems.

INSTALLATION

Piping

Series 510 Filters must be selected on the basis of flow rate (scfm) and pressure of the air to be filtered, not on the basis of pipe size. Piping size must also be selected on the basis of air flow rate and pressure, and not on the size of the filter connections. A threaded reducing bushing may be needed to install your filter in the piping system.

Location in System

Maximum operating temperature of the 510 Series Filter is 150° F. Install your filter downstream of an aftercooler or at any other location in the system where the compressed air temperature does not exceed 150° F.

When used with a refrigerated dryer, install the filter upstream of the dryer to prevent fouling of the heat exchangers. When used with a desiccant dryer, install the filter downstream of the dryer to prevent desiccant dust from passing downstream.

When the filter is installed in an existing piping system, locate the filter as near as possible to the point of use. Particulates that have accumulated at the use point will be removed more quickly with the filter at this location.

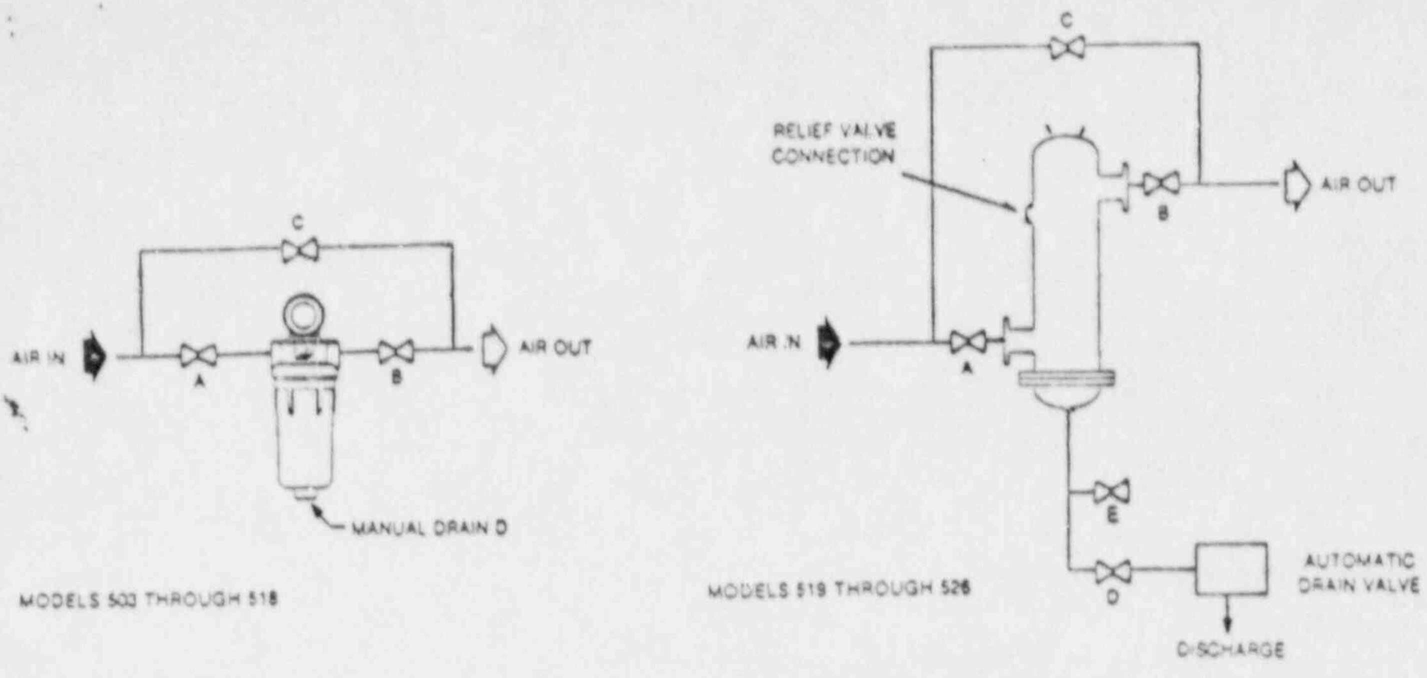

Figure 1

FILTER INSTALLED WITH 3-VALVE BYPASS

Filter Bypass

A 3-valve bypass around the filter is recommended so that elements can be changed without shutting down the branch line or the complete air system. A typical bypass arrangement is shown in Figure 1. Do not allow the piping to place any stresses on the filter connections.

A second filter may be installed in the bypass to protect downstream equipment while the primary filter is being serviced.

This arrangement (Models 519 through 526) also allows maintenance to be performed on the automatic drain valve without shutting down the filter. While the system is pressurized, slowly close valve D to isolate the drain valve.

Drain Valves

Liquid oil and water that fall to the sump in the bottom of the filter must be drained periodically. Do not allow liquids to build up in the sump. Accumulated liquids will be blown upward into the filter element and may cause high pressure drop, short element life, element failure or re-entry of separated contaminants into the air stream.

Models 503 through 518 are supplied with a manually operated drain at the center of the filter bottom. Models 519 through 522 have a 3/8-inch NPT drain connection; Models 523 through 526 have a 1/2-inch NPT drain connection. An automatic drain valve, rated for the maximum operating pressure of the filter, is recommended for these models.

Clearance

The 510 Series Filter must be installed vertically with the manual drain or drain connection at the bottom. Allow enough clearance below the filter for dismantling and element replacement. In general for Models 503 through 518 clearance equal to the overall length of the filter is adequate. For Models 519 through 526 allow 18 inches.

Connections

Observe inlet and outlet connections and direction of air flow. These are marked on all filter housings. Connection sizes are listed below.

MODEL	INLET, OUTLET (inches NPT)	DRAIN	MODEL	INLET, OUTLET FLANGE (inches)	DRAIN (inch NPT)	RELIEF VALVE CONNECTION	
						NPT	FLGE
503	1/2	Manual	519	4	3/8	2	
505	1/2	Manual	520	6	3/8	2	
508	1	Manual	521	6	3/8	2-1/2	
511	1-1/2	Manual	522	8	2	3	
512	2	Manual	523	10	1/2		4
518	3	Manual	524	10	1/2		4
			525	12	1/2		6
			526	12	1/2		6

CAUTION

DO NOT REVERSE CONNECTIONS TO AIR LINE. ELEMENT FAILURE MAY OCCUR IF CONNECTIONS ARE REVERSED.

Reverse flow may also occur if air is allowed to bleed back through the filter when the compressed air system is shut down. If conditions which result in reverse flow cannot be prevented, install a check valve at the outlet of the filter.

OPERATION

Once your 510 Series Filter has been installed according to instructions, it is ready for operation.

When the air system is started up, any moisture and oil that have condensed in the system will be carried to the filter. A sudden rush of accumulated condensed liquids may exceed the flow capacity of the drain valve and be forced back through the filter, causing high pressure drop and liquid carryover. To prevent this, the following procedure must be observed when the air system is started up. Refer to Figure 1.

1. Disconnect electrical power to automatic drain valve (if installed).
2. Close valves A, B and C.
3. Open valve D and, for Models 519 through 526, valve E.
4. Slowly open inlet valve A to the filter until the condensed liquid and oil are drained out. When all condensate is drained, close valve E. For Models 503 through 518, close manual drain D.
5. Very slowly open outlet valve B from the filter.
6. Connect electrical power to automatic drain valve.

The filter is now ready for air system start-up.

FILTER ELEMENT REPLACEMENT

With the filter in service, the accumulation of contaminants on the element causes a gradual increase in pressure drop through the filter. Pressure drop is indicated by the differential pressure gauge (standard on Models 511 and larger). When the indicator moves to the red zone the element must be replaced. If the element is not changed as indicated, excessive pressure drop may result in element failure, allowing contaminants to pass downstream.

CAUTION

BEFORE THE FILTER IS DISASSEMBLED, BE SURE THE INTERNAL AIR PRESSURE IS COMPLETELY VENTED TO THE ATMOSPHERE.

If your filter is installed as shown in Figure 1, the following procedure must be carried out to vent the internal pressure.

1. Open valve D.
2. Slowly open valve C.
3. Close valves A and B.
4. For Models 503 through 518, internal pressure will vent through manual drain D.
5. For Models 519 through 526, slowly open valve E. Internal pressure will vent through valve E.

Once the internal pressure has been completely vented to the atmosphere, the element can be replaced as described below.

Models 503 through 518

1. Remove bottom bowl by unscrewing it from the housing.
2. Remove and discard saturated element.
3. Clean any material out of bottom bowl. Use only soap and water.
4. Insert new element in bottom bowl.
5. Position O-rings in bottom bowl.
6. Reattach bottom bowl to top housing.
7. Slowly open valves A and B.
8. Close valve C.
9. Close valve D. The filter may now be returned to service.

Models 519 through 526

1. Vent internal pressure of filter to atmosphere (see above).
2. Disconnect electrical power to automatic drain valve.
3. Remove bolts in bottom flange.
4. Remove vessel bottom.
5. Remove and discard saturated element(s).
6. Clean any material out of vessel bottom. Use only soap and water.
7. Insert new element(s) in housing.
8. Replace vessel bottom and bolts.
9. Tighten bolts.
10. Connect electrical power to automatic drain valve.
11. Slowly open valves A and B.
12. Close valve C.
13. Close valve E. The filter may now be returned to service.

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Printed in USA

INSTALLATION, OPERATING

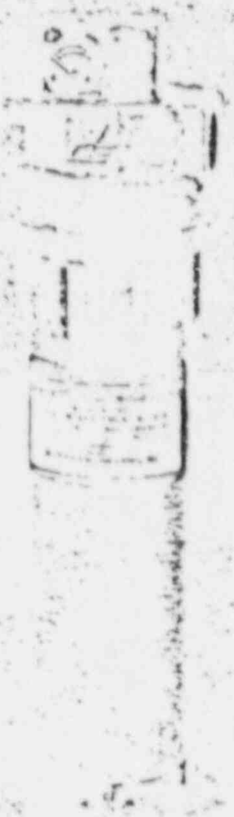
AND

MAINTENANCE MANUAL

FOR

DELTECH 310 SERIES FILTERS

To register your Deltech Filter and validate the warranty, the card enclosed in this manual must be completed and mailed to Deltech.



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THIS INSTRUCTION MANUAL MUST BE READ BEFORE INSTALLATION OF EQUIPMENT AND BY ANYONE WHO WORKS WITH THIS EQUIPMENT.

INTRODUCTION

Deltech 810 Series Filters are designed to remove, when used in accordance with these instructions, oil, oil mist, liquid water and dirt from compressed air. Consult the factory for suitability of these filters for any other compressed gas or gas mixture.

To ensure effective use and continuing good performance of the 810 Series Filter, persons concerned with the installation, use and maintenance of the filter must carefully follow the instructions given in this manual.

The use of replacement parts or elements other than those supplied by Deltech may cause failure of the filter or serious personal injury. Therefore, Deltech Engineering, Inc. bears no responsibility for the consequences of the use of equipment in which nonapproved parts are used.

SAFETY

Deltech 810 Series Filters are designed and built with safety as a prime consideration. Each filter is tested to 1-1/2 times its maximum operating pressure prior to shipment from the factory.

Do not use the filter at pressures or temperatures which exceed the maximum pressure and temperature shown on the filter label.

Do not allow the transparent lens of the differential pressure gauge to come in contact with methanol, gasoline, xylene, toluene; synthetic or fire-retardant lubricants (chlorinated hydrocarbons, phosphate esters), lacquer, aromatic or chlorinated hydrocarbon solvents; acetone or other ketones. These materials cause the lens to dissolve or stress crack and may result in equipment failure and serious personal injury.

Compressed air can be dangerous. Safety precautions must be observed in the use of compressed air and compressed air equipment. Before changing the element or doing any work on this equipment be sure the internal pressure has been completely vented to the atmosphere.

RECEIVING & INSPECTION

Immediately upon receipt of your Deltech 810 Series Filter, carefully inspect it for any damage that may have occurred during shipping. If there is any sign of damage do not install or attempt to repair the filter as this may invalidate the warranty. Contact the factory (302-328-1345) for action to be taken.

Since the filter is shipped F.O.B. Factory, the carrier is responsible for any damage incurred during shipping. Such damage is not covered by the filter warranty. To receive compensation for damage, file a claim with the carrier. Deltech will assist in every way possible to rectify any problems.

INSTALLATION

Piping

Series 810 Filters must be selected on the basis of flow rate (scfm) and pressure of the air to be filtered, not on the basis of pipe size. Piping size must also be selected on the basis of air flow rate and pressure, and not on the size of the filter connections. A threaded reducing bushing may be needed to install your filter in the piping system.

Location in System

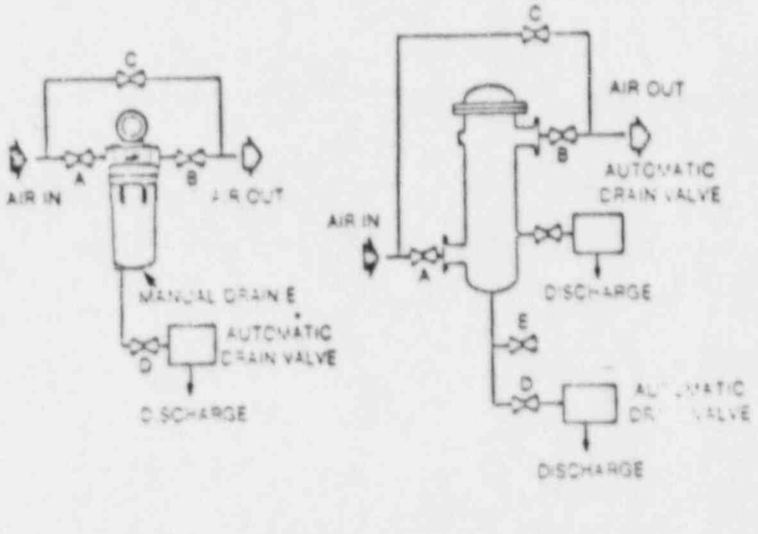
Maximum operating temperature of the 810 Series Filter is 150° F. However, since filter performance is improved at lower operating temperatures, it is recommended that filtration temperature not exceed 120° F.

Install your filter downstream of an aftercooler or at any other location in the system where the compressed air temperature does not exceed 150° F. If a refrigerated air dryer is installed in the air system, locate the filter downstream of the dryer. The dryer will remove a considerable quantity of dirt and condensed liquids, reducing the contaminant load on the filter and increasing the element life.

When the filter is installed in an existing piping system, locate the filter as near as possible to the point of use. Oil and dirt that have accumulated at the use point will be removed more quickly with the filter at this location.

Filter Bypass

A 3-valve bypass around the filter is recommended so that elements can be changed without shutting down the branch line or the complete air system. A typical bypass arrangement is shown in the schematics below. Do not allow the piping to place any stresses on the filter connections.



MODELS 811 THROUGH 819 MODELS 820 THROUGH 829

FILTER INSTALLED WITH 3-VALVE BYPASS

Figure 1

For applications that cannot tolerate oil during element replacement, a second filter should be installed in the bypass.

This arrangement also allows maintenance to be performed on the automatic drain valve without shutting down the filter. While the system is pressurized, slowly close valve D to isolate the drain valve.

DRAIN VALVES

The sump in the bottom of the filter is not a catchpot—it is part of the filtration system.

IMPORTANT: DO NOT ALLOW ANY LIQUIDS TO ACCUMULATE IN THE BOTTOM OF THE FILTER.

If liquids are allowed to accumulate in the sump they will be blown upward into the filter element and may cause high pressure drop, short element life, element failure or re-entry of oil and other separated contaminants into the air stream.

Each 810 Series Filter has two drain outlets. A manually operated drain at the center of the filter bottom is supplied on models 811 through 819. Manual draining once per day is usually adequate. All other drain outlets must be fitted with drain valves rated for the maximum operating pressure of the filter. Automatic drain valves are recommended for these outlets. Drain valves must discharge separately. Drain outlets must not be connected to a single, common drain valve.

Clearance

The 810 Series Filter must be installed vertically with the center drain at the bottom. For dismantling and element replacement in Models 811 through 819 allow a 5-inch clearance *below* the lowest portion of any drain valve or piping attached to the filter. For Models 820 through 829 allow a 42-inch clearance *above* the filter for element replacement.

Direction of Flow

Observe inlet and outlet connections and direction of air flow. These are marked on all filter housings. On Models 811 through 819 connections are NPT, straight through the top casting. On Models 820 through 829 connections are flanged. The inlet connection is near the bottom and the outlet connection is near the top of the filter housing. Connection sizes are listed below.

CAUTION

DO NOT REVERSE CONNECTIONS TO AIR LINE. ELEMENT FAILURE MAY OCCUR IF CONNECTIONS ARE REVERSED SINCE FILTERS ARE NOT DESIGNED FOR REVERSE FLOW.

Reverse flow may also occur if air is allowed to bleed back through the filter when the compressed air system is shut down. If conditions which result in reverse flow cannot be prevented, install a check valve at the outlet of the filter.

INLET, OUTLET CONNECTIONS

MODEL	NPT (Inches)	MODEL	FLANGE (Inches)
811	1/2	820	3
812	1/2	821	4
813	1	822	6
814	1	823	6
815	1-1/2	824	8
816	1-1/2	825	8
817	2	826	10
818	3	827	10
819	3	828	12
		829	12
DRAIN CONNECTION	1/4" NPT	DRAIN CONNECTIONS	3/4" NPT

OPERATION

Once your 810 Series Filter and automatic drain valve(s) have been installed according to instructions, the filter is ready for operation.

When the air system is started up, any moisture and oil that have condensed in the system will be carried to the filter. A sudden rush of accumulated condensed liquids may exceed the flow capacity of the drain valve and be forced back through the filter, reducing element life. To prevent this, the following procedure must be observed when the air system is started up.

1. Close valves A, B and C.

2. Open valves D and E.

3. Slowly open inlet valve A to the filter until the condensed liquid and oil are drained out. When all condensate is drained, close valve E.

4. Very slowly open outlet valve B.

FILTER ELEMENT REPLACEMENT

With the filter in service, the replaceable element adsorbs oil, causing a gradual increase in pressure drop through the element. Pressure drop is indicated by the differential pressure gauge. When the indicator moves to the red zone the element must be replaced. If the element is not changed as indicated, oil will be forced through the element into the air line.

If your filter is installed as shown in Figure 1, the following procedure must be carried out to vent the internal pressure.

CAUTION

BEFORE THE FILTER IS DISASSEMBLED, BE SURE THE INTERNAL AIR PRESSURE IS COMPLETELY VENTED TO THE ATMOSPHERE.

1. Open valve(s) D.
2. Slowly open valve C.
3. Close valves A and B.
4. Slowly open valve E. Internal pressure will vent through valve E.

Once the internal pressure has been completely vented to the atmosphere, the element can be replaced as described below.

Models 811 through 819

1. Disconnect drain lines at manual and automatic drain valves.
2. Remove bottom bowl by unscrewing it from the housing.
3. Remove and discard the saturated element.
4. Clean any material out of bottom bowl. Use only soap and water.
5. Insert new element in bottom bowl.
6. Position O-rings in bottom bowl.
7. Reattach bottom bowl to top housing.
8. Reattach drain lines.
9. Slowly open valves A and B.
10. Close valve C.
11. Close valve E. The filter is now back in service.

Models 820 through 829

1. Vent internal pressure of filter to atmosphere (see above).
2. Remove bolts in top flange.
3. Remove cover.
4. Remove hold-down bolts for elements.
5. Remove element end cap.
6. Remove elements and replace with new ones.
7. Replace end cap and tighten hold-down bolts.
8. Replace cover.
9. Replace and tighten bolts.
10. Slowly open valves A and B.
11. Close valve C.
12. Close valve E. The filter is now back in service.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 26 1985

J. A. GROBE
JUL 10 REC'D

Docket Nos.: 50-440
and 50-441

Mr. Murray R. Edelman, Vice President
Nuclear Operations Group
The Cleveland Electric Illuminating Company
P. O. Box 5000
Cleveland, Ohio 44101

Dear Mr. Edelman:

Subject: Request for Additional Information Regarding the Air Quality Standard for the Service Air System Changed in FSAR Amendments 17/18 - Perry Nuclear Power Plant (Units 1 and 2)

On the basis of its review of FSAR Amendment 17 and 18, the staff has identified the need for the enclosed additional information. The information required concerns the basis upon which the air quality standard for the service air systems has been changed from 3 to 40 microns for maximum allowable particle size.

Please advise the Perry Project Manager when we may expect to receive your reply within 5 days after receipt of this letter.

Sincerely,

Paul W O'Connor
for B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

Enclosure: As stated

cc: See next page

8507030706 4 PP.

JUN 26 1985

Mr. Murray R. Edelman
The Cleveland Electric
Illuminating Company

Perry Nuclear Power Plant
Units 1 and 2

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ENCLOSURE

AUXILIARY SYSTEMS BRANCH
REQUEST FOR ADDITIONAL INFORMATION
PERRY NUCLEAR POWER PLANTS, UNITS 1 AND 2
DOCKET NOS. 50-440 AND 50-441

Process Auxiliaries- Compressed Air Systems

1. FSAR Section 9.3.1, as revised per previous amendment(s) issued, including Amendment 17, and FSAR Section 6.8.4, as revised under Amendment 18 states the following:

   a. "The system meets the design guidelines of ANSI Standard MC-11-1 (ISA-S7.3) with the exception that the maximum allowable particle size for air to safety related equipment is 40 microns."

   b. "During operation, instrument air quality will be tested, on an annual basis, at the filter discharge for dewpoint and particulate contamination. The required air quality to safety related components supplied from this system is: zero particulates larger than 40 microns, dewpoint less than ¯40°F. On failure to meet acceptable air quality, branch lines will be tested to determine the extent of the problem and corrective action needed."

   c. "Air quality will be tested on a yearly basis downstream of the purifier package for dewpoint and particulate contamination. The required air quality to safety-related components supplied from this system is: zero particulates larger than 40 microns and a dewpoint less than ¯40°F."

   In order for us to evaluate these statements provide the following information:

   1. Provide the basis for your system design deviation from three(3) micron ANSI, MC-11-1 limit to 40 microns proposed limit for the air quality.

b. Provide verification that the involved safety related equipment will perform its intended functions utilizing the proposed 40 microns instrument air quality. Provide listing of the safety related equipment and corresponding manufacturer's recommended air quality.

c. Verify that the air quality, at the INLET of the involve safety related equipment, will meet the proposed 40 micron limit in order to perform its intended function. Provide procedures and/or technical specifications to test, detect, and correct the degradation of the proposed instrument air quality at the INLET of the involved safety related equipment in order to assure its intended operation.

Afterfilters: 1P52D0005A,B
2P52D0005A,B > Deltech model 510 series:
3μ

Prefilters: 1P52D0002A,B
2P52D0002A,B > Deltech model 810 series
.01 μ (

Afterfilter inspection: Repetitive task:

1P52-D0005A : R85-7929
1P52-D0005B : R85-7930
2P52-D0005A : R85-7931
2P52-D0005B : R85-7932

CAP 15-31 INLINE CENTRIFUGAL COMPRESSOR
GENERAL DATA - REVISED 801

RATED CONDITIONS OF SERVICE

TYPE OF GAS	AIR	
MOLECULAR WEIGHT	28.61	
RATIO OF SPECIFIC HEATS	1.4	
RELATIVE HUMIDITY	70	%
ATMOSPHERIC PRESSURE	14.7	PSIA
INLET PRESSURE	14.4	PSIA
INLET TEMPERATURE	90	°F.
DISCHARGE PRESSURE	139.7	PSIA
INLET CAPACITY	1475	ACFM ←
POWER	517.5	BHP
INPUT SPEED	3600	RPM
COOLING WATER SUPPLY TEMPERATURE	95	°F.

COOLER PERFORMANCE

COOLING WATER SUPPLY PRESSURE 125 PSIG MAXIMUM
COOLING WATER AVAILABLE PRESSURE DROP 17 PSI MINIMUM

INTERSTAGE AIR TEMPERATURE - MINIMUM 90 °F.
OPTIMUM 100 °F.
MAXIMUM 130 °F.

COOLING WATER TEMPERATURE RISE 30 °F.

TOTAL COOLING WATER FLOW AT RATED CONDITIONS 80 GPM

OIL SUPPLY TEMPERATURE - MINIMUM 104 °F.
OPTIMUM 115 °F.
MAXIMUM 122 °F.

INLET AIR FILTER PERFORMANCE

NOMINAL PRESSURE DROP (CLEAN)	2.0	H_2O
MAXIMUM PRESSURE DROP (DIRTY)	6.0	H_2O

OIL FILTER PERFORMANCE

NOMINAL PRESSURE DROP (CLEAN)	6	PSI
MAXIMUM PRESSURE DROP (DIRTY)	20	PSI

OIL RESERVOIR DATA

NORMAL CAPACITY (NEW CHARGE)	43	GAL.
MAXIMUM OIL LOSS AT REFILL	4	GAL.
MINIMUM OIL TEMPERATURE BEFORE STARTING	60	°F.

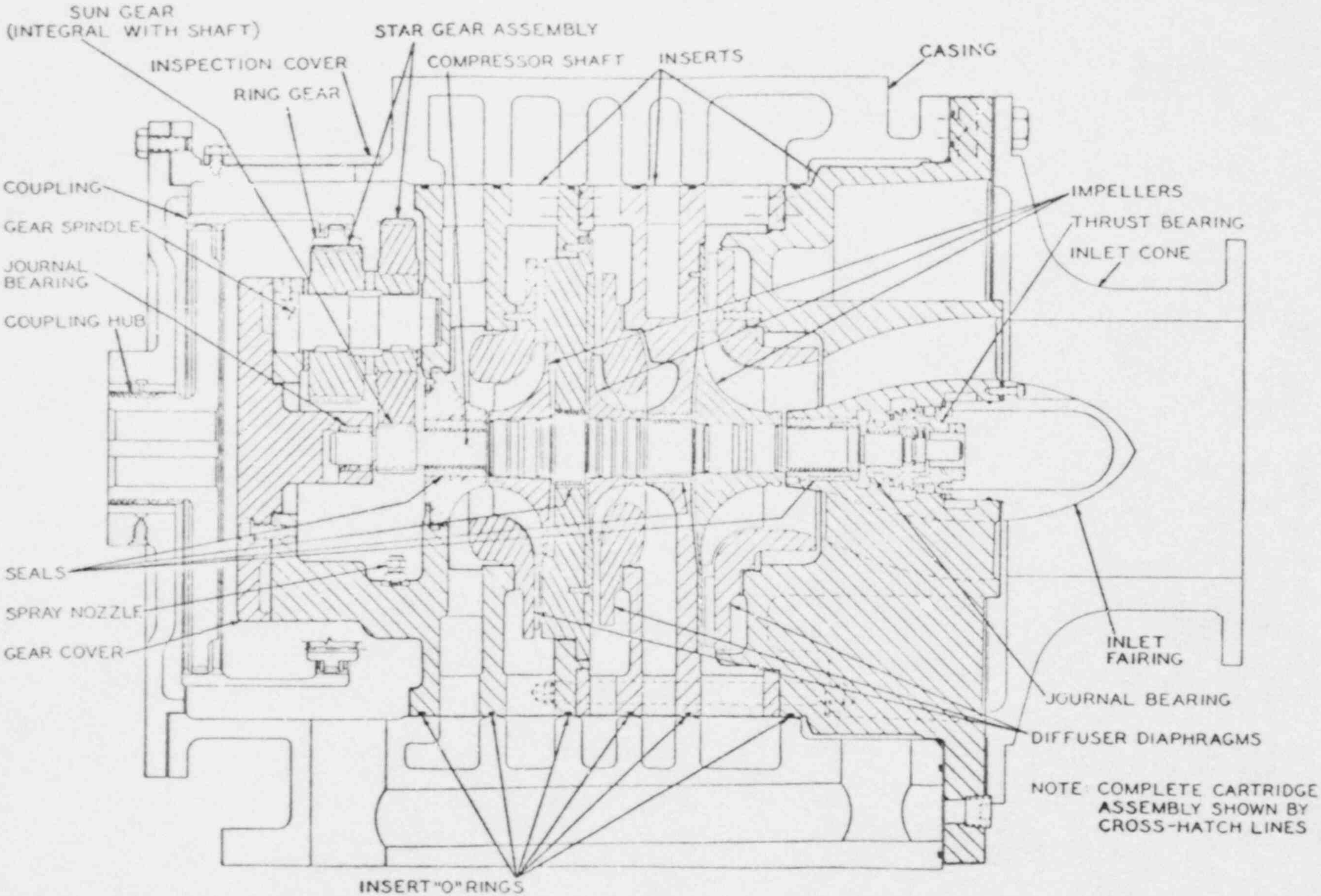
AIR REQUIREMENTS

INSTRUMENT AIR - SUPPLY PRESSURE TO PANEL	30	PSIG MINIMUM
	125	PSIG MAXIMUM
→ QUALITY-CLEAN (10 MICRON MAX), DRY CONSUMPTION	30	SCFM MAXIMUM
SEALING AIR - SUPPLY PRESSURE TO PANEL	30	PSIG MINIMUM
	125	PSIG MAXIMUM
CONSUMPTION	10	SCFM MAXIMUM

VIBRATION LIMITS

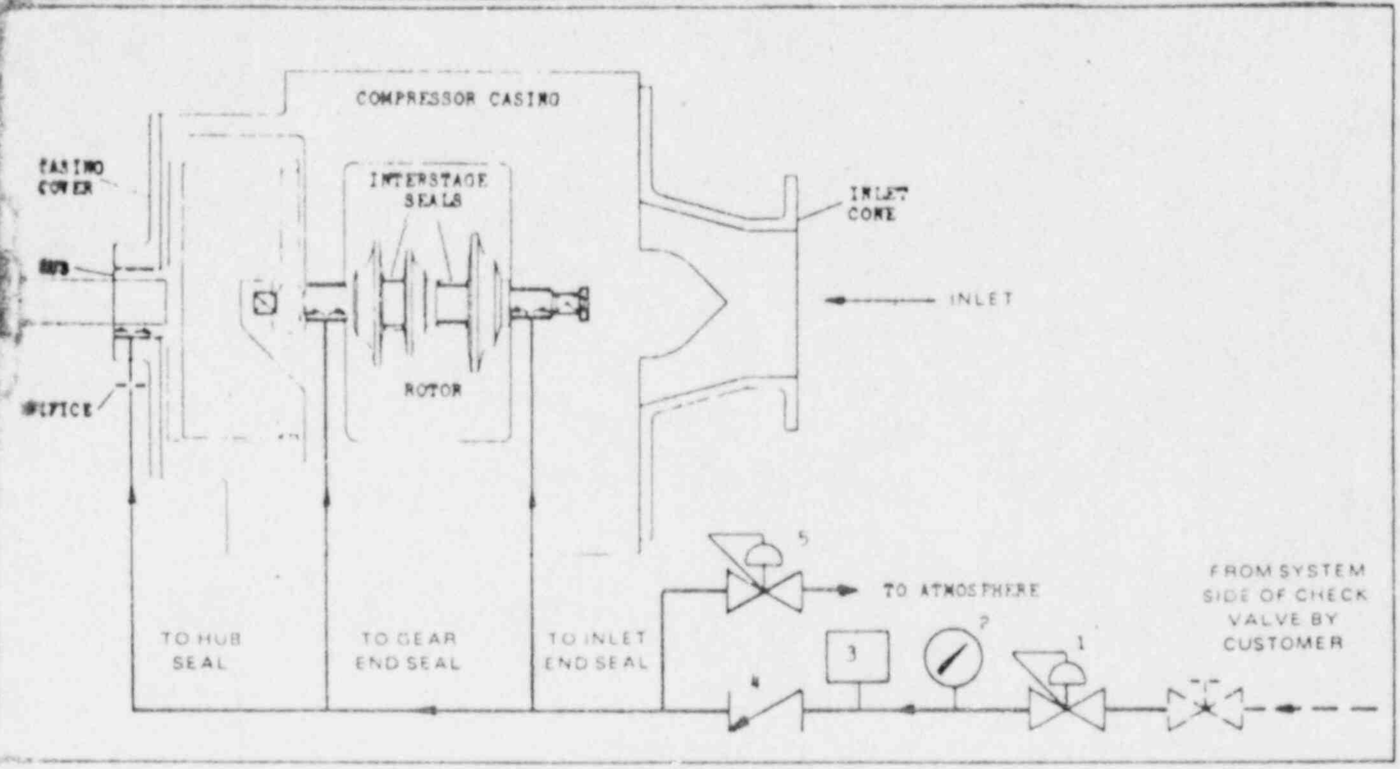
ALARM RELAY TRIP LEVEL IS 1.6 MILS PEAK TO PEAK. (Filter In)
SHUTDOWN RELAY TRIP LEVEL IS 1.8 MILS PEAK TO PEAK. (Filter In)

22



CASING AND CARTRIDGE ASSEMBLY CROSS SECTION
FIGURE 2

490021-176



SEAL AIR SYSTEM

ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	Pressure Regulating Valve	4	Check Valve
2	Pressure Gauge	5	Back Pressure Control Valve
3	Low Seal Air Pressure Switch		

The seal air system prevents oil from leaking out of the compressor or into the compressed air stream and prevents excessive air leakage between the stages of compression.

Oil leakage is prevented by buffered seals located inboard of the journal bearings and at the low speed hub extension thru the casing cover. Air leakage between impellers is controlled by interstage shaft seals which are non pressurized.

All seals consist of renewable babbitted shells located over serrated sections of the compressor shaft and hub extension.

Seal supply air to the oil seals is pre-piped from the regulating system in the control panel to drilled holes in the compressor casing leading to the seal areas. An air supply shut-off valve is normally furnished by the purchaser to conserve air when the compressor is not running.

The supply air pressure is controlled by pressure regulating valve (1) with pressure gauge (2) which is set to maintain the proper seal supply pressure. Seal air from this external source is supplied during start up and whenever the compressor is unloaded preventing lubricating oil from being drawn into the air passages. Low seal air pressure switch (3) prevents operation of the auxiliary lube oil pump and, therefore, starting of the compressor unless the proper seal supply pressure has been established.

During loaded operation, air pressure in the compressor rises, and supplies seal air through the gear end seal thus eliminating the need for an external seal air supply. Reverse flow is prevented by check valve (4). Excessive pressure build-up is prevented by back pressure control valve (5) which is set to vent the excess air when the seal pressure increases to about 1 PSI greater than that maintained by pressure regulating valve (2).

The supply pressure to the hub seal is reduced to the proper value by an orifice installed in this seal air supply line.

CONTROL

PARTS LIST

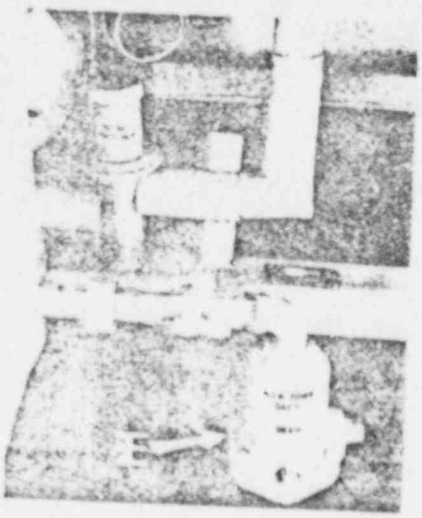
AUXILIARY EQUIPMENT

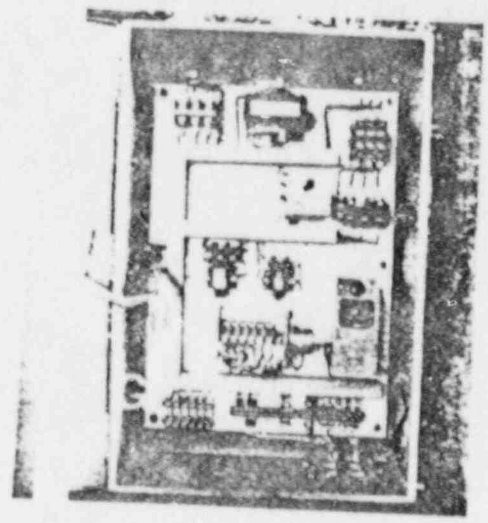
Every 6 months

1. Remove and clean out drain traps on chiller (E) and prefilter.

2. Have refrigeration engineer inspect refrigeration system and valve sequencing for correct functioning and confirm all pressure settings and readings.

3. Remove cover (F) and inspect desiccant for contamination. Consult Deltech Engineering for advice on desiccant replacement and for additional desiccant.





OPERATIONAL CHECKING AND TROUBLESHOOTING

General

As described in earlier sections, the flow of the refrigerant and air is controlled automatically from the cam timer (G) located in the electrical cabinet.

Operational Check - Drying

During a normal cycle the following conditions should be observed with the right bed drying the air and the left bed being regenerated.

1. Right tower is at line pressure.

2. Left tower is at atmospheric pressure.

NOTE

The tower on the drying cycle should be at line pressure, and the regenerating tower should be at zero pressure.

6. Check and log the refrigerant suction pressure for the refrigeration compressor.

Weekly

1. Check air pressure setting for operating cylinder. Gage (A) should read 60 psig minimum.

2. Inspect refrigeration sight port for system condition.

   a. A continuous stream of bubbles indicates loss of refrigerant charge.

   b. Color change of indicating area from green to yellow indicates contamination. For further information refer to troubleshooting section of this manual.

3. Insure that regeneration purge air pressure gage (B) is at correct setting. (Refer to Specification Sheet.)

4. Inspect let-down solenoid valve (C) and muffler (D) for blocking.

5. Check oil level in oiler that supplies oil to the air cylinder. Use any light lubricating oil.

6. Check oil level in refrigeration compressor.

The dotted line indicates the flow of refrigerant for the cooling cycle. Refrigerant flow for the instance shown is through the left bed, as solenoid valves SB and SC are open, allowing flow through check valves CA and CD. Under these circumstances, the left bed is on the drying cycle and the right bed is being regenerated. The flow pattern through the desiccant beds is reversed when the right tower is drying.

A second control valve (hot gas bypass, HGBV) is used in conjunction with the TEV to prevent freeze-up within the chiller, and to provide capacity control for the compressor when little or no compressed air is being used.

On Model ES9 and larger units, a second TEV is used to control the flow of refrigerant through the desiccant vessels. These valves are preset at the factory and may be readjusted on site by the startup engineer depending upon the application. Adjustments should be made only by a trained refrigeration engineer.

See the maintenance section of this manual for adjustment procedure and temperatures.

MAINTENANCE

<u>Daily</u>

1. Automatic drain on prefilter (if fitted) should be checked to insure proper functioning. A discharge in excess of one pint indicates a possible malfunction of the drain trap. Remove trap and clean all internal moving parts.
2. Afterfilter (if fitted) should be blown down by operating manual valve on filter. This will prevent the buildup of excess dust particles, etc.

<u>NOTE</u>

Just after startup, settling down of the desiccant within the towers will cause more dusting than can be expected during normal running periods. The amount of dusting will diminish with operation.

3. Chiller drain trap located at bottom of chiller should be checked to insure it is working. Use the manual bypass to check condensate discharge. If more than 8 ounces of liquid is present, remove trap, clean and replace.
4. Check for a positive discharge from the purge air muffler or line.
5. Check and log tower pressure gage readings in relation to bed sequence to assure that systems are functioning correctly.

DESIGN FEATURES

Desiccant System

Deltech Heat Pump Dryers utilize desiccants such as silica gel, activated alumina, or both to adsorb moisture. Life expectancy for the desiccant in Deltech Heat Pump Dryers is three to five years, depending upon inlet air quality and flow uniformity. Since there are no internal electrical heaters to cause large temperature differentials as in other types of compressed air dryers, the deleterious effect on the desiccant of excessive temperature has been virtually eliminated.

The heat exchangers within the desiccant vessels act as a support for the drying media while also ensuring uniform heating/cooling distribution during the drying and regeneration cycles.

Electrical System

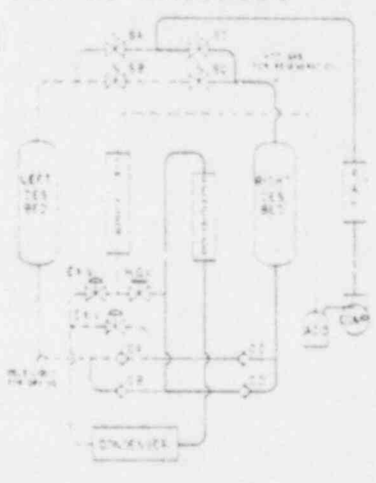
The electrical system of the dryer is designed around a cam timer that provides all the control function for changing the air flow and cooling/heating flow through the desiccant beds.

Indicating lights and all the other controls to provide starting and protection for the compressor are also included. The electrical schematic included with this manual details all the equipment provided for your dryer. The circuit describes the function of each control provided.

Refrigeration System

Refrigerant flow to the chillers is automatically regulated by a thermostatic expansion valve (TEV).

As shown in Figure 4, a system of solenoid valves (cam timer controlled) and check valves has been added to the basic refrigeration circuit of expansion valves, etc., to direct the flow of refrigerant from one bed to another.



BASIC SCHEMATIC FOR REFRIGERATION SYSTEM

Figure 4

THEORY OF OPERATION

The Heat Pump Dryer functions to provide a continuous supply of dry air by automatically cycling the operation of two desiccant beds one adsorbing moisture from the air, the other being reactivated. Desiccant is used to store the water removed from the inlet air until the cycle reverses and the water is carried out to the atmosphere by the low pressure reactivation purge air. Reactivation of the offstream bed is accomplished by reducing the pressure of a portion of the dried air, thus expanding its volume, and then passing this purge air through the bed of desiccant that is being reactivated. At the same time, this bed is being heated by hot refrigerant. The basic principle which makes this type of reactivation possible is that, at a given temperature, the quantity of water vapor carried in a saturated air stream depends only on the volume of the air. A volume portion of air at atmospheric pressure can contain as much water as a similar volume at an elevated pressure at the same temperature. The amount of water vapor removed from the system during reactivation is determined by the temperature and flow of reactivation air. The dryness of the exit air can therefore be maintained at a very low level by controlling the temperature and flow of reactivation air (purge air).

The Deltech Heat Pump Dryer utilizes a chiller to remove approximately 75% of the moisture contained in the inlet air before the air contacts the desiccant. The amount of desiccant needed to adsorb the remaining 25% moisture is much less than that required to adsorb the entire moisture load as is the case with ordinary desiccant dryers. The energy removed from the inlet compressed air in the chiller is used for regeneration of the offstream desiccant bed. The inlet energy, increased via the "Heat Pump" action of the refrigerant compressor, increases the temperature of the purge air, and thereby decreases the flow of the purge air required.

The capacity of a desiccant to adsorb moisture at ultra low vapor pressures (ultra low dew points) is increased as the temperature is reduced. In the Deltech Heat Pump Dryer, the chiller (refrigeration system) is also used to maintain the desiccant bed at low temperature throughout the drying cycle regardless of the heat of adsorption.

The refrigeration system quickly cools the desiccant when the vessel cycle shifts from regeneration to drying. Fluctuations in the dew point of the exit air are much less than those experienced in drying systems that do not include refrigeration.

Since the desiccant is not exposed to the very high temperatures needed for regeneration of systems without refrigeration, desiccant life can be expected to be substantially longer.

The Deltech Heat Pump Dryer is the most efficient desiccant drying system available. With proper maintenance it will provide years of trouble-free operation with very low operating costs.

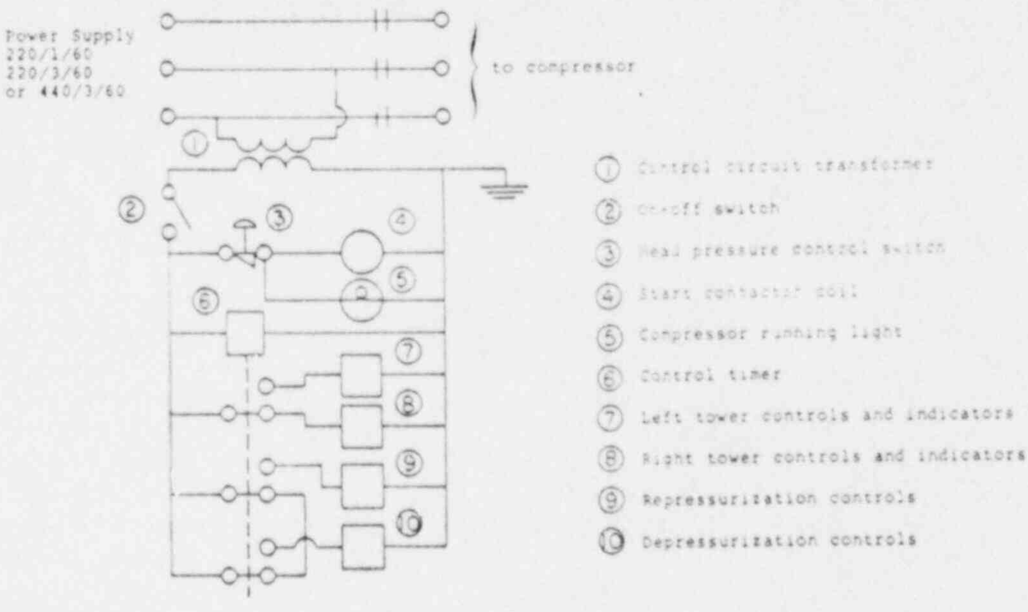
It is advisable to install the dryer with a bypass valving arrangement (see Figure 1) to allow maintenance of the dryer without interruption of air flow. All air lines must be adequately supported so that no load is applied to the dryer connections.

UTILITIES

Electrical

The normal operating voltage is 440/3/60 unless otherwise specified. Check the specification sheet at the front of this manual for the actual voltage and current ratings for your dryer.

A generalized electrical schematic is given in Figure 2. The wiring of all transformers, relays, controls and functional components has been completed at the factory in accordance with the electrical schematic supplied with this manual.



Electrical Schematic Diagram

Figure 2

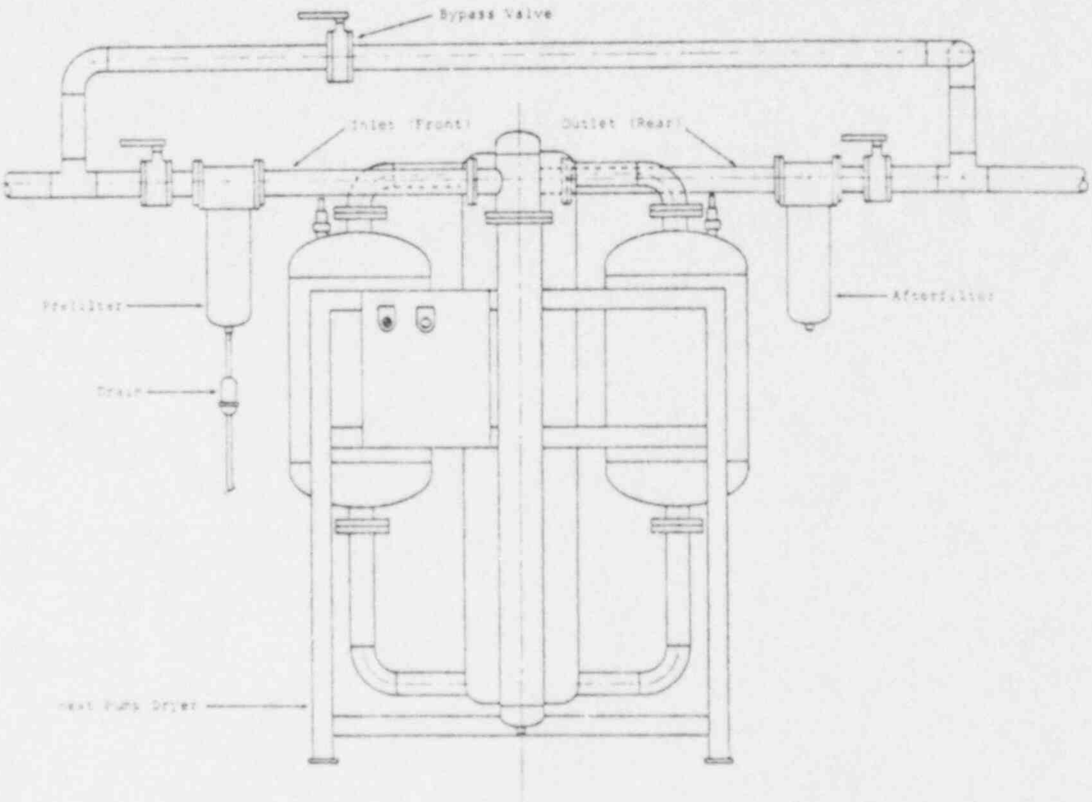
The dryers are constructed to NEMA 1 standards unless otherwise specified. Make power connections according to the electrical schematic supplied with this manual.

NOTE

GROUNDING OF THE FRAME IS REQUIRED.

Prefilter

All desiccants are adversely affected by oil or oil aerosols. If the compressed air is supplied by a lubricated compressor, adequate filtration of the inlet air is imperative. Standard Deltech prefilters are designed specifically for this function. In systems which rely on non-lubricated compressors, prefilters are recommended to remove foreign particles, rust, dirt, scale and water. The prefilter must be equipped with an automatic drain trap to discharge accumulated liquids separated from the inlet air stream.



Heat Pump Arrangement

Figure 1

Afterfilter

Deltech Heat Pump Dryers are designed for air velocities well below the fluidization point of the desiccant. However, it is good practice to install an afterfilter to prevent the carryover of desiccant fragments during line surges or unusual operating conditions. A standard Deltech afterfilter is available to protect downstream equipment from desiccant particles.

DRAFT

Potential Cause

Valve line-up of instrument air header system.

Discussion

Had an improper valve line-up in the instrument air header system occurred, numerous other air users throughout the plant would have been affected. Below are listed valves and the possible consequences had they been advertently closed.

1) 1P52-F640 (manual drywell isolation) Improper line-up of this valve would have prevented repeated actuation of B21-F022A, B, C, and D. This valve would also isolate the MSR valves as well as the personnel air lock at 599'-0" Elevation.
2) 1P52-MCV-F646 (drywell isolation) Had this valve closed, it would have been indicated by status lights on both H13-P601 and H13-P870 panels in the control room. ERIS points EC-007 and 008 would have also indicated closed.
3) 1P52-MCV-F200 (containment isolation) (A) Had this valve been closed the entire air supply into containment would have been isolated which in turn would have affected instrument air supply to all the air users off of the air distribution manifolds P52-J600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, and 612. (B) Also had this valve been closed it would have been indicated by status lights on both the H13-P601 and H13-P870 panels in the control room.
4) Manual valves P52-F554 and F605 - Had these valves been closed they would have isolated a large number of the air users throughout the containment.

With all of the discussion above the fact remains that the valves did operate as observed. This would not have been the cause since the valves would not have repeatedly functioned.

Conclusion

Unlikely to be occurring.

DRAFT

Potential Cause

Air pack wiring and termination failure resulting in a hot short.

Discussion

The air pack units are self contained for each solenoid and wired to a common junction box. This wiring and associated hardware is provided by the manufacturer. The field wiring is terminated at the respective solenoid valve junction boxes. Refer to drawings D-209-013 Sheets 2 through 9 for each of the MSIV assemblies.

Per review of the interconnection wiring diagrams and corresponding elementary schematics, the wiring and termination information is correct.

The control schematic for operation of the respective solenoids is "fail safe" by design basis, which requires the solenoid coil to be energized to prevent an isolation. De-energization would result in closure of the valve.

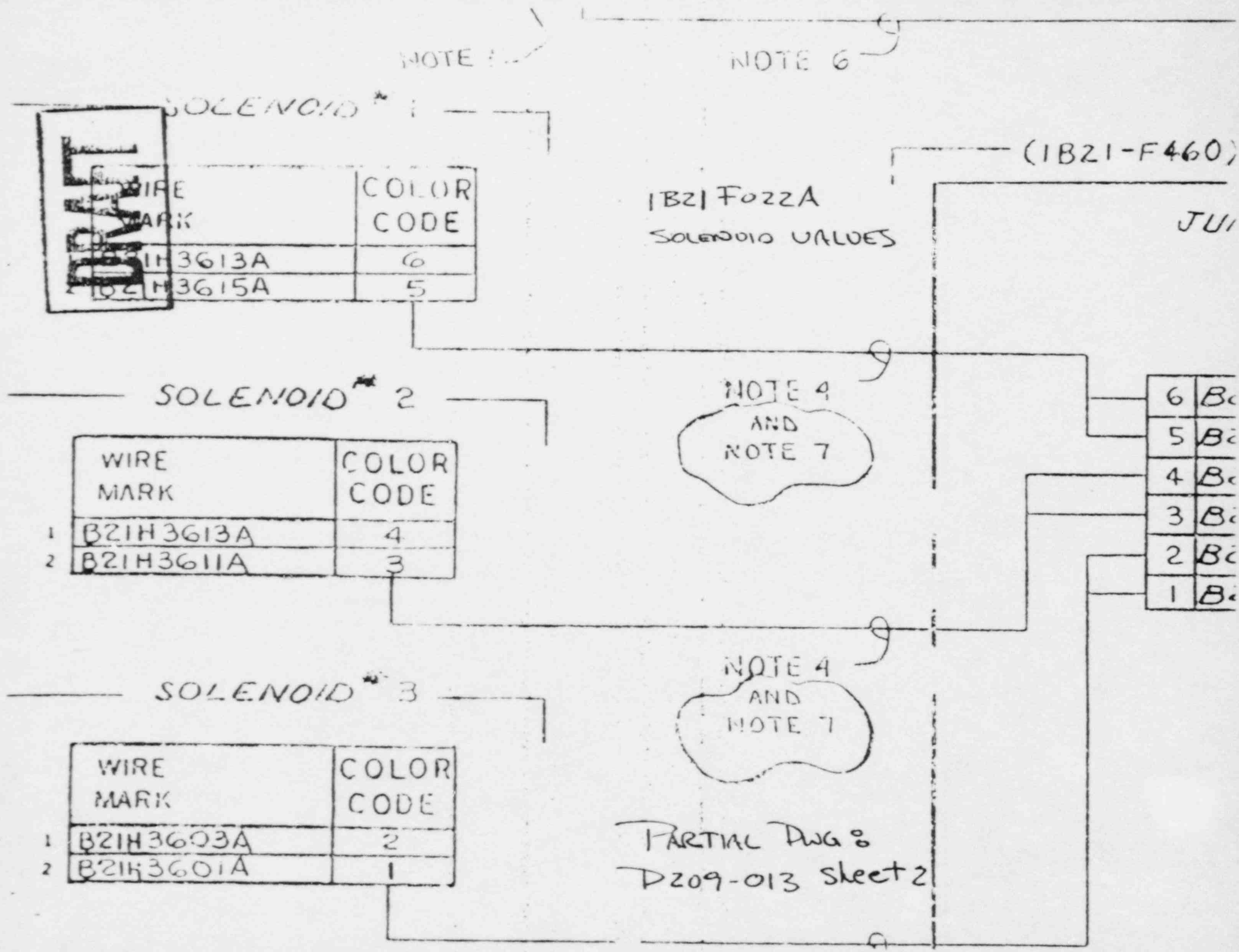
The wiring to each valve is classified as Class 1E. Although the 120VAC power to each of the A & B pilot solenoid valves pairs if continued in a common cable, each conductor is properly sized and meets the separation requirements. The cables are rated for 600 volt insulation, besides having minimum current draw. Therefore, the potential for a hot short is improbable.

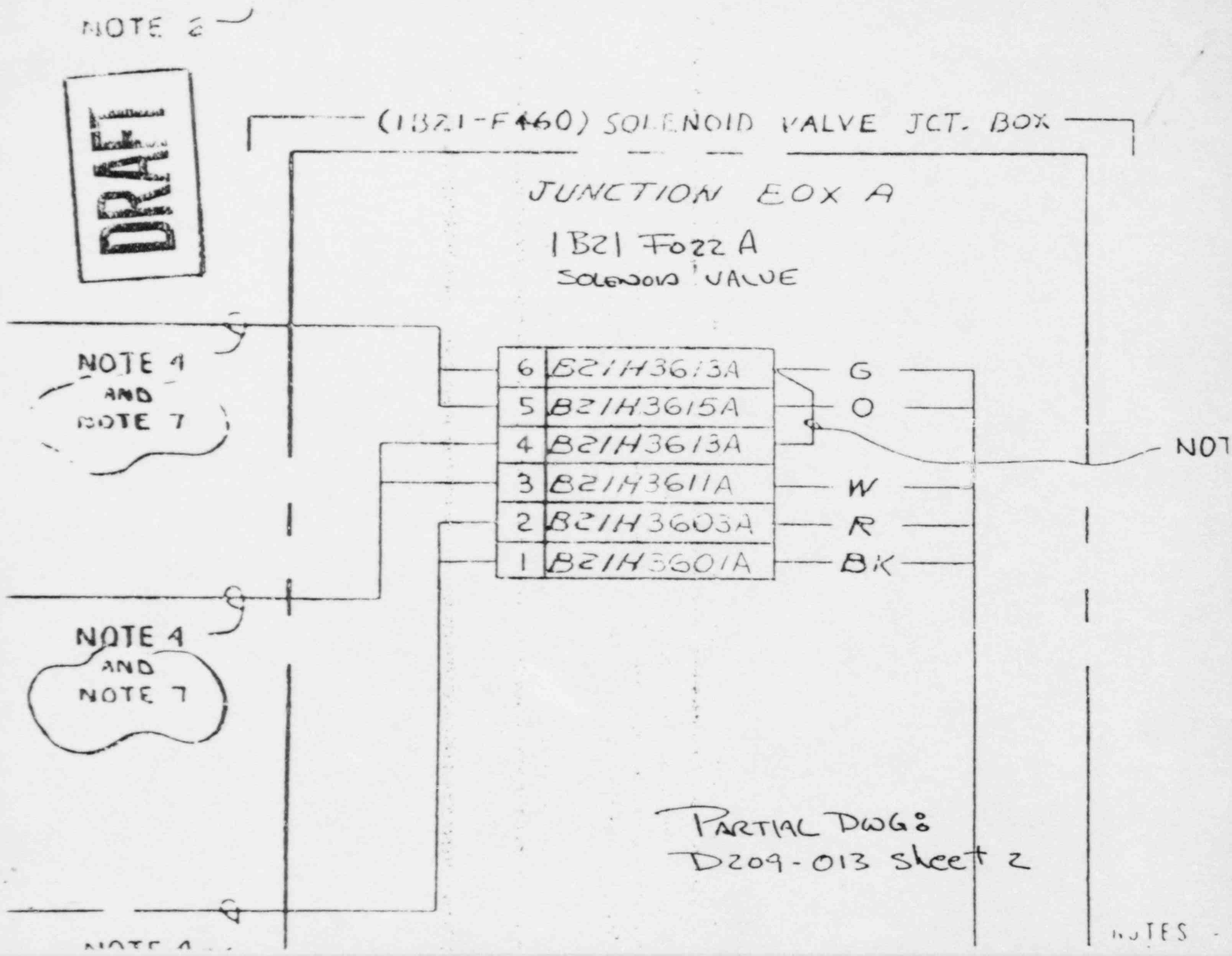
References

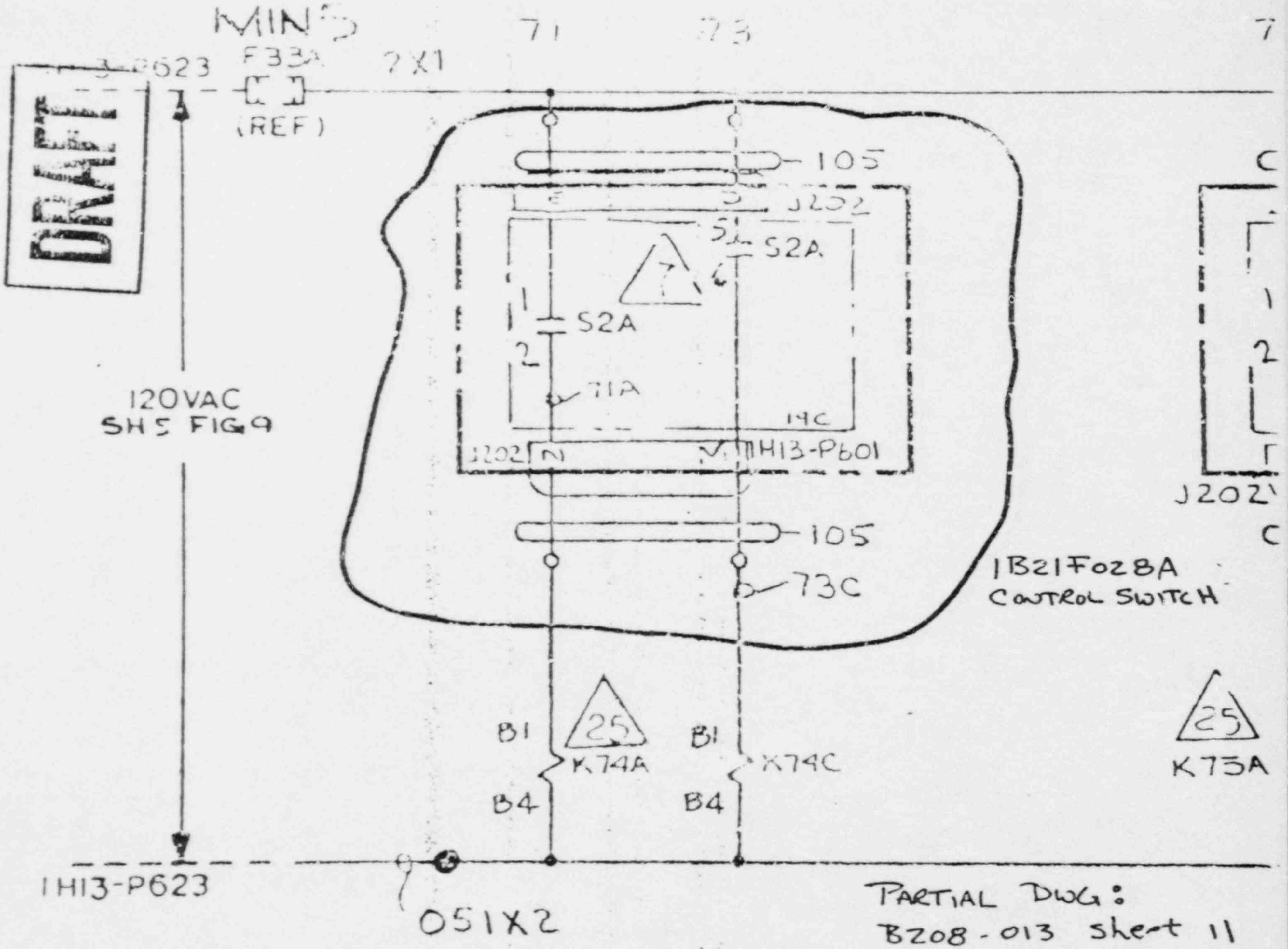
D-209-013 Sheets 2 through 9.

Conclusion

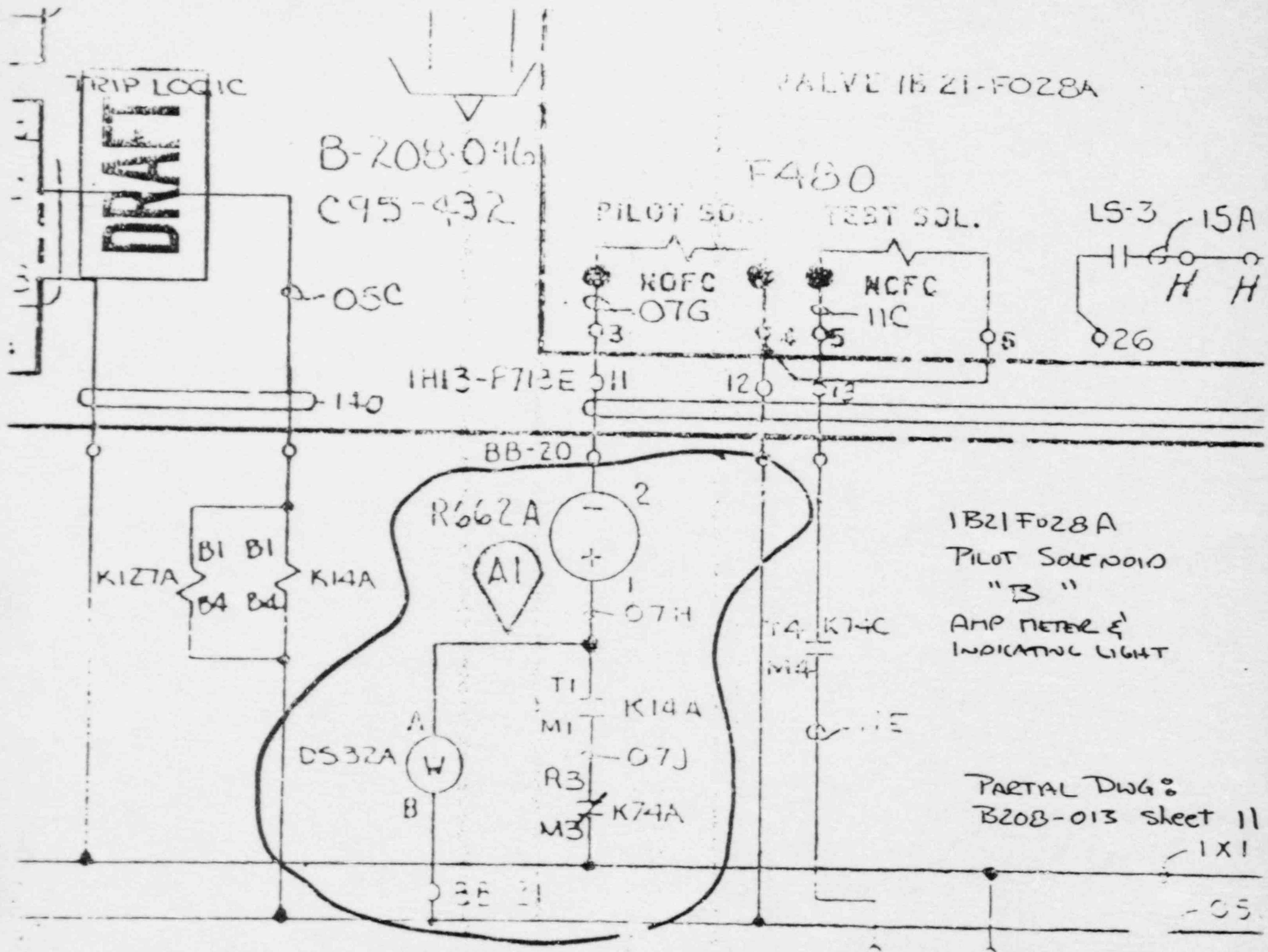
Unlikely that wiring or hot short is a potential cause.

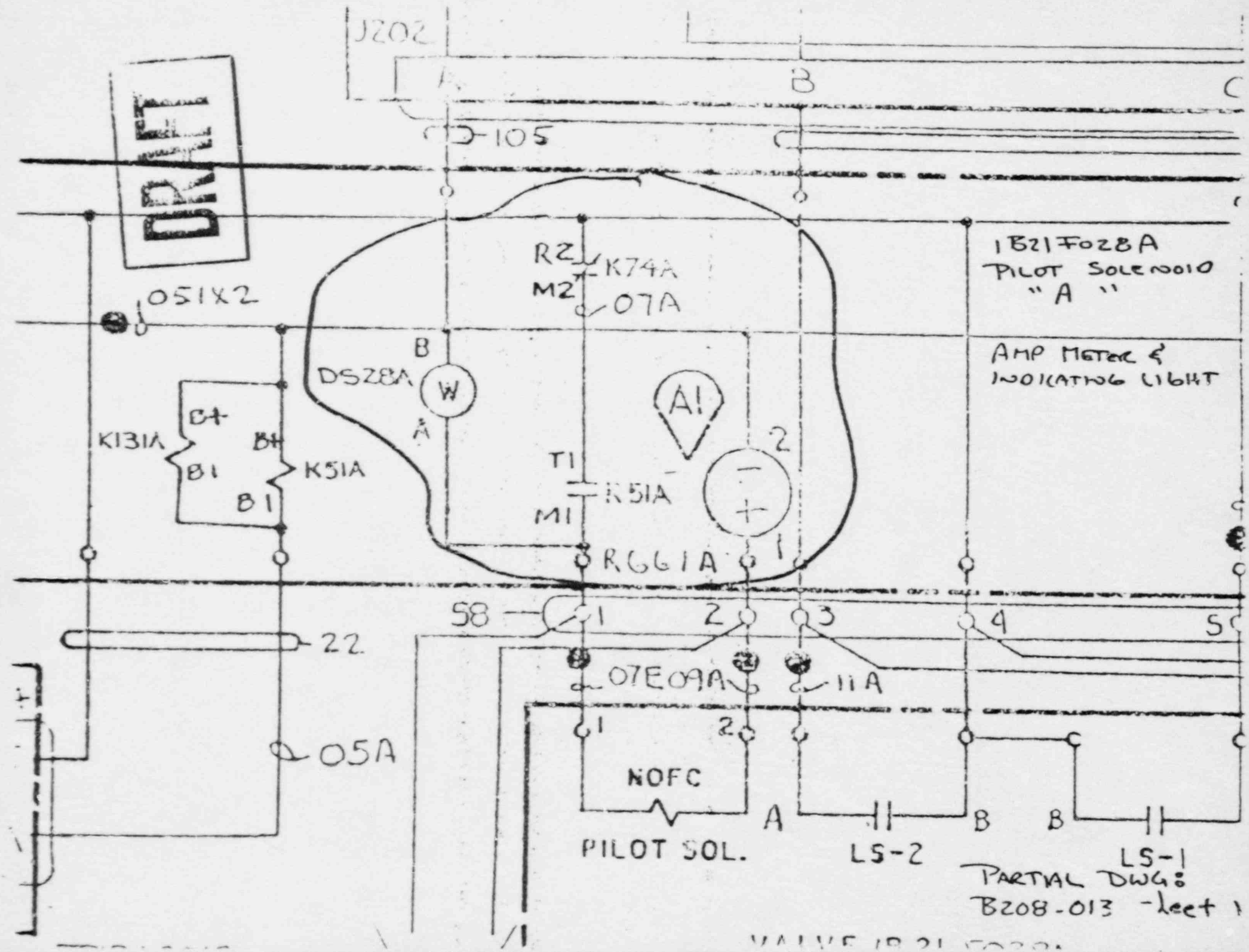

NOTE 6
SOLENOID * 1
WIRE MARK
COLOR CODE
3613A
6
3615A
5
(1B21-F460)
1B21 F022A
SOLENOID VALVES
SOLENOID * 2
WIRE MARK
COLOR CODE
1 B21H3613A
4
2 B21H3611A
3
NOTE 4 AND NOTE 7
SOLENOID * 3
WIRE MARK
COLOR CODE
1 B21H3603A
2
2 B21H3601A
1
NOTE 4 AND NOTE 7
PARTIAL DWG:
D209-013 Sheet 2
6
5
4
3
2
1


NOTE 2
DRAFT
(1B21-F460) SOLENOID VALVE JCT. BOX
JUNCTION BOX A
1B21 F022 A
SOLENOID VALVE
NOTE 4
AND
NOTE 7
6 B21H3613A
5 B21H3615A
4 B21H3613A
3 B21H3611A
2 B21H3603A
1 B21H3601A
G
O
W
R
BK
NOT
NOTE 4
AND
NOTE 7
PARTIAL DWG:
D209-013 sheet 2
NOTES

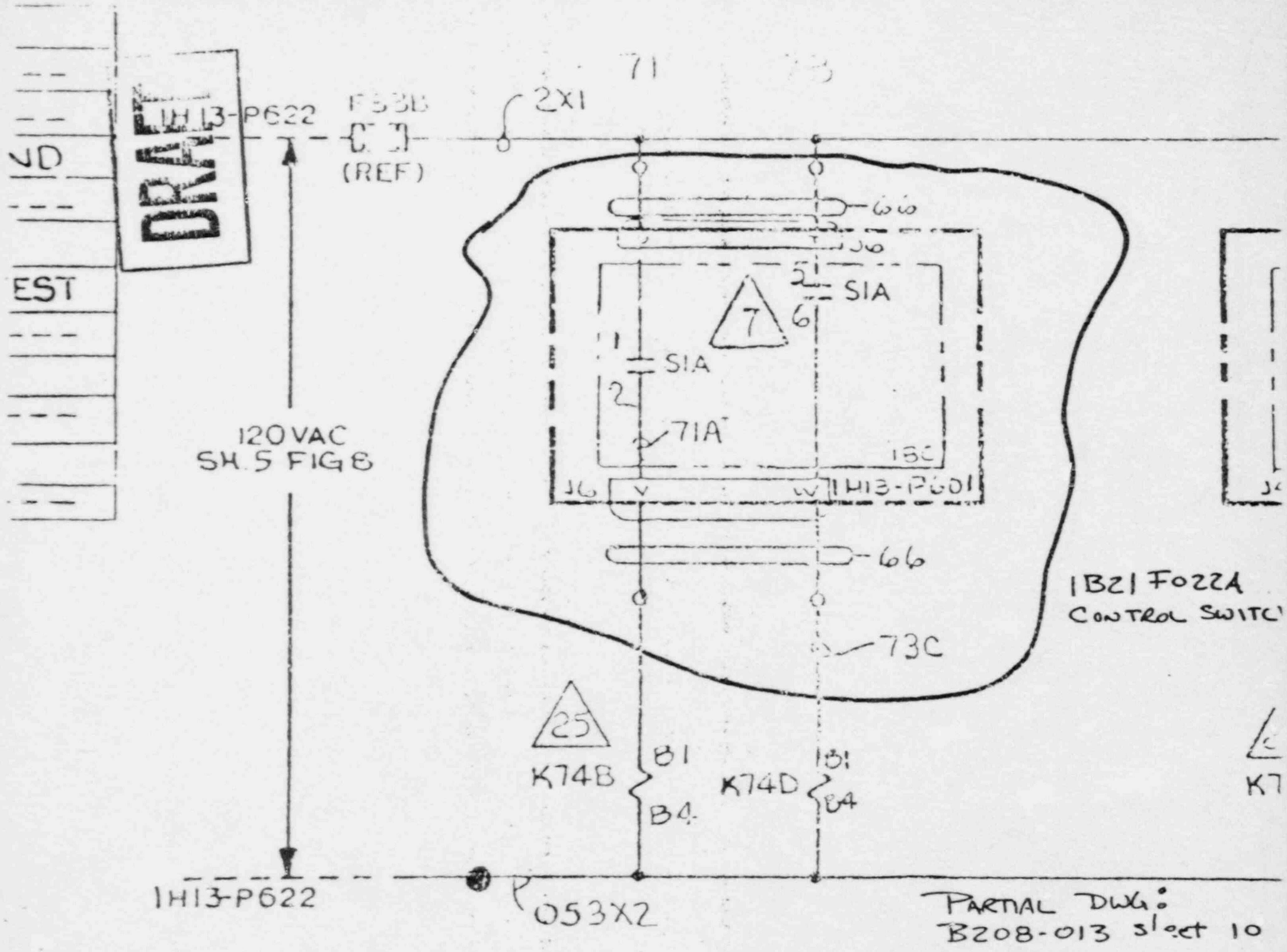


PARTIAL DWG:
B208-013 sheet 11

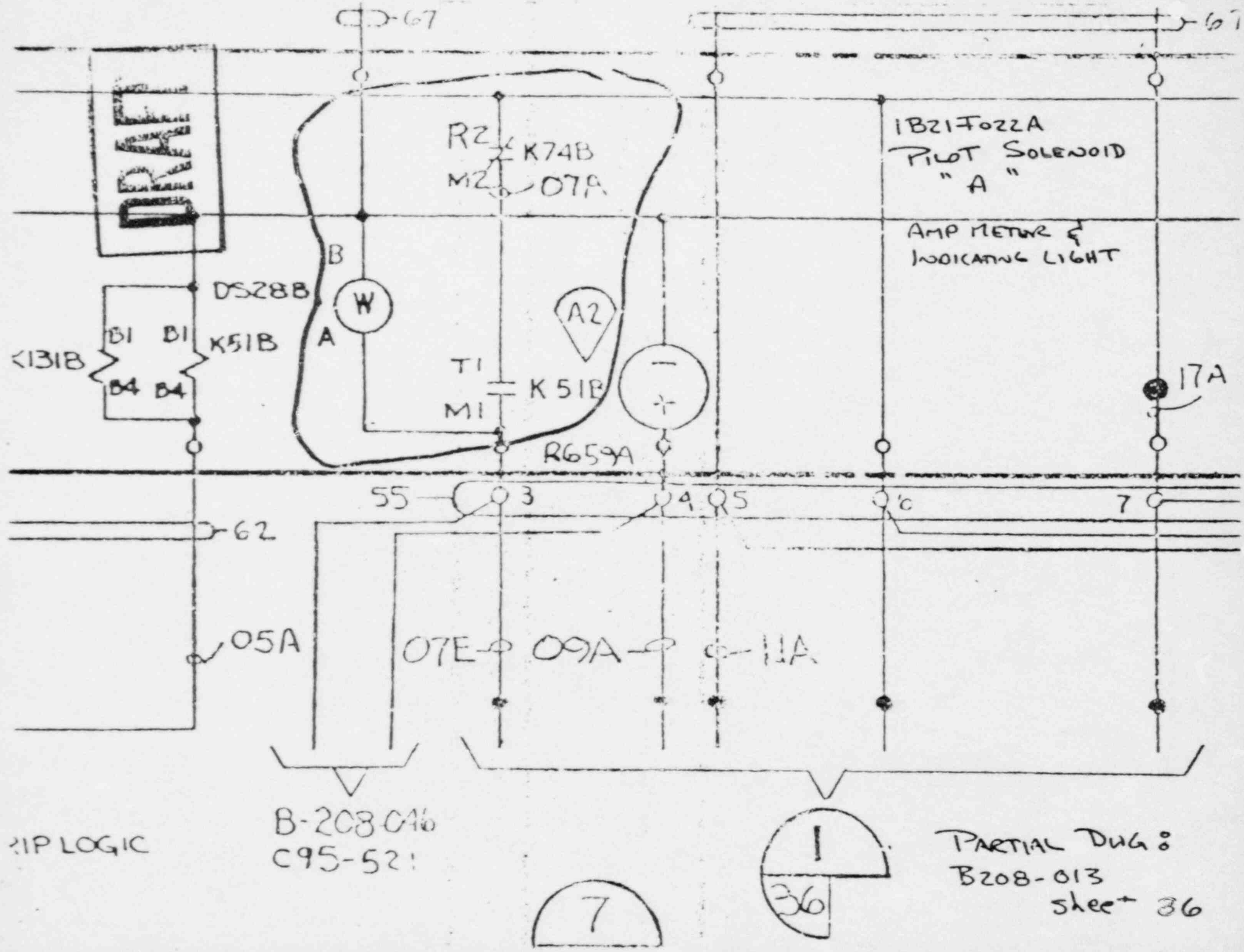

TRIP LOGIC
DRAFT
B-208-046
C95-432
VALVE 1B21-F028A
F480
PILOT SOL.
TEST SOL.
NOFC
07G
NCFC
11C
LS-3
15A
H
H
26
1H13-F718E
140
05C
BB-20
R662A
A1
K127A
K14A
B1
B4
07H
T4
K74C
M4
T1
M1
K14A
07J
R3
K74A
M3
DS32A
A
B
1B21F028A
PILOT SOLENOID
"B"
AMP METER &
INDICATING LIGHT
PARTIAL DWG:
B208-013 Sheet 11
1X1
05



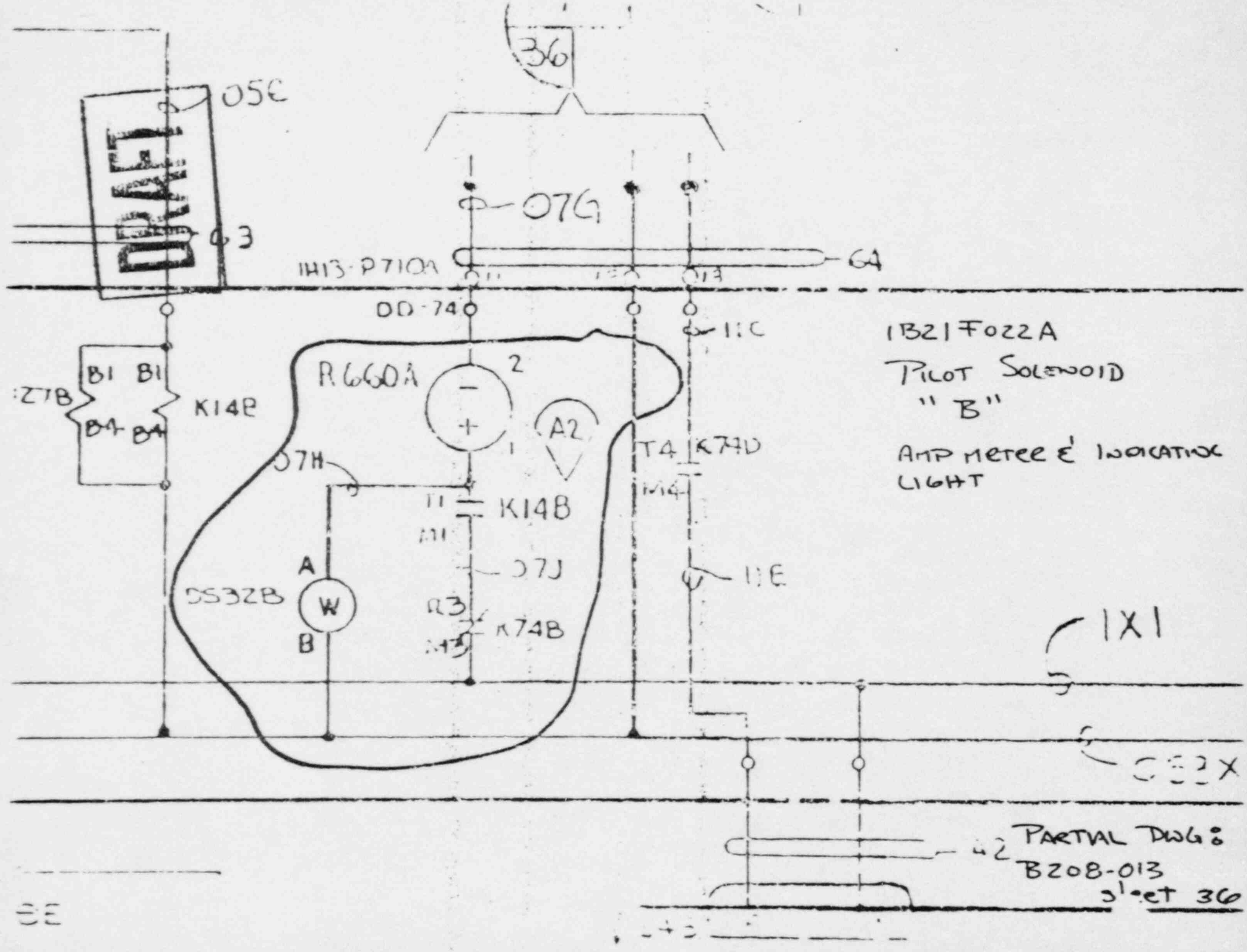
DRAFT
J202
A
B
C
105
051X2
B
DS28A
W
A
K131A
B+
B1
K51A
R2
K74A
M2
07A
A!
T1
K51A
M1
2
1
RGG1A
1B21F028A
PILOT SOLENOID
"A"
AMP METER &
INDICATING LIGHT
58
1
2
3
4
5
22
07E09A
11A
05A
NOFC
PILOT SOL.
A
LS-2
B
B
LS-1
PARTIAL DWG:
B208-013 -leet 1



DRAFT
1H13-P622
F33B
(REF)
2X1
71
ND
EST
120VAC
SH.5 FIG 8
66
SIA
5
6
7
1
2
71A
1BC
J6
1H13-P601
73C
1B21 F022A
CONTROL SWITC
25
K74B
B1
B4
K74D
053X2
PARTIAL DWG:
B208-013 sheet 10



DRAFT
67
R2
K74B
M2
07A
1B21-F022A
PILOT SOLENOID
"A"
AMP METER &
INDICATING LIGHT
B
DS28B
W
A2
A
B1
B1
K131B
K51B
B4
B4
T1
K51B
M1
17A
R659A
55
3
4
5
6
7
62
05A
07E
09A
11A
B-208-016
C95-521
RIP LOGIC
1
36
7
PARTIAL DWG:
B208-013
sheet 36


36
05C
DRAFT
63
07G
1H13-P710A
64
DD-74
11C
1B21F022A
PILOT SOLENOID
"B"
AMP METER & INDICATION LIGHT
R660A
2
B1 B1
27B
K14B
B4 B4
A2
T4 K74D
07H
K14B
07J
11E
A
DS32B
W
B
R3
K74B
1X1
PARTIAL DWG:
B208-013
SHEET 36

DRAFT

Potential Cause

Glazed contacts on control and relay components creating a high resistance which would result in discontinuity and potential mis-operation of the MSIV circuitry.

Discussion

Contact integrity and circuit continuity of the respective solenoid valve coils is constantly monitored by measuring the coil circuit current, in addition to an indicating light (white) which relies on actuating contact integrity to remain energized. Refer to attached partial of drawing B-209-013, Sheet 10 and Sheet 11.

The isolation control circuit(s) are a "fail safe" design, which requires the solenoid coil to be energized to prevent an isolation. If contact glazing had occurred resulting in a discontinuity (high resistance at connection or contact points) in the control circuit(s), the resulting effects would cause the lack of voltage to the coil(s). This condition due to the "fail safe" design basis, would cause an undesirable isolation (closure of the MSIV valves), rather than a failure to isolate.

References

D-208, Sheets H05, H10, H11 and H36.

Conclusion

Evidence of repetitive tasks to cycle these valves along with the proper configuration for power and control indication does not suggest any potential failure. Also, the control circuitry and electrical components for each of the inboard and outboard MSIVs is identical. In that there is no past or present evidence to support this cause scenario, it is highly unlikely that this is the root cause of the problem.

DRAFT

Potential Cause

Relay failure or incorrect operation resulting in mis-operation of the MSIV valves.

Discussion

The associated control and relay components are located in the PGCC which is designated as a non-harsh environment and is also seismically designed. Furthermore this area is controlled for relative humidity and temperature. The likelihood of a failure or incorrect operation due to component failure is highly impractical in that this failure would have to occur on three (3) different MSIV logic/control circuits. The proper operation and closure of these valves and repetitive testing positively indicates that relay failure is not the cause. Also, as shown through testing and verification the control functions and indication was correct.

Conclusion

Unlikely and highly impractical that relay failure is a potential cause.

DRAFT

Potential Cause

Panel control switch failure or mis-operation.

Discussion

The control switches nos. S1A-D and S2A-D are General Electric type CR2940, 3 position maintained contact. All of which are located in the PGCC. The control schematics as shown per drawing B-208-013 Sheet 10 (inboard) and B-208-013 Sheet 11 (outboard) are identical. No test data or evidence has been identified to suggest a failure of the switches. Repetitive testing has demonstrated the proper operation of each of these control switches.

References

B-208-013 Sheet H04, H10, and H11.

Conclusion

Evidence of repeated acceptable testing to cycle these valves does not suggest any potential failure. As such it is highly unlikely that this is a potential root cause of the problem.

DRAFT

Potential Cause

Limit switch settings incorrect or inoperable.

Discussion

The limit switches (total of 6 each) for each of the MSIV inboard and outboard valves are NAMCO type as furnished by Atwood & Morrill Company. These limit switches are not an active component in the control scheme which initiates opening or closure of the respective MSIV valves, rather they monitor and provide local indication in the control room for valve position. Refer to elementary drawings B-208-013 Sheets H10, H11, and H36.

The potential for inaccurate limit switch settings is possible, but other independent sources can verify and provide indication for closure or opening of the valves via instantaneous steam flow and steam line pressure. Again this issue would not impact the actual operation of the valves.

References

B-208-013 Sheets H10, H11, and H36.

Conclusion

In that the limit switches are not part of the control circuits, mis-operation would not affect valve closure.

DRAFT

Potential Cause

Mis-wiring for indication of instrumentation or switches

Discussion

This potential cause was recently a problem wherein the "A" and "B" solenoid valves were wired to a common Reactor Protection System (RPS) bus. The basis of the design requires that each of the trip solenoids A and B for each of the MSIVs be wired to different RPS buses. This issue was corrected via the preparation and issue of Design Change Package (DCP) 870414. As part of this design package and a prerequisite for start-up, each of the MSIVs were verified and tested for applicable power sources and functional operations. The probability of additional wiring errors is highly unlikely in that repetitive testing of these valves did not indicate mis-operation.

References

B-208-013 Sheets H05, H10, H11, and H36.

Conclusion

Although this item was a problem previously, it is highly unlikely that a similar type of problem could be the root cause. The efforts to resolve this RPS problem, retesting and management exposure significantly rule out this potential cause. Also, recent testing of the specific valves in question indicate that the instrumentation and switches are correct.

DRAFT

Potential Cause

Data acquisition failure.

Discussion

Failure in the data acquisition and recording system could lead to improper assumptions on closing speed being drawn.

Valve speed data is taken and recorded using the TRA subsystem of ERIS. This system has the capability to sample data from a wide variety of signals for later analysis. Data on reactor power, steam flow, reactor pressure, limit switch position, and solenoid current are all consistent. Measurements exterior to ERIS, main control panel and back panel indicating lights, for example, are also consistent with the ERIS data. In summary, multiple concurrent failures necessary for this scenario to occur make it incredible.

Conclusion

Highly unlikely to be occurring.

DRAFT

Potential Cause

Procedural error for testing. Most previous fast speed MSIV closures have been performed using SVI B21-T2001. The first failure was noted while performing the test per STI-B21-025A section 8.3 and the remaining failures were noted while performing the MSIV strokes using the system operating instruction (S.O.I.)

Discussion

Although most previous tests have been performed using the SVI, this is not the first time that an STI has been performed. As early as 10/12/86 an STI-B21-025A section 8.1 was used to fast stroke the valves. Additionally, the use of the SOI has been demonstrated before and after the failures. During the B21-F022D, B21-F028B, and B21-F022D failure on 10/29/87 and the B21-F022D and B21-F028D failure on 11/3/87 the SOI was used, however this is the same SOI that was used for the remaining valves which passed their stroke time.

Conclusion

It is highly unlikely that there is a procedure problem

DRAFT

Potential Cause

High Steam Flow/High Reactor Power Interaction. All previous low and high speed MSIV closure tests have been performed at low to medium reactor power. The potential exists that the higher steam flows associated with high reactor power could interfere with MSIV closure.

Discussion

Although all previous tests have been run at low power, the valve design basis is closure at full flow, and the capability of the valve to close under full power conditions has been demonstrated numerous times at numerous operating BWRs. The valves that showed delayed closure are identical in design to valves that closed within specifications, and the affected valves closed successfully following cycling. The valve design is such that pressure drop associated with steam flow will actually assist in closing the valve.

Conclusion

It is highly unlikely that this is the cause of the problem

DRAFT

Potential Cause

Incorrect reassembly and installation of ~~the air pack.~~ The air packs were all removed, however not disassembled, during the September 22, 1987 forced MSIV outage. The purpose for removing all of the air packs was to allow for temporary air supply to be installed and allow local stroking of the MSIV to check stroke measurements.

Discussion

During the September 1987 outage all air packs were removed from the MSIVs to facilitate local stroking of each valve to set the stroke length. After final reinstallation of the air packs there were several fast and slow strokes performed. These strokes were performed using SVI C71-T0039 and SVI B21-T2001. Even though SVI C71-T0039 (slow stroke testing) does not test the same valves as SVI B21T2001 (fast stroke testing) the same air pack is used and the mating surface between the air pack and actuator remains the same as does all hose connections.

Conclusion

It is highly unlikely that this is the problem due to the number of strokes performed after reassembly.

DRAFT

Potential Cause

Actuator binding/stem binding

Discussion

Binding of the actuator internals for both the hydraulic and pneumatic assemblies is highly unlikely. Neither assembly is subject to external loads to cause stem bending. The hydraulics are not subject to external particulate contamination and contamination within the main air cylinder may score the cylinder but could not likely stop the movement by resisting the air pressure force.

Conclusion

This cause would likely have shown up during prior history of stroking the valves and would not likely apply to multiple valves at one time. Nor would such binding likely apply to the top of stroke only. Thus this cause is estimated to be highly improbable.

DRAFT

SECTION 4

FAILURE ROOT CAUSE DESCRIPTIONS

DRAFT

Potential Cause:

High Temperature

Discussion:

Localized high temperature conditions existed during the plant cycle due to reported steam leakage and elevated area temperature indications. Steam leakage is known to have occurred in MSIV 1B21-F022B packing and the MSIV leakage control system isolation valves. This leakage was in the direct vicinity of the MSIV's affected by slow closure. Steam in excess of 300 degrees F is suspected of being directed toward the subject MSIV air packs.

The observed hardened dimples on the disc holder assembly and core assembly hardened elastomer seals in the dual solenoid valves is consistent with high temperature conditions. Other evidence of steam conditions include degradation of the solenoid valve O-rings and observed rust/moisture discoloration of the 1B21-F022D solenoid coil, implying a steam environment.

Conclusion:

The high temperature is considered to be highly probable in the vicinity of the 1B21-F022D, 1B21-F028B, and 1B21-F028D MSIVs.

DRAFT

Potential Cause

Blockage of the dual solenoid valve exhaust port with tape.

Discussion

During the previous MSIV refurbishment where the air packs were removed, duct tape was used to cover exposed ports including the solenoid valve exhaust port. On F028D the exhaust port tape had apparently not been removed following the refurbishment. Blockage of the solenoid valve exhaust port could delay the closure of the MSIV.

However, the strength of the tape adhesive is considered weak compared to the pneumatic pressure forces. Typically the tape will blow outward remaining connected on one side during de-energization and fall back in place like a flap. Further tests of the F028D valve has verified the tape is not an effective block.

Conclusion

Very unlikely to be occurring.

DRAFT

Potential Cause

Jamming of kinematic components.

Discussion

In order for the valve to shift to the de-energized condition, both solenoid movable cores must slide within their guides. The disc holder assembly is also a guided component which must shift for the valve to operate.

Failure of the components to shift may be caused by foreign material contamination of the sliding surfaces, either particulate or fluid (adhesive in nature), or by physical damage to the valve parts.

Examination of the F022D valve, and the air supply system has not identified any unusual substances or damage which could explain the MSIV delayed closure condition. Considering the proportion of valves which demonstrated the delayed closure (3 of 8), an extremely dirty system would be expected for this effect.

Conclusion

Unlikely to be occurring.

DRAFT

Potential Cause

Oxidation of EPDM rubber compound used in gaskets, seals and disc seal materials.

Discussion

Oxidation of EPDM rubber in the presence of a brass catalyst has been suggested as cause for a similar incident at Brunswick-2. This has been documented in IE Bulletins 85-17 and 80-11, and in INPO Significant Event Report 57-85. Review of SER 57-85 indicates that although catalytic oxidation is a potential cause for the Brunswick situation, that utility was never able to determine the exact cause for EPDM degradation. There is, however, a relatively large data base for use of EPDM elastomer in brass valve bodies with acceptable results.

Conclusion

Catalytic oxidation of EPDM in the presence of brass cannot be completely ruled out as the root cause for pilot valve failure. While postulated as a failure mechanism, its validity has not been proven. If catalytic oxidation does play a part, it is most likely as a contributing factor, in the high temperature scenario, for example.

DRAFT

Potential Cause

Residual magnetism following coil de-energization

Discussion

Sufficient residual magnetism of the ferritic steel materials in the region of the coil could cause the valve to remain open following de-energization.

The probability of this is considered low. The valve does not show repeatable effects which would be expected from residual magnetism.

Also, while theoretically possible, no similar experience has been found elsewhere. Any residual magnetic forces would be low compared to the closure force unless additional magnetic mass was added to the coil vicinity.

Conclusion

Unlikely to be occurring.

DRAFT

Potential Cause

Wrong materials.

Discussion

This failure root cause description considers the use of wrong materials for the disc holder elastomer seal. The potential for wrong lubricant is considered separately.

Dimpling of the disc holder seal in the dual solenoid valve is postulated to result in wedging of the seal in the exhaust to cylinder ports. The use of a wrong material could result in the observed dimpling. The proper disc material is an ASCO proprietary EPDM, utilized in their nuclear qualified valves. Material problems may include the following:

- Wrong material of lower strength or thermal capability.

- Improperly cured EPDM.

- Improperly formulated EPDM.

An analysis of the disc material may be performed to identify the material or formulation; however, it is unlikely to determine the relative cure of the compound.

Conclusion

Moderate potential.

DRAFT

Potential Cause

LOCA seal vapors

Discussion

In order to seal the solenoid housings on the solenoid valves a LOCA seal is poured in the opening and allowed to cure. The cure reaction reportedly produces hydrogen gas Hydrogen is a reducing agent which might result in softening of some elastomer materials under certain conditions. Hydrogen's effect on EPDM is probably unlikely due to its hydrocarbon (Ethylene Propylene) structure.

Additionally, hydrogen being very light would tend to rise from its point of application, which is several inches away from the valve body.

Conclusion

Unlikely to be occurring.

DRAFT

Potential Cause

O-ring/lubricant interaction

Discussion

During the disassembly and inspection of the ASCO dual solenoid valves, the three body gaskets (o-rings) were found to be significantly degraded. Degradation included hardening, flattening and adherence to the mating valve body.

The observed condition of the gaskets is consistent with the effects of an improper lubricant. The EPDM gaskets are susceptible to hydrocarbon oils. Normally a silicone oil (Dow Corning 550) is used as a gasket lubricant. EPDM is compatible with silicone fluids.

The degradation of the gaskets could not affect the valve itself, as they are located away from the moving components. However, vapors from the lubricant (no signs of fluid migration were observed) could result in softening of the disc pads resulting in the dimple effect suspected as being the physical cause of sticking.

Other potential causes of the observed gasket degradation are high heat conditions, wrong o-ring material (silicone rubber is affected similarly by silicone fluids) and brass/EPDM interaction.

Conclusion

Possible. The o-rings should be investigated for proper material and lubricant.

INSTALLATION & MAINTENANCE INSTRUCTIONS

ASCO.
BULLETIN
8003

GENERAL PURPOSE AND EXPLOSION-PROOF SOLENOIDS

Form No. V5380R5

DESCRIPTION

Catalog numbers 80031 and 80032 solenoids have a Type 1, General Purpose Solenoid Enclosure. Catalog numbers 80033 and 80034, 8003A3, and 8003A4 solenoids have an explosion-proof solenoid enclosure designed to meet Enclosure Type 3-Raintight, Type 7 (C & D) Explosion-Proof Class I, Groups C & D and Type 9 (E,F & G)-Dust Ignition-Proof Class II, Groups E,F & G, and have a temperature range code of TC3. Bulletin 8003 and 8003A solenoids when installed as a solenoid and not as part of an ASCO valve, are supplied with a core which has a 0.250-28-UNF-2B tapped hole with 3/8" or 5/8" minimum full thread.

OPERATION

When the solenoid is energized, the core is drawn into the solenoid base sub-assembly. **IMPORTANT: When the solenoid is de-energized, the initial return force for the core, whether developed by spring, pressure, or weight, must exert a minimum force to overcome residual magnetism created by the solenoid. Minimum return force for AC construction is 1 pound 5 ounces and 5 ounces for DC construction.**

INSTALLATION

Check nameplate for correct catalog number, voltage, frequency, wattage, and service.

IMPORTANT: To protect a solenoid operator or valve, install a strainer or filter, suitable for the service involved in the inlet side as close to the valve or operator as possible. Clean periodically depending on service conditions. See ASCO Bulletins 8600, 8601 and 8602 for strainers.

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the solenoid base sub-assembly area.

Wiring

Wiring must comply with local codes and the National Electrical Code. The general purpose solenoid housing has a 7/8" diameter hole to accommodate 1/2" conduit. To facilitate wiring the general purpose solenoid enclosure may be rotated 360° by removing the retaining cap or clip. **WARNING: When metal retaining clip disengages, it will spring upward.** Rotate solenoid enclosure to desired position. Then replace retaining cap or clip before operating. Use rigid metallic conduit to ground all enclosures not provided with a green grounding wire. For the explosion-proof solenoid enclosure, electrical fittings must be approved for use in hazardous locations. The explosion-proof solenoid enclosure has a 1/2" conduit connection and may be rotated 360° to facilitate wiring. To rotate enclosure, loosen housing cover using a 1" socket wrench. Two wrenching flats are provided on the housing to hold it securely in place while the cover is being loosened or tightened. Rotate housing to desired position and replace cover before operating. Torque cover to 135 ± 15 inch-pounds (15,3 ± 1,7 newton-meters).

NOTE: Alternating current (AC) and direct current (DC) solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid including the core and solenoid base sub-assembly, not just the coil. Consult ASCO.

Solenoid Enclosure Assembly

Catalog 80031, 80032 solenoids may be assembled as a complete unit. Tightening is accomplished by means of a hex flange at the base of the solenoid enclosure.

Catalog 80033, 80034, 8003A3, and 8003A4 solenoids may be assembled as a complete unit. Tightening is accomplished by means of two milled slots (wrenching flats) above the threaded area of the solenoid base sub-assembly. Use special ASCO wrench supplied (order No K168-146-1). An alternate type wrench adapter is also available which tightens the assembly by means of four (4) pin holes in the solenoid base sub-assembly. If this alternate wrench is used the solenoid must be completely disassembled, see "Coil Replacement".

Solenoid Temperature

Standard solenoids are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched by hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burning coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize solenoid operator and/or valve before making repairs.

Cleaning

All solenoid operators and valves should be cleaned periodically. The time between cleaning will vary depending on medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise, or leakage will indicate that cleaning is required. Clean strainer or filter when cleaning the valve.

Preventive Maintenance

1. Keep the medium flowing through the solenoid operator or valve as free from dirt and foreign material as possible.
2. While in service, the solenoid operator or valve should be operated at least once a month to insure proper opening and closing.
3. Depending on the medium and service conditions, periodic inspection of internal solenoid or valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

Causes Of Improper Operation

1. Faulty Control Circuit: Check the electrical system by energizing the solenoid. A metallic "click" signifies that the solenoid is operating. Absence of the "click" indicates loss of power supply. Check for loose or blown fuses, open-circuited or grounded coil, broken lead wires or splice connections.
2. Burned-Out Coil: Check for open-circuited coil. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate.
3. Low Voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.

Coil Replacement

NOTE: Check nameplate for solenoid catalog number and proceed as follows:

WARNING: Turn off electrical power supply and disconnect coil lead wires.

Catalog Numbers 80031 and 80032 General Purpose Solenoid Enclosure. (Refer to Figure 1.)

1. Disconnect coil lead wires and grounding wire if present.
2. Remove retaining cap or clip, nameplate, and housing.
   WARNING: When metal retaining clip disengages, it will spring upward.
3. Slip spring washer, insulating washer, and coil off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
4. Coil is now accessible for replacement. Reassemble solenoid in reverse order of disassembly. Use exploded view (Figure 1.) for identification and placement of parts.

Catalog Numbers 80033 and 80034 Explosion-proof Solenoid Enclosure (Refer to Figure 2.)

1. Disconnect coil lead wires and grounding wire if present.
2. Unscrew housing cover using a 1" socket wrench. Two wrenching flats are provided on the housing to hold it securely in place while the cover is being removed or replaced.
3. Remove take up spring, flux plate, insulating washer, and coil. Insulating washers are omitted when a molded coil is used.

Printed in U.S.A.

ASCO Valves ASCO.

Automatic Switch Co. 50-60 Hanover Road, Florham Park, New Jersey 07932

13/79

ORDERING INFORMATION FOR ASCO SOLENOID ENCLOSURE KITS OR COILS

Parts marked with an asterisk (*) in the exploded view are supplied in solenoid enclosure kit.

- When Ordering ASCO Solenoid Enclosure Kits, Specify Catalog Number, Serial Number, Voltage and Frequency.
- When Order Coils for ASCO Solenoid Operators or Valves, order the number stamped on your coil

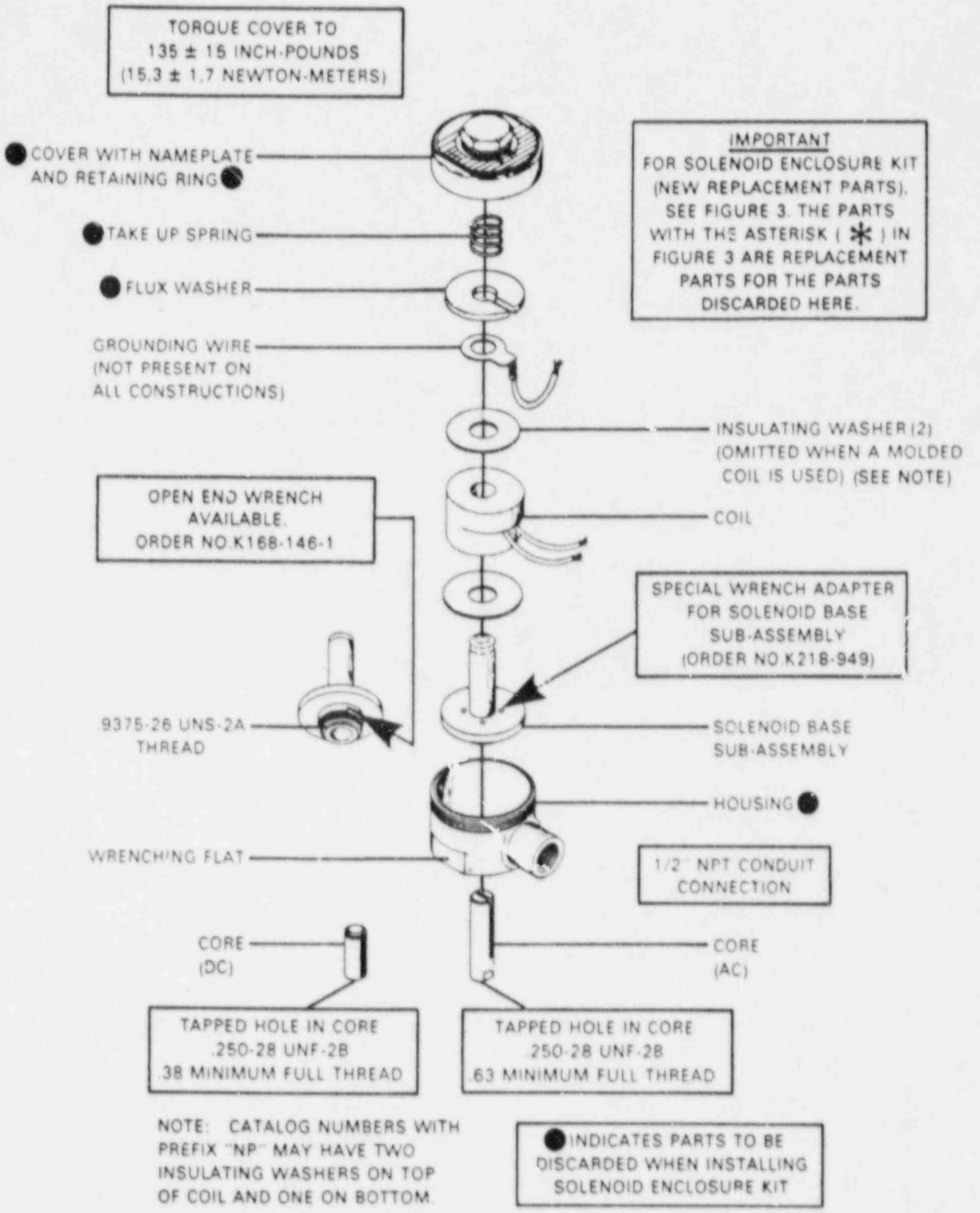


Figure 2. Catalog Nos.80033 and 80034
Explosion-Proof Solenoid Enclosure

Form No. V5380R5

4. Coil is now accessible for replacement. Reassemble solenoid in reverse order of disassembly. Use exploded view (Figure 2.) for identification and placement of parts. Before reassembly, see "NOTE" for cleaning and greasing requirements.

5. Torque housing cover to 135 ± 15 inch-pounds (15,3 ± 1,7 newton-meters).

Catalog Number 8003A3 and 8003A4 Explosion-Proof Solenoid Enclosure (Refer to Figure 3.)

1. Disconnect coil lead wires and grounding wire if present.
2. Unscrew housing cover using a 1" socket wrench. Two wrenching flats are provided on the housing to hold it securely in place while the cover is being removed or replaced.
3. Remove retaining cup from solenoid base sub-assembly.
4. Slip yoke, spring washer, insulating washer, and coil off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
5. Coil is now accessible for replacement. Before reassembly, refer to "NOTE" for greasing requirements.
6. Reassemble solenoid in reverse order of disassembly. Use exploded view for identification and placement of parts.
7. Torque housing cover to 135 ±15 inch-pounds (15,3 ± 1,7 newton-meters).

CAUTION: Solenoid must be fully assembled because the housing and internal parts complete the magnetic circuit. Be sure to replace insulating washer at each end of non-molded coil.

NOTE: Catalog numbers 80033, 80034, 8003A3, and 8003A4 - Installation and maintenance of explosion-proof equipment requires more than ordinary care to insure safe performance. All finished surfaces of the solenoid are constructed to provide a flame-proof seal. Be sure that the surfaces are wiped clean before reassembling. Grease the joints of the explosion-proof solenoid enclosure with DOW CORNING® 111 Compound lubricant or an equivalent high-grade silicone grease. Grease all joints thoroughly including the underside of the solenoid base sub-assembly flange and internal threads of the housing cover.

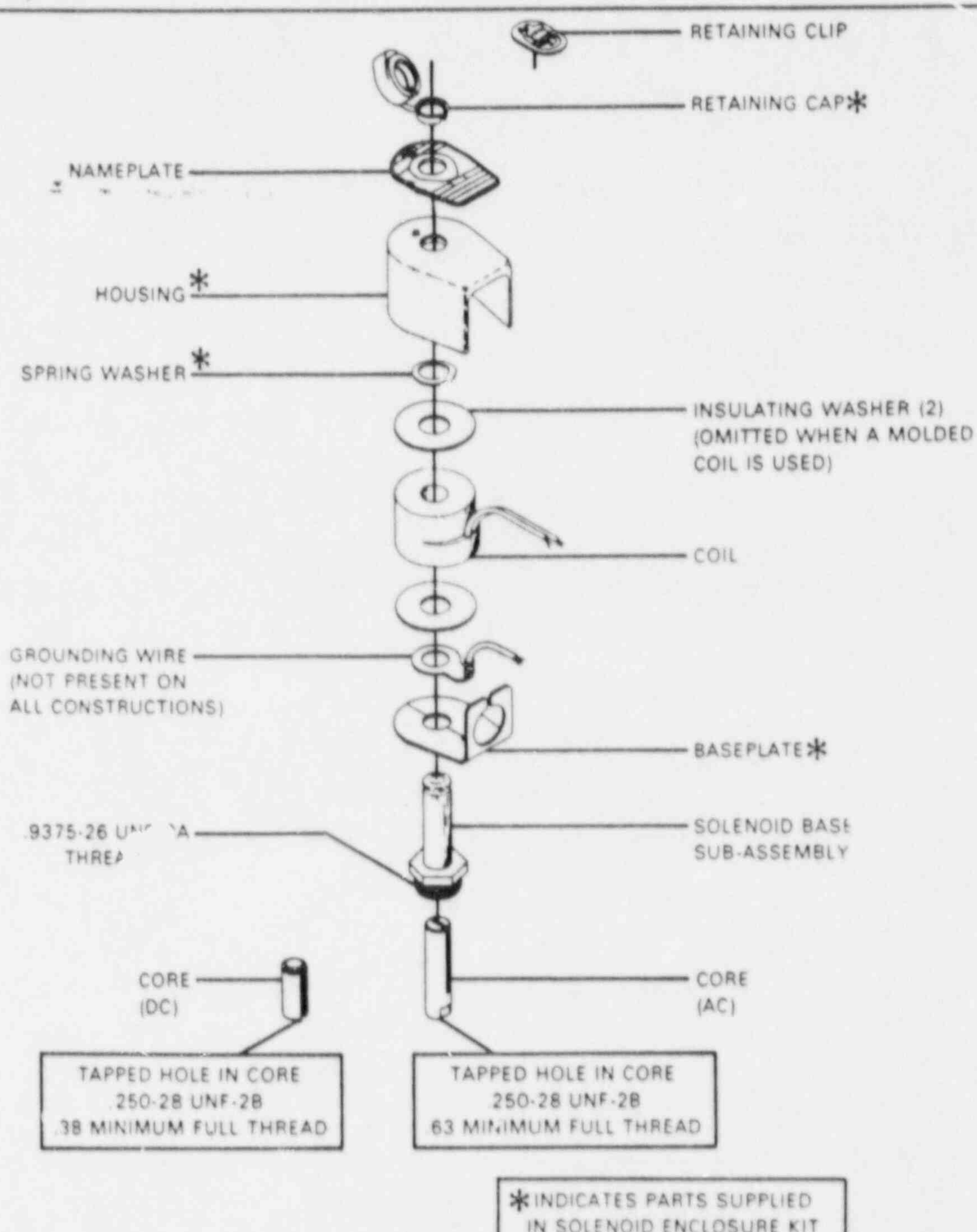
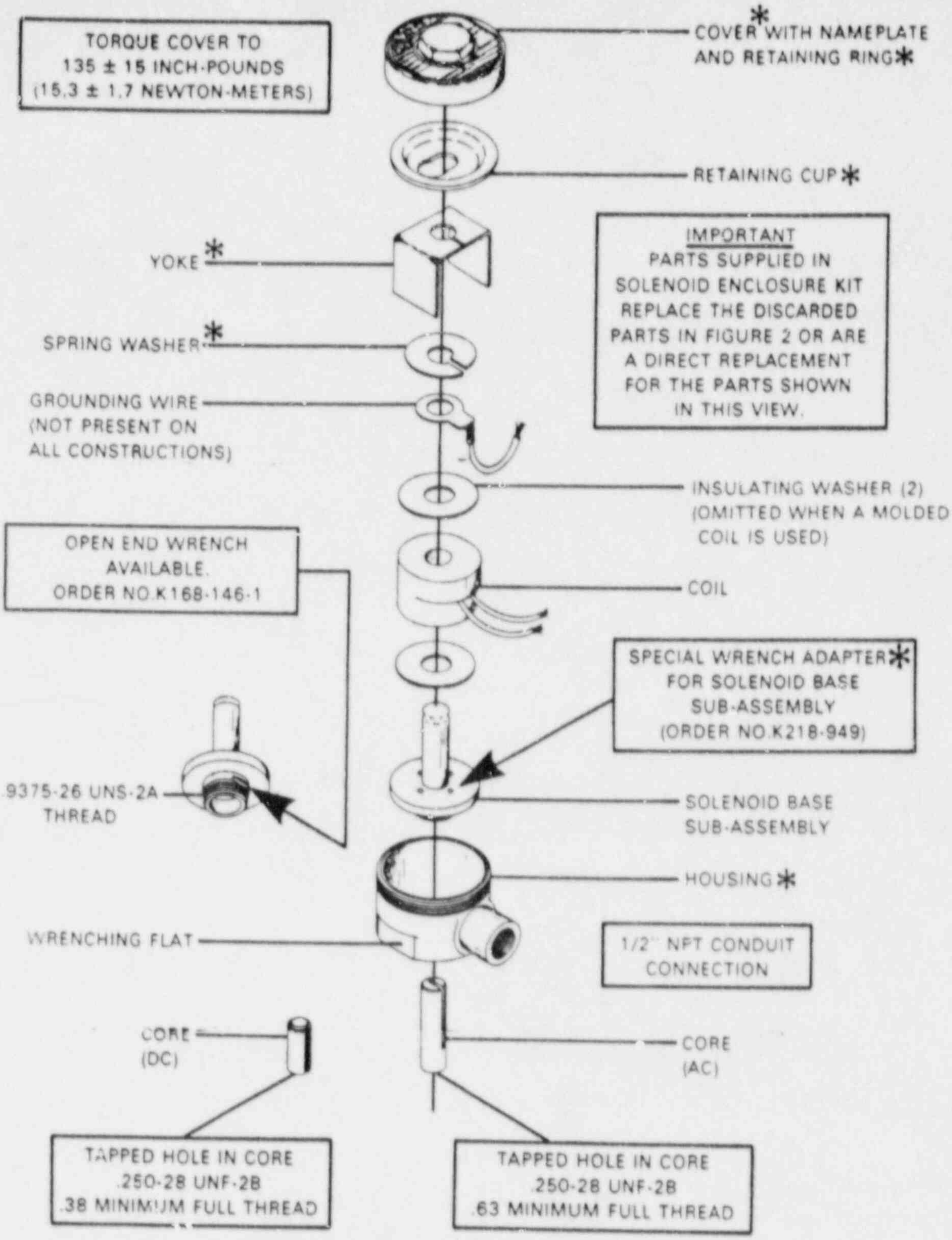
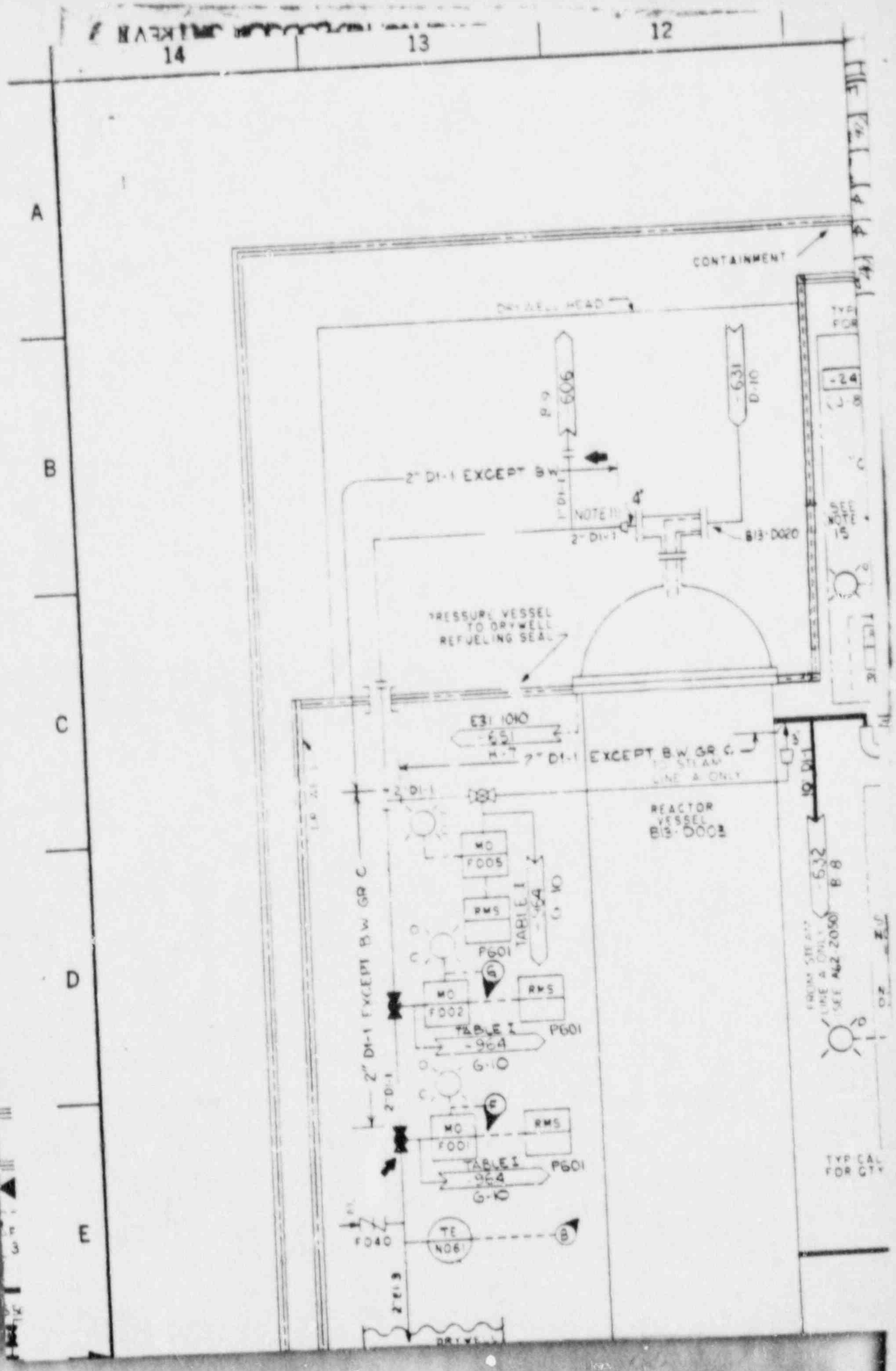


Figure 1. Catalog Nos.80032 and 80032
General Purpose Solenoid Enclosure



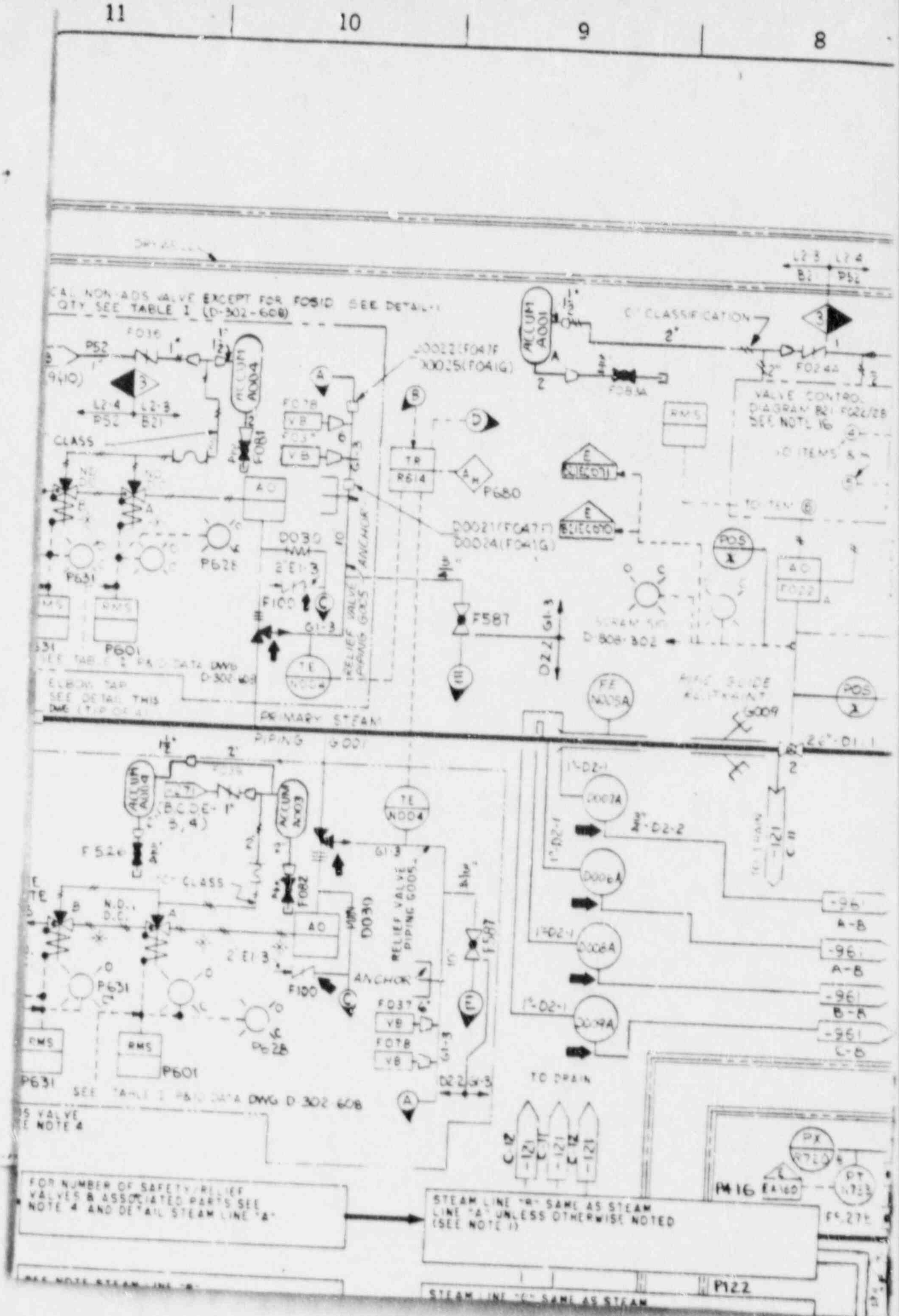
* INDICATES REPLACEMENT PARTS SUPPLIED IN ASCO SOLENOID ENCLOSURE KIT. THESE PARTS ARE ONLY NECESSARY WHEN THE SOLENOID ENCLOSURE HAS BEEN DAMAGED AND ARE NOT SUPPLIED IN ASCO REBUILD KITS.

Figure 3. Catalog Nos.8003A3 And 8003A4
Explosion-Proof Solenoid Enclosure

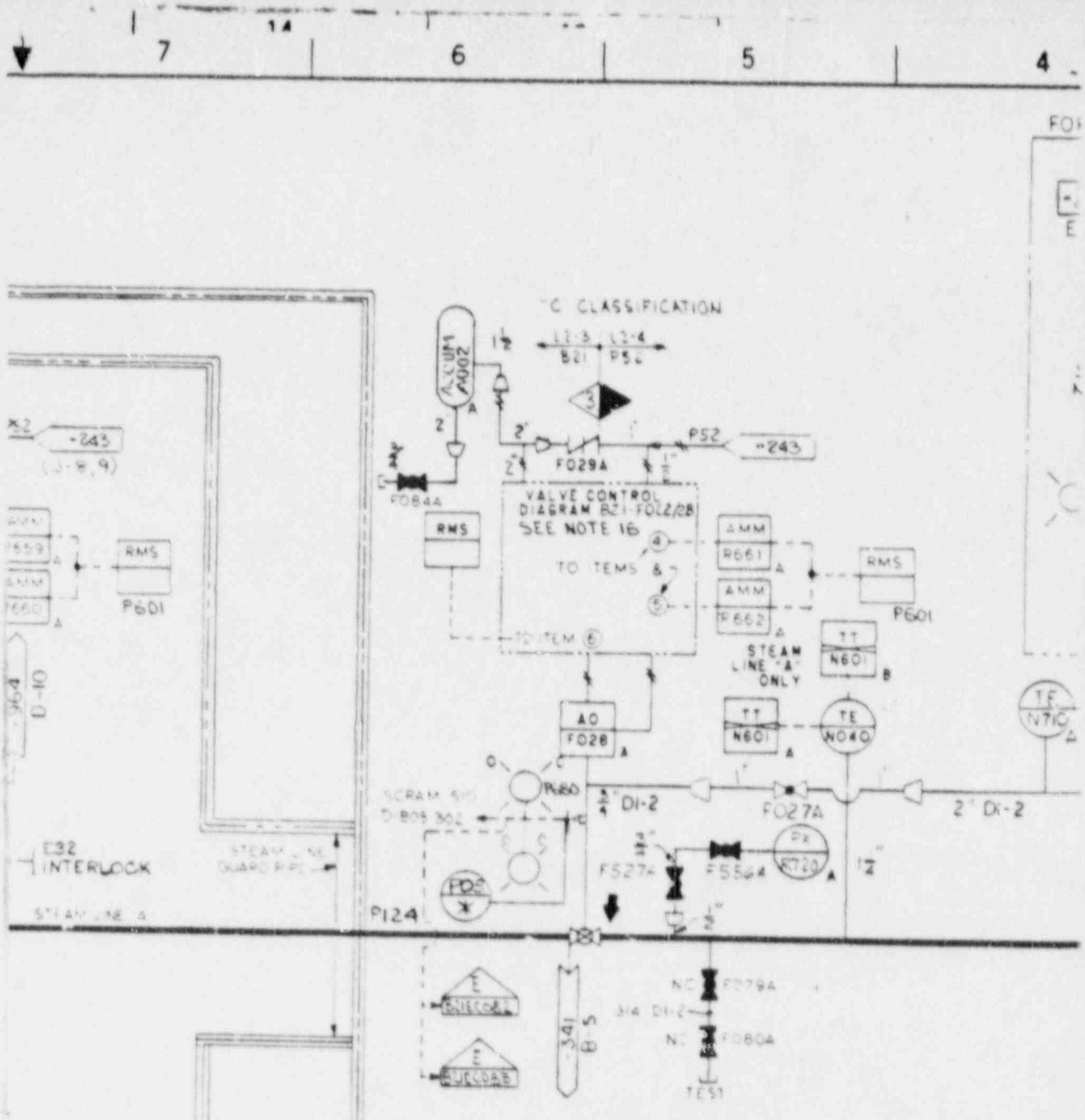


14
13
12
A
B
C
D
E
CONTAINMENT
DRYWELL HEAD
606
P-9
-631
D-10
2" DI-1 EXCEPT B.W.
NOTE 11
2" DI-1
4"
B13-D020
SEE NOTE 15
-24
PRESSURE VESSEL TO DRYWELL REFUELING SEAL
E31 1010
-651
H-7
2" DI-1 EXCEPT B.W. GR C
TO STEAM LINE A ONLY
2" DI-1
REACTOR VESSEL B13-D003
MO
F005
RMS
TABLE I
-964
G-10
P601
2" DI-1 EXCEPT B.W. GR C
-632
B-8
FROM STEAM LINE A ONLY SEE M-2 2050
MO
F002
RMS
TABLE I
-964
G-10
P601
2" DI-1
MO
F001
RMS
TABLE I
-964
G-10
P601
TYPICAL FOR QTY
F040
TE
N061

13/80

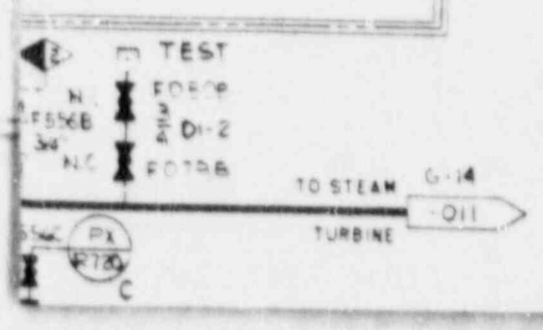


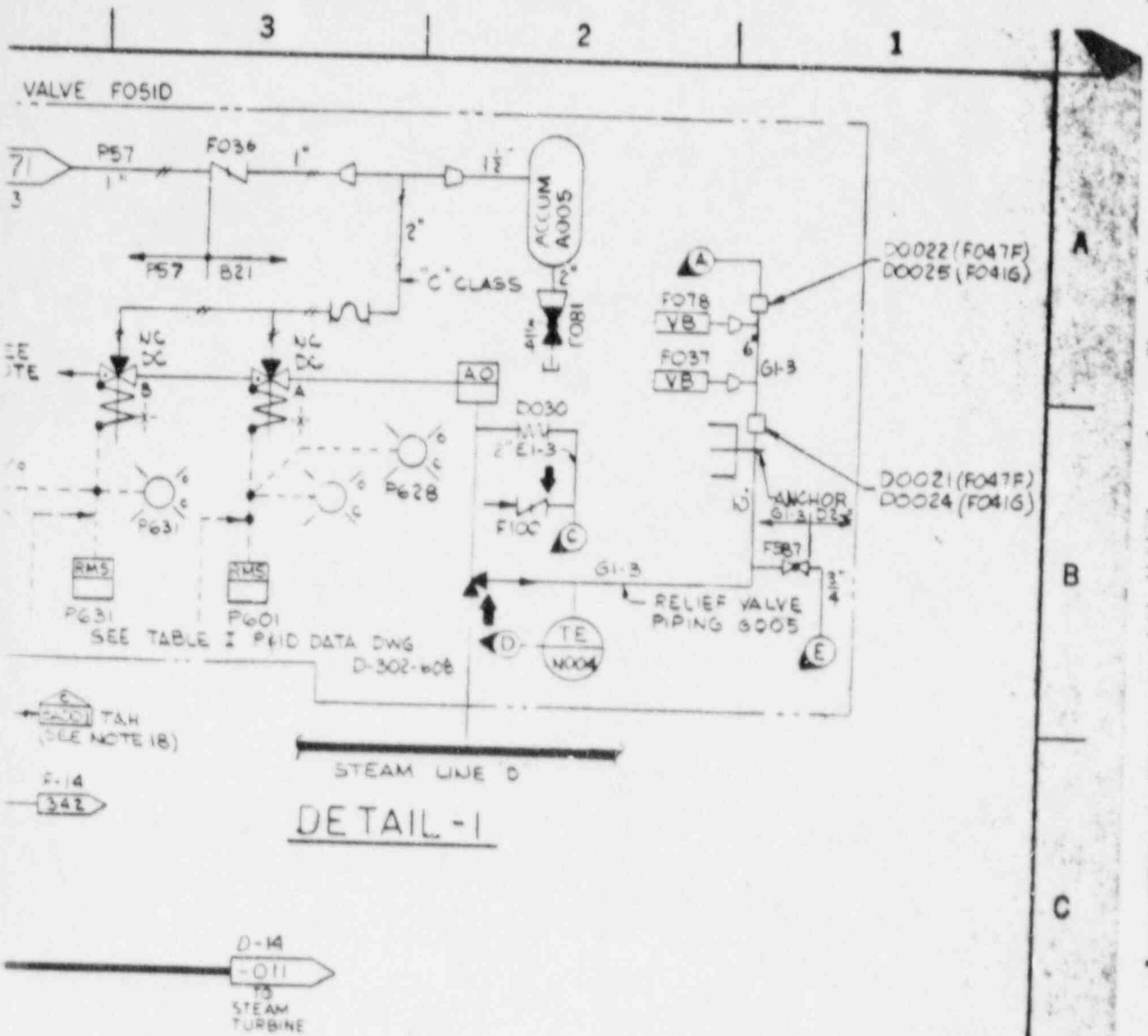
11
10
9
8
QTY SEE TABLE I (D-302-608)
ACCUM A004
ACCUM A001
"C" CLASSIFICATION
F024A
F083A
VALVE CONTROL DIAGRAM B21-F022/28 SEE NOTE 16
D0022(F047F)
D0025(F041G)
TR R614
P680
D0021(F047F)
D0024(F041G)
F081
AO
VB
F078
D030
2" E1-3
F100
TE N004
RELIEF VALVE PIPING G005
ANCHOR
F587
G1-3
D2-2
D-808-302
SCRAM SIG
POS
P628
P631
RMS
P601
SEE TABLE 2 P&ID DATA DWG D-302-608
ELBOW TAP SEE DETAIL THIS DWG (TYP OF 4)
FE N005A
PRIMARY STEAM PIPING G001
G009
26"-D1-1
ACCUM A003
ACCUM A004
F526
"C" CLASS
F082
N.D. D.C.
1"-D2-1
D007A
D006A
D008A
D009A
D2-2
-961
A-B
B-B
C-B
TO DRAIN
-121
C-12
F037
F078
SEE TABLE 2 P&ID DATA DWG D-302-608
FOR NUMBER OF SAFETY/RELIEF VALVES & ASSOCIATED PARTS SEE NOTE 4 AND DETAIL STEAM LINE "A"
STEAM LINE "B" SAME AS STEAM LINE "A" UNLESS OTHERWISE NOTED (SEE NOTE 1)
STEAM LINE "C" SAME AS STEAM
PX
PT
P416
P122



REFERENCE DOCUMENTS:-

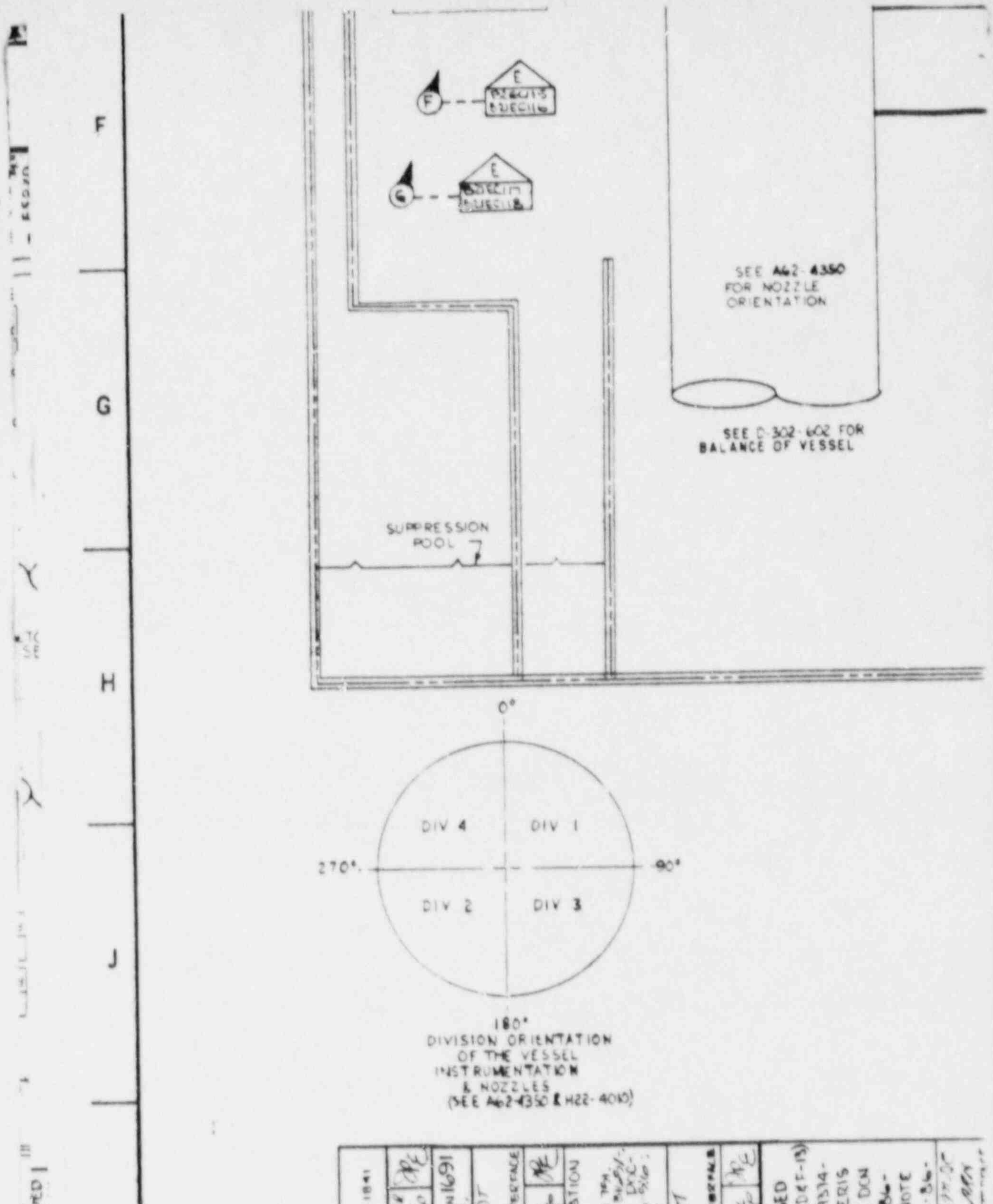
D-302-602	REACTOR RECIRCULATION SYSTEM
D-302-820	CONTROL ROD DRIVE HYDRAULIC SYSTEM
B-206-025	FEEDWATER CONTROL SYSTEM
D-302-691	STANDBY LIQUID CONTROL SYSTEM
D-808-302	REACTOR PROTECTION SYSTEM
D-302-964	LEAK DETECTION SYSTEM
D-302-631	RCIC SYSTEM
D-302-632	RCIC SYSTEM
A62-2050	REACTOR SYSTEM OUTLINE DRAWINGS
D-302-871	REACTOR WATER CLEANUP SYSTEM
B13-2020	REACTOR ICD
B21-F022/28	ISOLATION VALVE INTERFACE CONTROL DRAWING
A62-4050	MECHANICAL EQUIPMENT SEPARATION
D-808-201	REMOTE SHUTDOWN SYSTEM
A62-4050	ELECTRICAL EQUIPMENT SEPARATION
C94-4030	DCS I/O LIST
B13-D020	HEAD COOLING SPRAY NOZZLE
C91-4030	PERFORMANCE MONITORING SYSTEM
E32-1010	MSIV-LCS





NOTES:-

1. STEAM LINES, ENCLOSED IN BOXES SHALL HAVE PART NUMBERS CORRESPONDING TO THEIR RESPECTIVE LINE NUMBERS, UNLESS OTHERWISE NOTED.
   EXAMPLE - XXXB IS ON LINE "B"
   XXXC IS ON LINE "C"
2. ALL EQUIPMENT AND INSTRUMENTS AND PANELS STARTING TO THE DISPLAY CONTROL SYSTEM ARE PREFIXED BY SYSTEM NUMBER B21, UNLESS OTHERWISE SPECIFIED.
3.
4. SEE DWG. D-302-608 FOR QUANTITY AND ORIENTATION OF SAFETY RELIEF VALVES AND ASSOCIATED EQUIPMENT.
5. LOCATE IN AREA SERVED BY STANDBY GAS TREATMENT. F027 SHOULD BE ACCESSIBLE DURING NORMAL OPERATION.
6. FOR OTHER MODES OF OPERATION, SEE NUCLEAR BOILER SYSTEM PROCESS DIAGRAM AND PROCESS DATA G.E. DWGS. 131C7611 AND 131C7612.
7. (PI) TO BE CONNECTED INTO THE STRAIGHT RUN OF PIPE DOWNSTREAM OF F027 WITH UPSTREAM AND DOWNSTREAM STRAIGHT LENGTH FROM THE TAP TO GIVE AS ACCURATE A PRESSURE MEASUREMENT AS FEASIBLE. TAPS TO MEET ASME PTC 6 1964 "STEAM TURBINES" PARAGRAPH 4.74
8. AN EXPANSION LEG SHALL BE PROVIDED IN [illegible]



F
G
H
J
K
SEE A62-4350
FOR NOZZLE
ORIENTATION
SEE D-302-602 FOR
BALANCE OF VESSEL
SUPPRESSION
POOL
0°
90°
180°
270°
DIV 4
DIV 1
DIV 2
DIV 3
DIVISION ORIENTATION
OF THE VESSEL
INSTRUMENTATION
& NOZZLES
(SEE A62-4350 & H22-4010)
AS-BUILT PER DCN 1841
AS-BUILT PER DCN 1691
REMOVED NOTE 3,
COORDINATE E-3
INTERFACE
DESIGN CONFIGURATION
MANAGEMENT
AS-BUILT REVISED
3/16" = 1'-0"

F		3-4			

AS-BUILT FOR SYS. 1B13 1B21A, B, C & 1N11B SCOPING PKG. ADDED 3"x2" REDUCER (C-12) PER ECN 16165-44-5131/C. ADDED PT N733, PT N734, ERIS PTS. EA360, EA361, & PIPING CLASS BREAK; VALVES F527B, F527D, F556B & F556D WERE SHOWN NORMALLY CLOSED, (E, G-B, 7) PER ECN 26630-48-158/A. DELETED ZS N437, ZS N478 COMPUTER POINT & NOTE 4 (TYP.~3 PLACES) (A, B, C, E-11, 10, 2, 1) PER ECN 25691-86-1050 STEAM LINE 'D' WAS 'A' (E-2).

INTEFACE

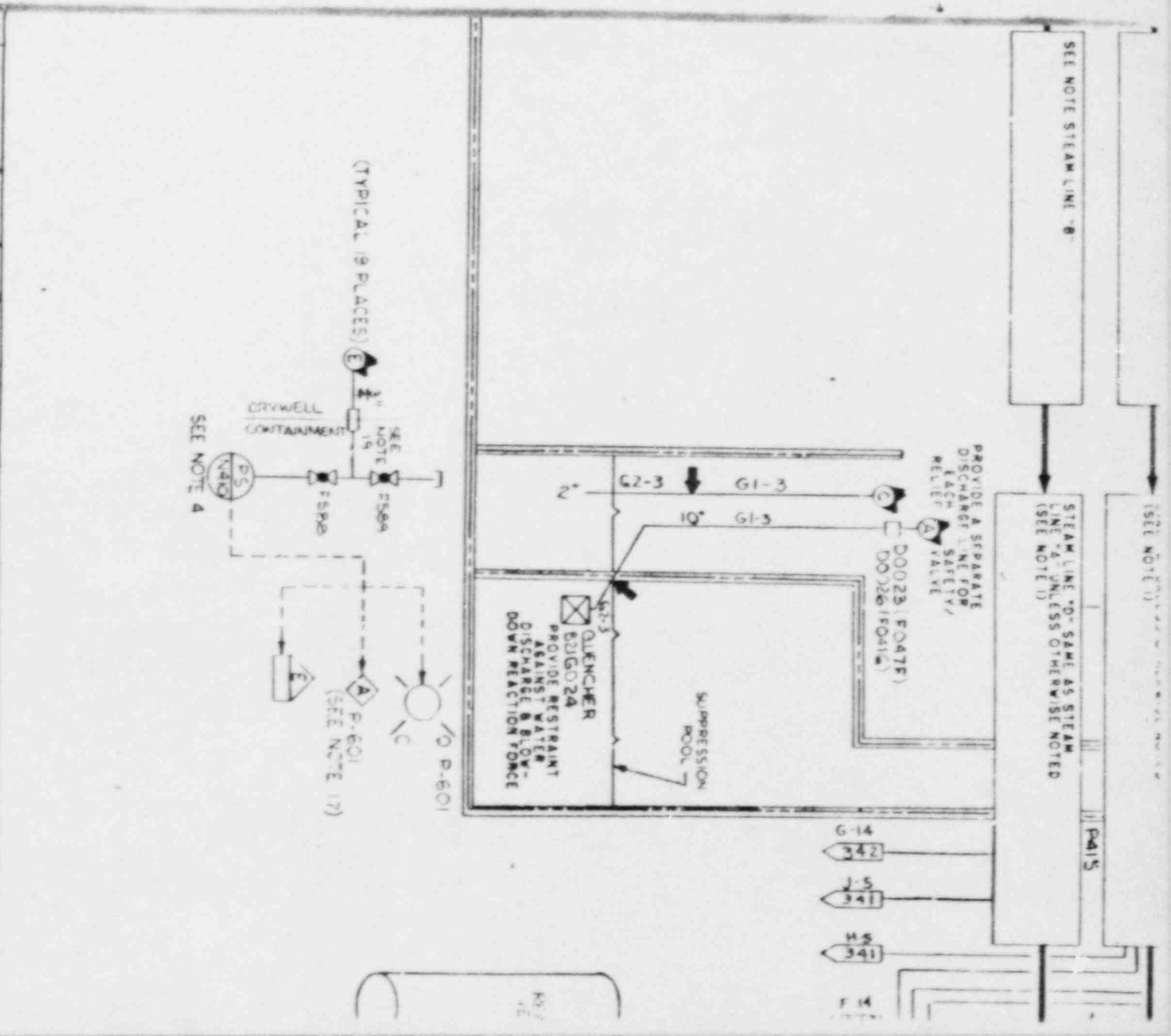
E		DA			

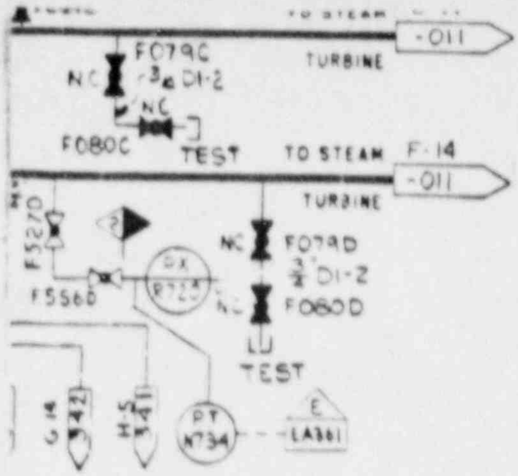
ADDED POSITION INDICATING SWITCHES 3 PLACES (C-6, C-8) & REV'D G.E. DWG. № PER IDCI 883. ADDED SAFETY CLASSIFICATION TO PIPING AT (B+E-13, B-12) PER ECN 16165-44-5131. REMOVED LINE ROUTINGS FROM PANELS 1B21-D019A, L D020A (G.H-5+7) PER ECNS 19989-90-1603 & 19354-14-6815

INTERFACE

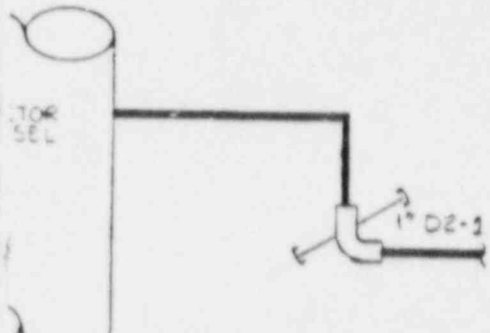
D					

ADDED PS N410 (H, 3-9, 10)
ADDED LINE SPEC AND SIZE (C, D, E-9)
ADDED VALVE F58T TO ANNUNCIATORS (C, D-9)
REVISED G.E. DWG NO. (K.1, 2)
ADDED COMPUTER POINT ELEMENTS (B, E-10) (C-11)
REMOVED "D-302" IN 17 PLCS
ADDED "BIRDBEAK-D" (B-9)
REMOVED REDUCER (B 8, 11)
ADDED DETAIL-1 (A, B 1, 2, 3, 4)
ADDED (2) REDUCERS (C-4, 5)
ADDED NOTES 17, 18, & 19
ADDED COORDINATES (D, E 13)
DWG. COORD "F-14" WAS "G-12" (C-4). REMOVED (2)





H22-4010	LOCAL PANEL DESIGN SPECIFICATION
B33-1010	REACTOR RECIRCULATION SYSTEM P AND I DATA
B33-1080	JET PUMP ELEMENTARY
B21-1050	NUCLEAR BOILER PROCESS INSTRUMENT ELEMENTARY
A62-4430	MSSE DESIGN SPECIFICATION
B-208-015	REACTOR RECIRCULATION SYSTEM ELEMENTARY
D-302-011	MAIN STEAM SYSTEM
D-302-121	MAIN, REHEAT EXTRACTION, AND MISCELLANEOUS DRAINS
D-302-861	LEAK DETECTION SYSTEM
D-302-651	FUEL POOL COOLING AND CLEAN-UP SYSTEM
D-302-603	REACTOR RECIRCULATION SYSTEM
D-302-604	REACTOR RECIRCULATION SYSTEM
B21-1020	NUCLEAR BOILER PROCESS DIAGRAM
C22-4010	REDUNDANT REACTIVITY CONTROL
C22-1010	REDUNDANT REACTIVITY CONTROL SYSTEM ELEMENTARY
A62-4070	PROCESS INSTRUMENTATION DESIGN SPEC.



DETAIL
ELBOW TAP AND ASSOCIATED EQUIPMENT
(TYP OF 4)

SUPPORTING DOCUMENTS:-

1. PIPING AND INSTRUMENT SYMBOLS
2. PRESSURE INTEGRITY OF NUCLEAR

NUCLEAR BOILER SY

WATERTIGHT PENETRATION THROUGH THE VESSEL TO DRYWELL REFUELING SEAL. THE EXPANSION LEG AND PIPING INSTALLATION SHALL BE DESIGNED TO ALLOW FOR MAXIMUM CHANGE OF VESSEL LENGTH WITH TEMPERATURE TO AVOID OVER STRESSING THE PIPING OR THE SEAL OR DAMAGE TO THE INSULATION AROUND THE VESSEL. THE CONDENSING CHAMBER 0002, SHALL BE LOCATED ABOVE THE HEAD VENT CENTER LINE IN ACCORDANCE WITH SPEC. A62-4070.

9. PROVISION FOR INSTRUMENT LINE ISOLATION SHALL BE IN ACCORDANCE WITH CURRENT LICENSING PRACTICES. ONE ORIFICE SHALL BE INSTALLED IN EACH INSTRUMENT LINE CONNECTED TO THE REACTOR COOLANT PRESSURE BOUNDARY (RCPB). ORIFICE SHALL BE AS CLOSE AS FEASIBLE TO THE RCPB. ORIFICE SIZE IS 1/4" AND MAXIMUM NUMBER OF ORIFICES PER LINE IS ONE.

10. VALVE MOTOR OPERATORS AND PILOT SOLENOIDS ARE AC OPERATED, UNLESS OTHERWISE SPECIFIED.

11. LOCATE TEE AS CLOSE AS POSSIBLE TO REACTOR VESSEL.

12. SEE TABLE [illegible] AND IC DATA, DWG. D-302-60[illegible].

13. ALL INDICATOR LAMPS LOCATED ON H13P601, UNLESS OTHERWISE SPECIFIED.

14. FOR CONTROL ROOM, LOCAL OR REMOTE PANEL AND RACK IDENTIFICATION NUMBERS FOR INSTRUMENT, SEE THE INSTRUMENT INDEX.

15. FOR SOLENOID IDENTIFICATION NUMBERS, SEE INSTRUMENT INDEX.

16. VALVE CONTROL DIAGRAM SHOWN ON DWG [illegible]-0[illegible]0-[illegible]. FOR SOLENOID IDENTIFICATION NUMBERS, SEE INSTRUMENT INDEX.

17. ANNUNCIATOR IS COMMON TO ALL SAFETY RELIEF VALVES POSITION SWITCHES.

18. COMPUTER POINT I.D. NUMBERS FOR B21N110[illegible], [illegible], AND [illegible] ARE [illegible]BA[illegible], B[illegible]D[illegible], AND [illegible] RESPECTIVELY.

19. FOR PENETRATION NUMBERS, SEE INSTRUMENTATION INSTALLATION DWGS. D-814-605 AND D-814-666.

DRAWING UNDER DESIGN
CONFIGURATION MANAGEMENT
AS OF REV. G

RECEIVED
SEP [illegible] 1987
DRAWING CONTROL

NUCLEAR SAFETY RELATED

[illegible]PONENTS A42-1010
A62-4030

ISSUED ON NOV 04 1987
EXPIRES ON NOV 17 1987
WORKING COPY

NO	DATE	MADE	CHKD	APPROVALS

REVISIONS

CONSTRUCTION	
LIMITED CONSTRUCTION: AS NOTED	
PRELIMINARY NOT FOR CONSTRUCTION	
BIDDING PURPOSES	
DATE	RELEASED FOR	ENGR.

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

PERRY NUCLEAR POWER PLANT UNIT 1

PIPING SYSTEM DIAGRAM B21

NUCLEAR BOILER SYSTEM

READING PA. GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS

DRAFTING — ENGINEERS APPROVALS

MADE T.A.A. — CHECKED — ARCHITECTURAL N/A — CIVIL N/A — STRUCTURAL N/A — ELECTRICAL N/A

APPROVAL — MECHANICAL — ENVIRONMENTAL N/A — NUCLEAR N/A — I&C

SCALE NONE | 04 | 4549 | D-302-605 | J

W.O. 048966 000 — DRAWING NUMBER — REV.

P.N.G.

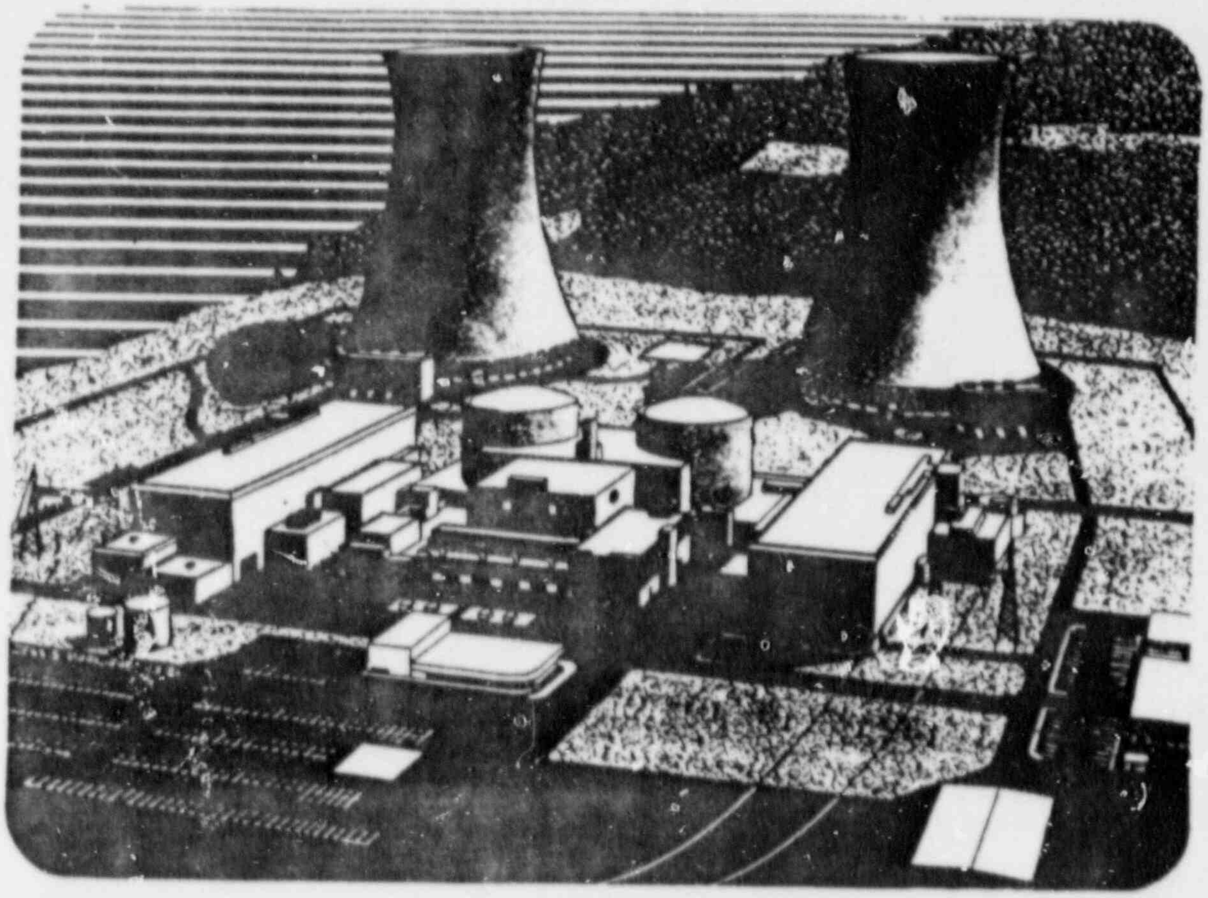
REV	DESCRIPTION	DATE	MADE	CHKD	APPROVALS
A	NOTES (TYP. 3) REMOVED ARROW (D-9). F022A BECAME LOCK CLOSED. F079A BECAME NORMALLY CLOSED. ADDED LINE SIZE (C-8). REVISED DETAIL (H-6). ADDED INSTRUMENTATION (D-8). ADDED VALVES (C,E,D-10). REMOVED FE-N005 (C-7) & RELOCATED TE (E-7). ADDED 2" LINE (G-9).		N.Y.		

REVISIONS

T | M

GE DWG NO. 769E305CA SH1 REV 11

PERRY POWER PLANT



SYSTEM DESCRIPTION MANUAL

B21/N11

MAIN STEAM SYSTEM

This manual is intended for Training Purposes Only and shall not be used for operation of the facility, system, or components.

13/81

I. INTRODUCTION AND GENERAL DESCRIPTION

A. SYSTEM PURPOSE

The purpose of the Main Steam System is to:

a. Direct generated steam flow to the main turbine and selected support equipment.
b. Provide a relief path for steam in the event of a reactor overpressure condition.
c. Bypass steam directly to the main condenser.
d. Provide system isolation in the event of a steam line break in order to minimize the release of radioactive fission products to the environment.

B. SYSTEM DESCRIPTION AND FLOW PATHS

1. General Description

The Main Steam System consists of piping, valves, and instrumentation necessary to direct steam to the following components (see Figure 1):

a. High pressure section of the main turbine,
b. Reheat steam for the 2nd stage of the Moisture Separator Reheaters,
c. Turbine bypass valves,
d. Reactor feedwater pump turbines,
e. Steam seal evaporator,
f. Steam jet air ejectors,
g. Off-gas preheaters,
h. RCIC turbine (A Main Steam Line only), and
i. Residual Heat Removal System (A Main Steam Line only).

Incorporated into the Main Steam System is a safety relief valve (SRV) network to allow for overpressure protection of the Reactor Pressure Vessel. Some of these SRVs can be actuated by the Automatic Depressurization System B21C.

There are four main steam lines, denoted A,B,C, and D. A penetration on Main Steam Line A provides continuous venting of the Reactor Vessel Head area during reactor operation. The venting action removes non-condensible gases, and minimizes the buildup of free hydrogen and oxygen formed by the radiolytic decomposition of water.

Each of the main steam lines contains a flow restrictor welded into the pipe to restrict the flow of steam in the event of a steam line rupture, thereby limiting the loss of coolant during the time lapse between the rupture and Main Steam Isolation Valve (MSIV) closure. The flow restrictor also provides a steam flow signal to the Nuclear Steam Supply Shutoff System (B21C) and to the Feedwater Control System (C34).

Two MSIVs are located in each of the four main steam lines. The combination of two MSIVs in each steam line provides a highly reliable means of isolating the reactor vessel to minimize the loss of reactor coolant inventory and to limit the release of radioactive materials. Both valves are identical in construction and operation.

The Main Steam System is also equipped with drains for warming equipment and piping systems during start-up, and draining moisture from main steam piping during start-up and low load operation.

2. System Flow Paths

Refer to Figure 1 during the following discussion.

All the Main Steam System flow paths originate at one of the four 26 inch diameter steam lines, that direct steam from the Reactor Pressure Vessel. From the reactor vessel, the steam lines penetrate the Drywell and Containment via guard pipes. Within the Drywell, each steamline contains a number of safety relief valves which, at the proper setpoint, will lift to direct steam to the suppression pool. A temperature element monitors the temperature in the discharge piping from each SRV. An increase in the discharge piping temperature provides an indication that the associated valve is open or leaking by. To provide a more positive indication of an open SRV, a pressure switch is installed downstream of the temperature element to monitor the pressure inside the discharge piping. After a SRV reseats, the steam remaining in the discharge piping will condense, forming a vacuum which could draw water from the suppression pool into the discharge piping. If the valve is again opened while this condition exists, severe water hammer could occur. For this reason, vacuum breakers are installed in the discharge piping from each valve and will open to prevent the formation of a vacuum. Upstream of the SRVs in steam line A is a penetration that allows steam to be supplied to the RCIC turbine (E51) and RHR System (E12). The RHR System uses main steam for its steam condensing mode of operation.

Inside the Drywell wall, and downstream of the flow restrictor in each line, is the inboard MSIV, B21-F022. Each steam line then passes through the Drywell wall and the Shield Building wall via the steam guard pipes. These pipes prevent pressurization of the containment volume from a steam line break, by containing escaping steam and routing it back into the Drywell. I f these pipes were unguarded, a main steam line rupture within the containment would result in a direct release of steam to the containment atmosphere. This would allow the pressure suppression features of the Containment to be bypassed and thus, a potential could exist for a pipe rupture to produce significant contaiment pressures. Immediately outboard of the Shield Building wall in each steam line is the outboard MSIV, B21-F028.

A Main Steam Shutoff Valve (MSSV), N11-F020, is located in the Auxiliary Building downstream of the outboard MSIV. The four main steam lines then enter the Turbine Building where they eventually terminate at the Main Turbine Stop and Control Valves.

Upstream of the Main Turbine Stop and Control Valves, all four main steam lines are interconnected by a pressure/flow equalizer manifold. This manifold supplies steam to the following:

a. 2nd stage of four Moisture Separator Reheaters (tube side) for reheating High Pressure Turbine exhaust steam,
b. Steam jet air ejectors,
c. Reactor feedwater pump turbines,
d. Steam seal evaporators, and
e. Off-gas preheaters.

Downstream of the pressure/flow equalizer manifold, main steam can be bypassed directly to the main condenser through seven turbine bypass valves. This flow path is necessary during start up and rapid load rejections, and can bypass up to 35% of rated main steam flow. Seven turbine bypass steam valves are provided to regulate the amount of steam bypassed to the main condenser. Four valves are mounted on a common manifold which receives steam from Main Steam Lines A and C. The remaining three bypass valves are mounted on a common manifold which receives steam from Main Steam Lines B and D.

Main steam line drain flow paths are provided for draining the main steam lines to the main condenser. There are three separate flow paths:

- Inboard - drains steam lines upstream of inboard MSIVs,
- Outboard - drains steam lines between inboard and outboard MSIVs, and
- Downstream - drains main steam lines downstream from the MSSVs.

Each drain section directs condensation to the condenser via a wye strainer and a restricting orifice.

Main Steam System drains are covered in more detail in SDM N22.

Reheat Steam and Moisture Separator Reheaters are covered in more detail in SDM N31.

C. MAJOR COMPONENT DESCRIPTIONS

The major components of the Main Steam System are:

1. System Piping,
2. Safety Relief Valves (SRV),
3. Steam Flow Restrictors,
4. Main Steam Isolation Valves (MSIV),
5. Main Steam Shutoff Valves (MSSV),
6. Pressure/Flow Equalizer Manifold, and
7. Main Turbine Bypass Valves.

1. System Piping

The individual main steam lines are 26 inch diameter stainless steel pipes. The design pressure and temperature is 1250 psig and 575°F, respectively. Piping design and layout take into consideration seismic effects and make provisions to mitigate postulated steam line piping breaks.

2. Safety Relief Valves

Located on the four main steam lines, between the Reactor Pressure Vessel and inboard MSIV, are nineteen SRVs. These valves provide overpressure protection for the Reactor Pressure Vessel. Eight of the nineteen SRVs are associated with the Automatic Depressurization System (B21C). As shown in Figure 2, two SRVs associated with each main steam line can be actuated by ADS logic.

Each SRV is a spring loaded, seal-bonnet, angle-globe valve with an externally attached pneumatic operating cylinder. See Figure 3.

Each SRV can be operated either in the safety mode or the relief mode.

a. Safety Mode

The system pressure in the inlet nozzle of the valve applies a force in the opening direction to the seated main disc. When the system pressure rises to a given setpoint (see Table 1) for the SRV self-actuating pressure setpoints, the valve will open very rapidly without a further increase in pressure. The opening of the main disc is produced in three stages, all working together to attain a continuous motion.

- The lift is initiated when the opening force (steam pressure under main disc) exceeds the closing force (mass of moving parts and spring force),

- The small amount of steam escaping from the nozzle is deflected by the nozzle ring and the piston, and the force of its reaction opens the main disc wider, and

- The escaping steam is deflected by the liner ring and the force of its reaction opens the main disc completely driving the SRV piston to its mechanical stop.

The main disc remains completely opened until the system is depressurize to the reseating pressure of the valve during which period steam is leaking through the piston/liner clearance. The steam leakage results in a pressure build-up above the SRV piston.

At the reseating pressure the main disc closes in an abrupt motion as a result of three fulfilled conditions:

- The opened position of the main disc has increased the spring force upon the moving parts,

- The pressure built-up above the piston is stabilized and has additionally increased the total closing force, and

- System depressurization has decreased the opening force.

Operation of the SRVs in the safety (self-actuating) mode is not affected by the adaptations for pneumatic valve operation.

b. Relief Mode

Pneumatic operation is the result of an electric command to an actuator solenoid, see Figure 3. Energizing a solenoid will open a pilot valve admitting pneumatic pressure to the piston of the pneumatic operating cylinder. The piston will stroke upwards, acting upon the roller brearings and linkage lever to lift the SRV main disc off the closed seating surface.

When the solenoid is deenergized, the pilot valve will switch back, exhausting the pneumatic pressure beneath the piston of the pneumatic operating cylinder. The piston is returned to the zero position by an internal spring and the SRV main disc closes.

The Relief mode may be initiated by any one of the following conditions:

- Manually by positioning control switches in the Control Room.
- Automatically, on the receipt of two independent high reactor pressure vessel signals, See Table B21-1 for these auto pressure relief setpoints, or

- Automatically, on the receipt of an ADS signal (applicable only to the 8 SRVs incorporated in the ADS). Refer to SDM B21C for additional ADS information.

3. Main Steam Line Flow Restrictors (FE N005 A,B,C, and D)

Refer to Figure 4 during the following discussion.

A Main Steam Line Flow Restrictor is installed in each of the four main steam lines upstream of the inboard MSIVs. The restrictor has no moving parts and is welded into the line.

The restrictor consists of a venturi type nozzle insert designed to withstand the forces and velocities associated with a main steam line break. Type 304 stainless steel is used because of its high resistance to corrosion/erosion in systems with high steam velocities.

The restrictor functions to limit the coolant blowdown rate to less than 170 percent rated steam line flow if a main steam line break occurs. This action will minimize the amount of coolant actually lost from the time the break occurs to the closure of the MSIVs. Also, the flow restrictors limit the differential pressure across the steam dryer and other reactor vessel internal components due to high steam velocities.

Two sets of 1-inch upstream and downstream taps penetrate the flow restrictor assembly. The upstream tap will sense the high pressure region of the assembly. The downstream tap senses the low pressure region of the assembly. Each 1-inch line supplies steam to a condensing chamber. Both sets of high and low pressure steam condensing chambers supply two differential pressure transmitters. Each of the differential pressure transmitters has a differential pressure switch that provides an input signal to the main steam line isolation logic for control and alarm purposes. One set of condensing chambers per main steam line supply a flow transmitter which provides steam flow signals to the Feedwater Control System (C34) for water level control and steam flow indication.

4. Main Steam Isolation Valves

Refer to Figures 1 and 5 during the following discussion.

a. General Design and Orientation

Two Main Steam Isolation Valves are installed in a horizontal run of piping in each main steam line. The inboard MSIVs B21-F022A,B,C and D, are located just inside the primary containment barrier. The outboard MSIVs B21-F028A,B,C and D, are located outside the primary containment barrier in the Steam Tunnel. Rated steam flow through each valve is 3.85×10^6 lb/hr.

The basic design of all eight MSIVs is identical. The valves are 26-inch angled globe valves of the Y configuration. The cup-shaped poppet of the main disc moves on a centerline that is 45^o upward from the horizontal centerline of the piping run. The diameter of the main valve seat is approximately the same as the inside diameter of the pipe, and the entrance and exit are streamlined to minimize the pressure drop across the valve.

The poppet is moved by a stem that penetrates the valve body cover through a stuffing box having 2 sets of chevron packing with a lantern ring and leak-off connection between the sets. The upper end of the stem is attached to a combination air cylinder/dashpot. The air cylinder provides the motive force to open and close the valve, while the dashpot controls the speed of valve operation. The hydraulic dashpot consists of an oil filled cylinder, hydraulic piston, two external speed control valves, and piping.

The air cylinder is supported on large rods screwed into bosses on the valve cover. These rods serve as guide shafts for helical springs which provide valve closing force. A spring seat member transmits compression force to the helical springs during an open cycle, and transmits closing force when the valve is closed. This spring seat member also actuates limit switches for valve position indication.

The bottom of the valve stem acts as a pilot valve which reduces the differential pressure acting over the poppet area. When the valve stem is raised by the action of the air cylinder, the pilot valve will be opened allowing pressure in the balancing cylinder to be relieved to the downstream side of the valve. This reduces the operating force required to open the valve.

b. MSIV Opening Operation

The MSIVs are opened by air pressure supplied by the Instrument Air

System (P52). The air cylinder mounted at the top of the valve is designed to open the valve against a maximum pressure differential of 200 psid. Air pressure is directed to the bottom of the air cylinder in the opening operation by the cycling of various control valves. The operation of these control valves is discussed in section II.C.2.

c. MSIV Closing Operation

To close a MSIV, air pressure is applied to the top of the air cylinder piston and the valve stem starts to move downward.

In the event of failure of the air supply, the helical closing springs provide, by themselves, sufficient forces to close the valve. In addition, steam flow through the valve assists in valve closure.

As the valve stem moves downward, the piston in the dashpot moves with it, displacing oil from the space above the piston to the space below it through two external lines and hence controls the rate of valve closure. The rate of this oil displacement is controlled by the adjustment of the flow control valves in the external lines. Two external piping valve arrangements are provided on the dashpot to permit both coarse and fine adjustments of the flow rate. The closing speed can be adjusted over a range of 3 to 5 seconds and is set fast enough to provide sufficient protection in the event of a main steam line rupture, but slow enough to prevent imposing an excessive pressure transient on the reactor vessel.

Air pressure is directed to the top of the air cylinder in the closing operation by the cycling of various control valves. The operation of these control valves is discussed in section II.C.2.

5. Main Steam Shutoff Valves

A Main Steam Shutoff Valve is located in each of the four main steam lines downstream from the outboard MSIVs in the Auxiliary Building. This valve is a 28-inch, normally open, AC motor-operated gate valve. A cross-sectional view of the valve is shown in Figure 6. Although not required to be shut automatically when isolation of the nuclear system is necessary, these valves may be shut by the operator in post-accident situations to provide backup isolation.

6. Pressure/Flow Equalizer Manifold

The pressure/flow equalizer manifold is a 28-inch line located in the Turbine Building Downstream Of The Main Steam Shutoff Valves. See Figure 1. This manifold is designed to minimize pressure differences between the steam lines and minimize the maximum flow of steam in any one steam line.

7. Main Turbine Bypass Valves

The turbine bypass steam piping provides the means for dumping steam which cannot be absorbed by the main turbine directly to the main condenser. Although the bypassing of steam to the main condenser constitutes a net loss of usuable energy, it will be necessary during start-ups, shutdowns, turbine load rejections, and other conditions that result in excessive steam pressure.

Seven turbine bypass steam valves are provided to regulate the amount of steam bypassed to the main condenser. As shown on Figure 1, each valve is mounted on one of two valve manifolds which receive steam from the main steam lines downstream of the pressure/flow equalizer manifold. The valve manifold which receives steam from Main Steam Lines A and C is shown in Figure 7. A detailed cross-sectional view of an individual bypass valve is shown i Figure 8.

Steam enters the steam chest through inlet penetrations at each end of the bypass valve manifold. When the bypass valves are open, steam flows from the chest down through the valve seat and out the discharge piping. The force required to open each valve is supplied by an actuator mounted directly below the valve and acts directly on the valve stem. The actuator is a double acting hydraulic piston which is positioned by hydraulic fluid controlled by a servo valve. The positioning signal for the actuator is provided by the bypass valve control unit of the Electro-Hydraulic Control (EHC) System and is described in detail in SDM N32/C85.

The bypass valve has a globe type disc with the valve stem attached to the underside of the disc and passing down through the discharge chamber of the valve. This arrangement minimizes stem leakage when the valve is closed since it is only necessary to seal the stem against condenser vacuum. Any leakage that does occur between the valve stem and its bushings is bled off at two stem leakoff points.

The seven bypass valves are opened sequentially by the EHC System and are able to pass a total of 35% of the maximum turbine steam flow.

Three bypass valves direct steam to the high pressure (HP) condenser section, two bypasss valves direct steam to the intermediate pressure (IP) condenser section, and two bypass valves direct steam to the low pressure (LP) condenser section. Before reaching the condenser bypass steam passes through pressure reducers.

These reducers consist of successive series of pressure breakdown plates which act to reduce the pressure of the steam entering the main condenser and thereby preventing an excessive pressure from developing in the condenser shell.

D. DESIGN BASES

1. Main Steam Line Design Bases

To satisfy the safety design bases, the main steam lines are designed:

a. To accommodate stresses, such as internal pressure and earthquake loads, without a failure that could lead to the release of radioactivity in excess of the guideline values in published regulations.

b. To provide suitable accesses to permit inservice testing and inspections.

2. Main Steam Line Flow Restrictor Design Bases

In the event of a main steam line rupture, the main steam line flow restrictors are designed:

a. To limit the loss of coolant from the reactor vessel following a main steam line break to the extent that the reactor vessel water level remains high enough to provide cooling within the time required to close the Main Steam Line Isolation Valves (MSIV).

b. To withstand the maximum pressure difference expected across the restrictor, following complete severance of a main steam line.

c. To limit the amount of radiological release outside of the Drywell prior to MSIV closure, for ruptures outside the containment.

d. To provide trip signals for MSIV closure.

3. Safety Relief Valves (SRV) Design Bases

The SRVs have been designed to:

a. Prevent overpressurization of the nuclear system that could lead to failure of the reactor coolant pressure boundary.

b. Provide automatic depressurization for small breaks in the nuclear system concurrent with failure/improper operation of the High Pressure Core Spray System (E22A) , so that the Low Pressure Coolant Injection (LPCI) mode of Residual Heat Removal System (E12) and the Low Pressure Core Spray Systems (E21) can operate to protect the fuel barrier.

c. Permit verification of operability.

d. Withstand adverse combinations of loadings and forces resulting from normal, upset, emergency or faulted conditions.

e. Reclose automatically after all actuations, except manual and ADS actuations, so that maximum operational continuity can be obtained.

4. Main Steam Isolation Valve (MSIV) Design Bases

The MSIVs, individually or collectively, will:

a. Isolate the main steam lines within the time established by design basis accident analysis to limit the release of reactor coolant.

b. Isolate the main steam lines slowly enough that simultaneous isolation of all steam lines will not induce transients that exceed the nuclear system design limits.

c. Isolate each main steam line when required despite failure of either valve, thus providing a high level of reliability for the safety function.

d. Use separate power sources as the motive force to close the redundant isolation valves in the individual steam lines.

e. Use local stored energy, compressed air and/or springs, to close at least one isolation valve in each steam line without relying on the continuity of electrical power to furnish the motive force to achieve closure.

f. Be able to isolate the steam lines, either during or after seismic loading, to assure isolation if the nuclear system is breached.

g. Be testable, during normal operating conditions, to demonstrate that the valves will function.

II. MAJOR INSTRUMENTATION AND CONTROL

A. INSTRUMENTATION

1. Control Room

a. Process Instrumentation

Table 2 shows major Main Steam System Process Instrumentation available to the Control Room operator. Refer to Figures 1 and 9 for instrument tap locations.

B. ALARMS

1. Control Room

Table 4 includes all Control Room annunciators associated with the Main Steam System.

2. Local

There are no local alarms associated with this system.

C. CONTROL FUNCTIONS AND INTERLOCKS

The following control functions and interlocks are described in this part:

1. Safety Relief Valve Control,
2. MSIV Control,
3. Main Steam Shutoff Valves Control, and
4. Turbine Bypass Valve Control.

1. Safety Relief Valve Control

As mentioned in section I.C.2, the SRVs open in the safety mode when vessel steam pressure exceeds the spring closing force, and open in the relief mode when an actuator solenoid is energized. Each SRV has an A and a B actuator solenoid. Energizing either of the solenoids will cause the associated SRV to open. See Figure 2.

Energizing the A(B) actuator soleniod for each of the 19 SRVs can be accomplished in the following ways (see Figure 10):

- Automatically, on the receipt of two independent high pressure signals sensed from the A(B) side RPV level instrumentation piping, with the associated keylock control switch on panel P601(P631) in AUTO.

- Manually, by positioning the associated control switch on panel P601(P631) to OPEN.
- The 8 ADS SRVs will be energized by the receipt of an initiating signal from ADS logic channel A(B).

With both control switches, one on panel P601 and one on panel P631, for a selected SRV in the OFF position, the relief mode of operation for that SRV is disabled. The safety function and the ADS function, if the selected SRV is an ADS SRV however, would not be affected.

In order to reduce the number of SRVs that reopen following a reactor isolation event six of the 19 SRVs, see Table 1 and Figure 9, have a Low-Low Set (LLS) function. This function is armed whenever any SRV opens in the relief mode. When the LLS function is armed, the normal setpoints for the affected SRVs are overridden by the low-low setpoints. For two of the 6 SRV's (F051C and F051D), the LLS function lowers both the open and close setpoints. For the other four valves, only the close setpoint is lowered.

Following the opening of SRVs due to a reactor isolation event, see Figure 11, those valves affected by the LLS function will stay open longer, reclosing at a lower setpoint than the unaffected valves. This reduces the number of valves cycling for a given condition, thus prolonging valve life.

2. MSIV Control

Two control switches for each MSIV are provided on panel P601. These switches are the manual control switch and the test control switch. The manual control switch is a three-position, maintained contact selector switch with CLOSE-AUTO-TEST positions. The test control switch is a push button, momentary contact switch. Table 5 lists the function of each MSIV switch position.

The manual control switches and the test control switches control the MSIVs by means of the MSIV control logic (Figure 12) and a pneumatic control unit (Figure 13). The control logic for each MSIV provides valve position indication, see Table 3, and provides control power to the solenoids of the pneumatic control unit. The pneumatic control unit for each MSIV is attached to the valve's operating cylinder. An accumulator is installed on the air supply line to provide the capability of conducting one air-assisted closing operation without Instrument Air System (P52) header pressure. A check valve on the air supply line ensures that the stored energy in the accumulator can be used to shut the MSIV and not bleed back into the air header on loss of air header pressure.

Each pneumatic control unit contains:

- A four way, pilot operated main control valve whose function is to direct air to either the top or the bottom of the operating cylinder,

- A two way, pilot operated auxiliary air pilot valve whose function is to ensure venting of the bottom of the operating cylinder when closing the MSIV,

- A three-way, dual solenoid operated main pilot control valve whose function is to reposition the main control valve and the auxiliary air pilot valve,

- A three way, pilot operated test control valve, with an attached air metering valve, whose function is to ensure venting of the bottom of the operating cylinder cylinder when testing the MSIV, and

- A three way, solenoid operated test pilot control valve whose function is to reposition the test control valve.

In the remainder of this section MSIV manual and automatic control operations will be discussed. Since each MSIV has almost identical control circuitry, the discussion will be confined to outboard MSIV B21-F028A.

a. Manual Opening Operation

Refer to Figures ~~12~~ 11 and 13 12A during the following disucssion.
Valve B21-F028A can be opened if the following conditions are met:

- Power available (RPS bus A and B) to pilot and test solenoids, and
- Trip logic is reset and K51 and K14 relays are energized.

With these conditions met, valve B21-F028A is opened by taking its manual control switch, S2A, to the AUTO position. This switch action will cause the following to occur in the F028A control circuitry:

- S2A switch contact opens to deenergize relay K74A,
- Relay K74A closes contacts to energize the A and B pilot solenoids,
- Solenoid action positions the main pilot control valve to admit air to the main control and auxiliary air pilot valves,
- The auxiliary air pilot valve blocks air from exhausting off the bottom of the air cylinder,
- The main control valve passes air via the test control valve to the bottom of the air cylinder, which causes the MSIV to open,
- Air from the top of the air cylinder is exhausted through the main control valve, and
- When the valve is 90% open, a limit switch LS-1 will open to deenergize the green closed indication light. At the same time, limit switch LS-2 will close to energize the red open light.

b. Manual Closing Operation

Refer to Figures ~~12~~ 11 and ~~14~~ 12B during the following discussion.

Valve B21-F028A is closed by taking its manual control switch, S2A, to the CLOSED position. This switch action will cause the following to occur the control circuitry:

- S2A switch contact closes to energize relay K74A,
- Relay K74A opens contacts to deenergize the A and B pilot solenoids. NOTE: Both pilot solenoids must deenergize to initiate a valve closure,
- Solenoid action positions the main pilot control valve to exhaust air off of the auxiliary air pilot and main control valves,
- The main control valve repositions to admit air to the top of the air cylinder and to exhaust air from the bottom of the cylinder via the test control valve
- The auxiliary air pilot valve repositions to provide a second exhaust path for venting air from the bottom of the air cylinder.
- When the valve is 10% closed, limit switch LS-1 closes to energize the green closed indication light. At the same time, LS-2 opens to deenergize the red open indication light.

c. Manual Testing Operation

Refer to Figures 12 and 15 during the following discussion.

While in the open position, i.e., the pilot solenoids energized, B21-F028A may be test closed by first placing its manual control switch, S2A, to the TEST position, and then depressing the test control pushbutton, S4A. These switch actions cause the following to occur in the B21-F028A control circuitry:

- S4A switch contact closes to energize the test solenoid. Note: with S2A in TEST, contact K74C in the test solenoid circuit will already be closed,

- Test solenoid action repositions the test pilot control valve causing it to admit air to the test control valve, and

- The test control valve repositions to bleed air off the bottom portion of the air cylinder, causing the MSIV to move slowly in the close direction.

d. MISV Automatic Isolation

Refer to Figure 12 during the following discussion.

The MSIV automatic isolation logic has four logic channels A,B,C and D, each with an associated relay, K7A,B,C and D. An MSIV automatic isolation condition deenergizes these relays causing relays K51A and K14A to deenergize. Deenergizing relays K51A and K14A causes an interruption of power to the A and B pilot solenoids resulting in MSIV closure.

The following conditions will initiate an automatic MSIV isolation:

- Low RPV water level, Level 1,
- Low main steam line pressure, with reactor mode switch in RUN,
- Main steam high temp turbine building,
- Main steam line area high temperature,
- Main steam line high radiation,
- Main steam line high flow,

- Condenser low vacuum, or
- Manual isolation.

The logic channels are arranged so that failure of any one instrument or channel will not cause MSIV isolation. Refer to SDM B21H, for a more detailed description of MSIV automatic isolation.

3. Main Steam Shutoff Valve Control

Refer to Figure 16 during the following disucssion.

Each MSSV is controlled from panel P601 by the use of a 3-position keylock switch with CLOSE-NORM-OPEN positions. The keylock switch spring returns to NORM. The key can be removed while in the NORM position.

To open (close) the valve, the switch is placed in the OPEN (CLOSE) position. Since the contacts seal in, the switch does not have to be held in the OPEN or CLOSE position while opening or closing the valve. Assuming the MSSV is closed initially, taking the keylock switch to OPEN will cause the following to occur:

- 42F (open relay) will energize causing its respective seal-in contact (42Fa) to close and causing contact 42Fb in the closing circuit to open,

- 42F contacts (not shown) close to energize the 480 VAC motor,

- Valve motor drives valve open until a limit switch contact opens to deenergize relay 42F, and

- Limit switch contacts reposition during valve stroking to extinguish green closed light, and illuminate red open light.

Assuming the MSSV is open initially, taking the keylock switch to CLOSE, will cause the following to occur:

- 42R (close relay) will energize causing its respective seal-in contact (42Ra) to close and causing contact 42Rb in the opening circuit to open.

- 42R contacts (not shown) close to energize the 480 VAC 3 motor.

- Valve motor drives valve closed until a limit switch contact opens to deenergize relay 42R.

- Contacts reposition during valve stroking to extinguish red open light and illuminate green closed.

4. Turbine Bypass Valve Control

The control features for the turbine bypass valves are explained in SDM N32/C85.

III. OTHER SYSTEM RELATED INFORMATION

A. OPERATIONAL

1. MSIV Hydraulic Damper Cylinder Failures

At an operating BWR, inboard MSIV's were opened at a reactor pressure of 850 psig with the outboard MSIV's closed. The piping between the inboard and outboard MSIV's, was at approximately atmospheric pressure before the event. As the inboards were stroking open, a pressure spike in the steam lines between the MSIV's accelerated the lifting of the main disk and caused a pressure spike in the hydraulic damper cylinder. Consequently, it is important to adhere to operating procedures that limit differential pressure against which the MISV's are opened.

2. Low-Low Set Function

Upon reaching the opening setpoint of the first SRV in the relief mode, 1103 psig, the Low-Low Set function is armed. This means that immediately the second Low-Low Set SRV will open because RPV pressure will be above its

Low-Low Set opening valve. This is consistant with GE design and has proven successful in preventing the next group of valves from opening at 1113 psig.

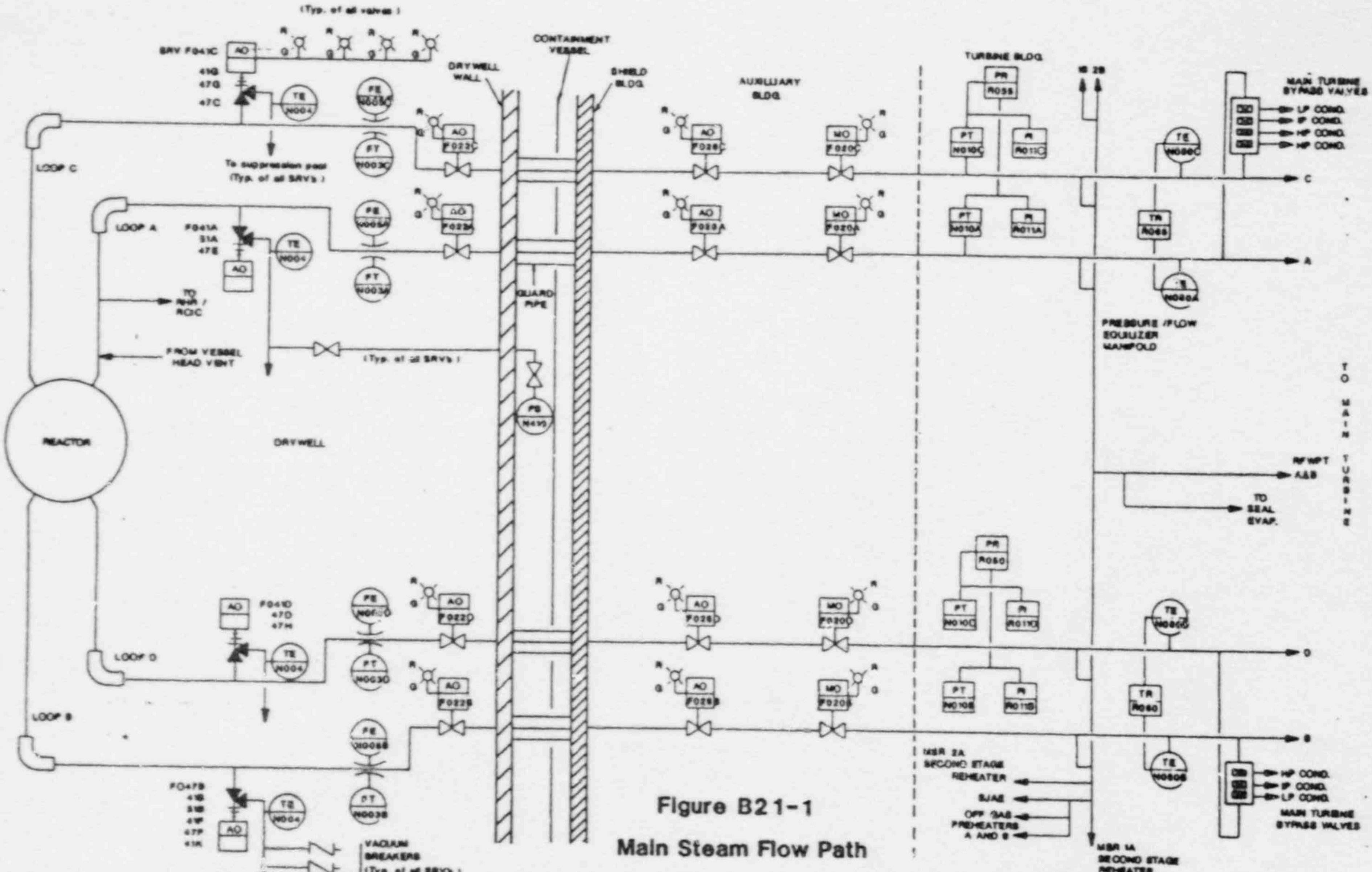


Figure B21-1

Main Steam Flow Path

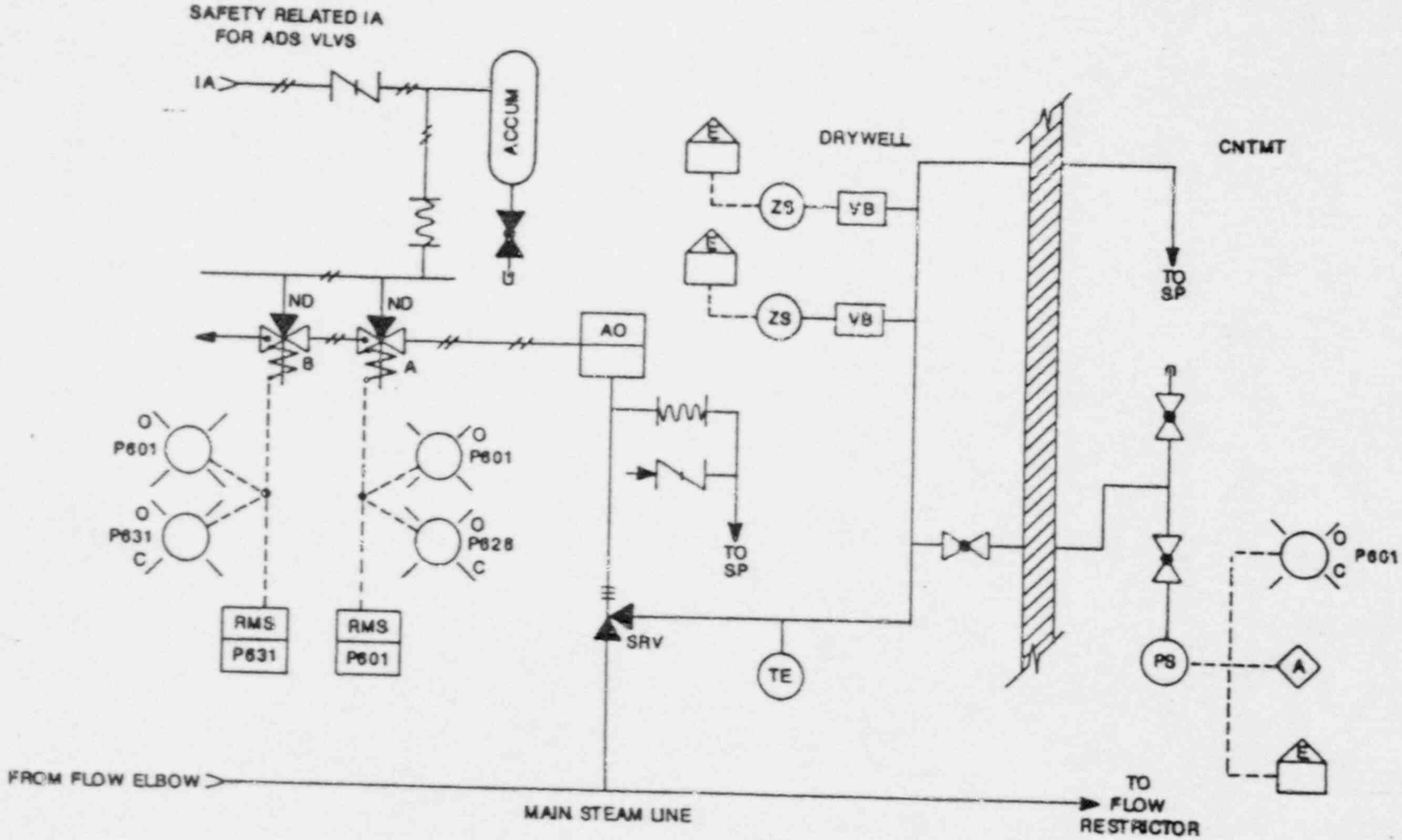


Figure B21-2
Safety Relief Valve Flow Path

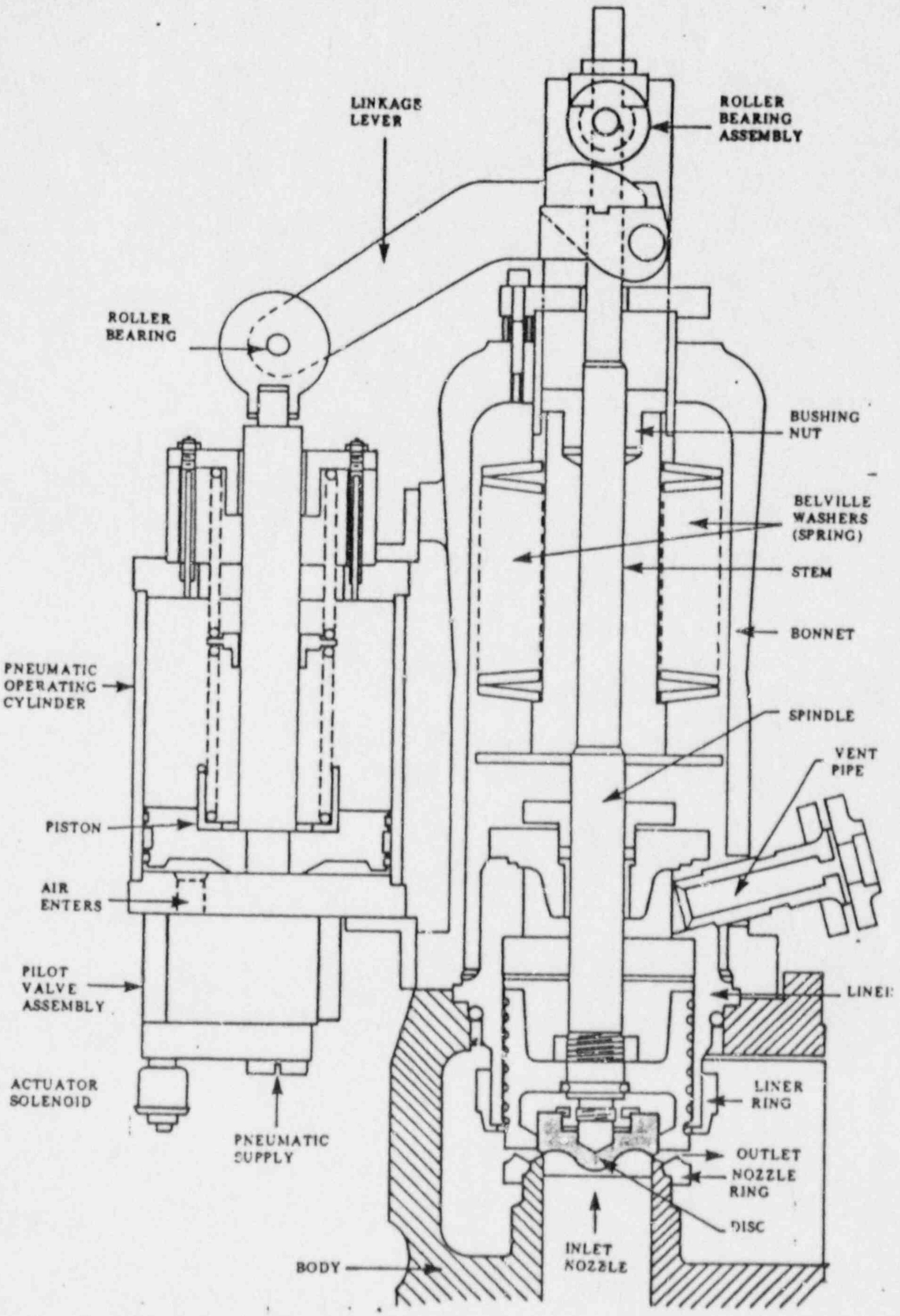


Figure B21-3
Safety Relief Valve

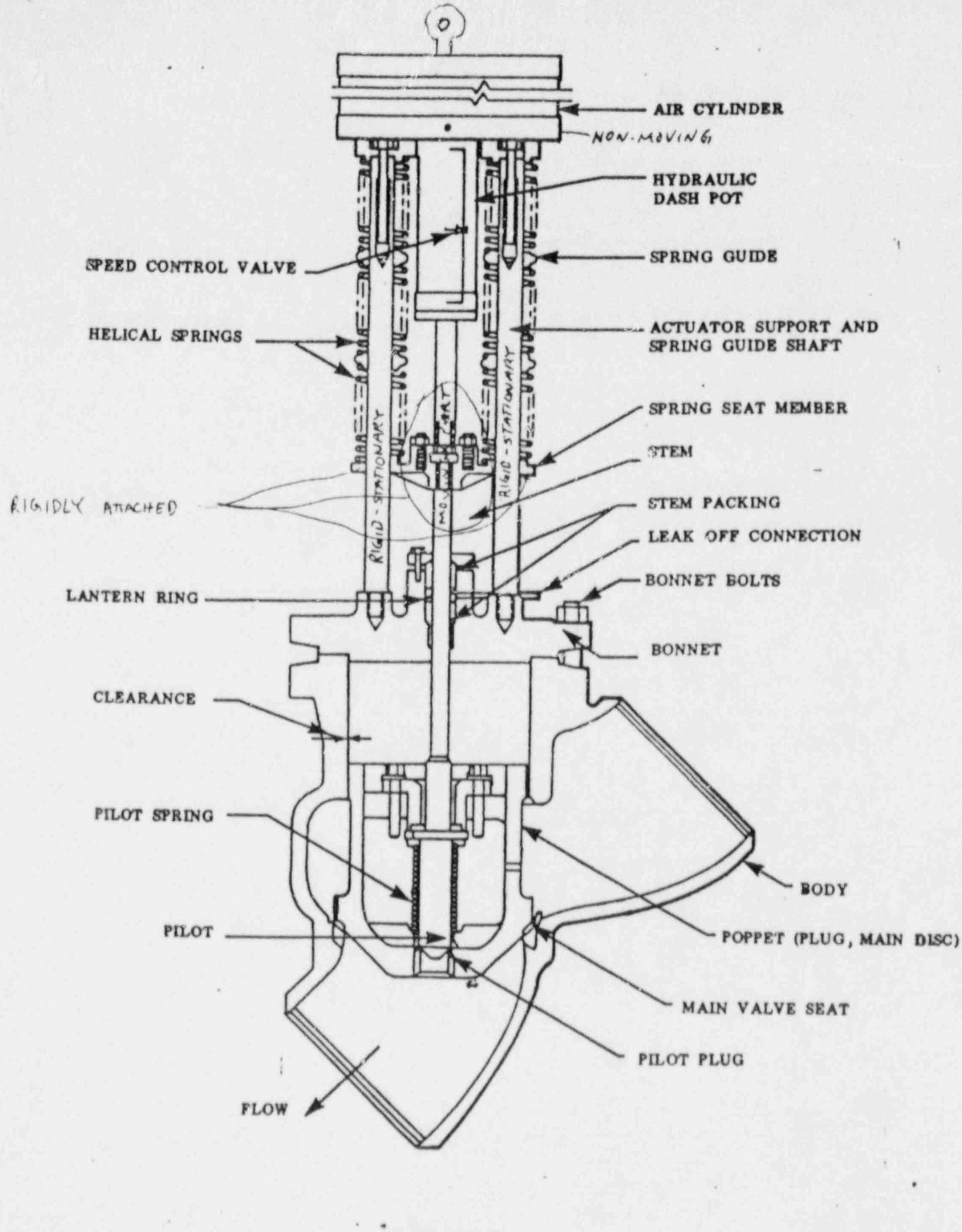
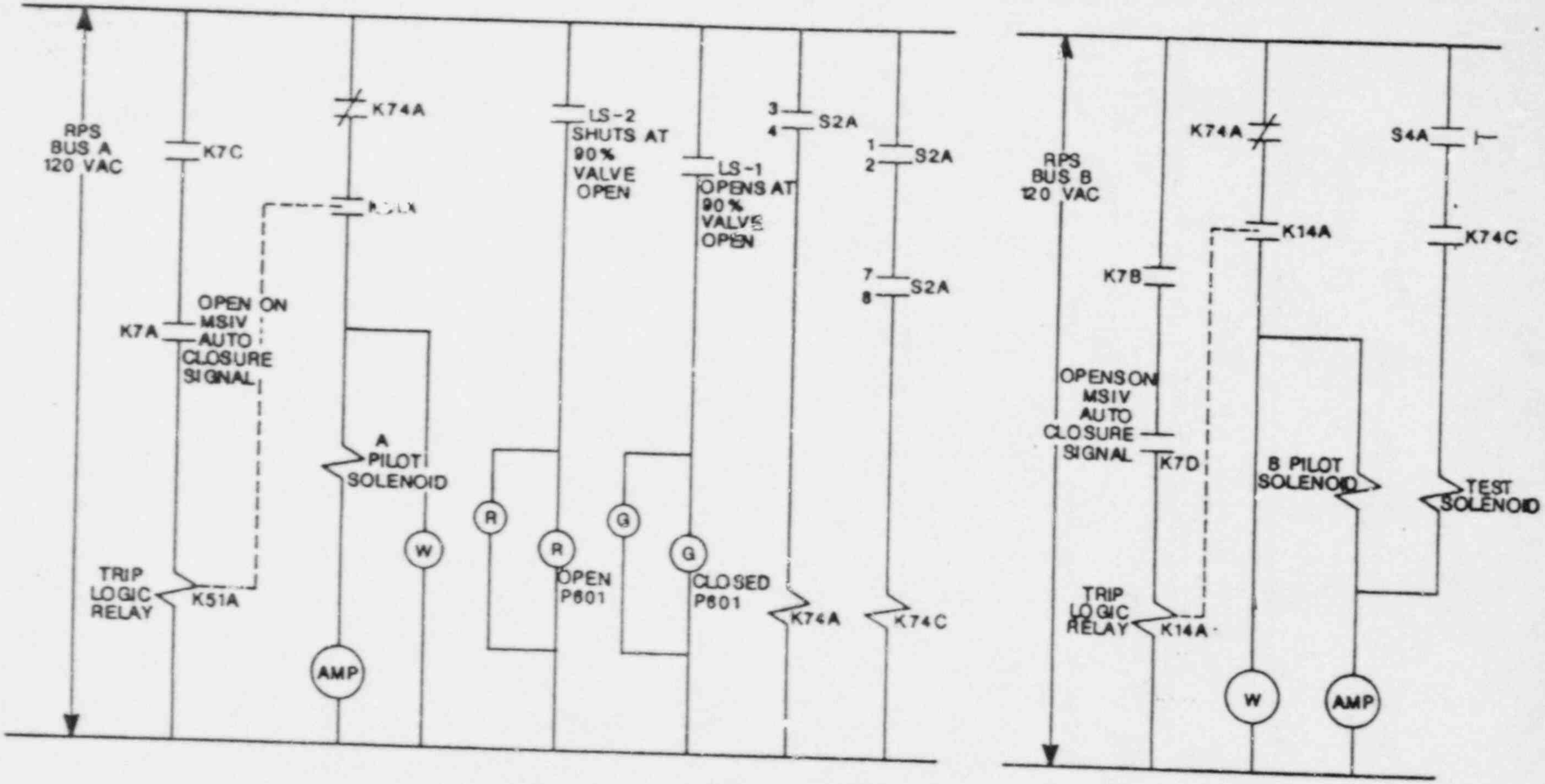


Figure B21-5
Main Steam Isolation Valve

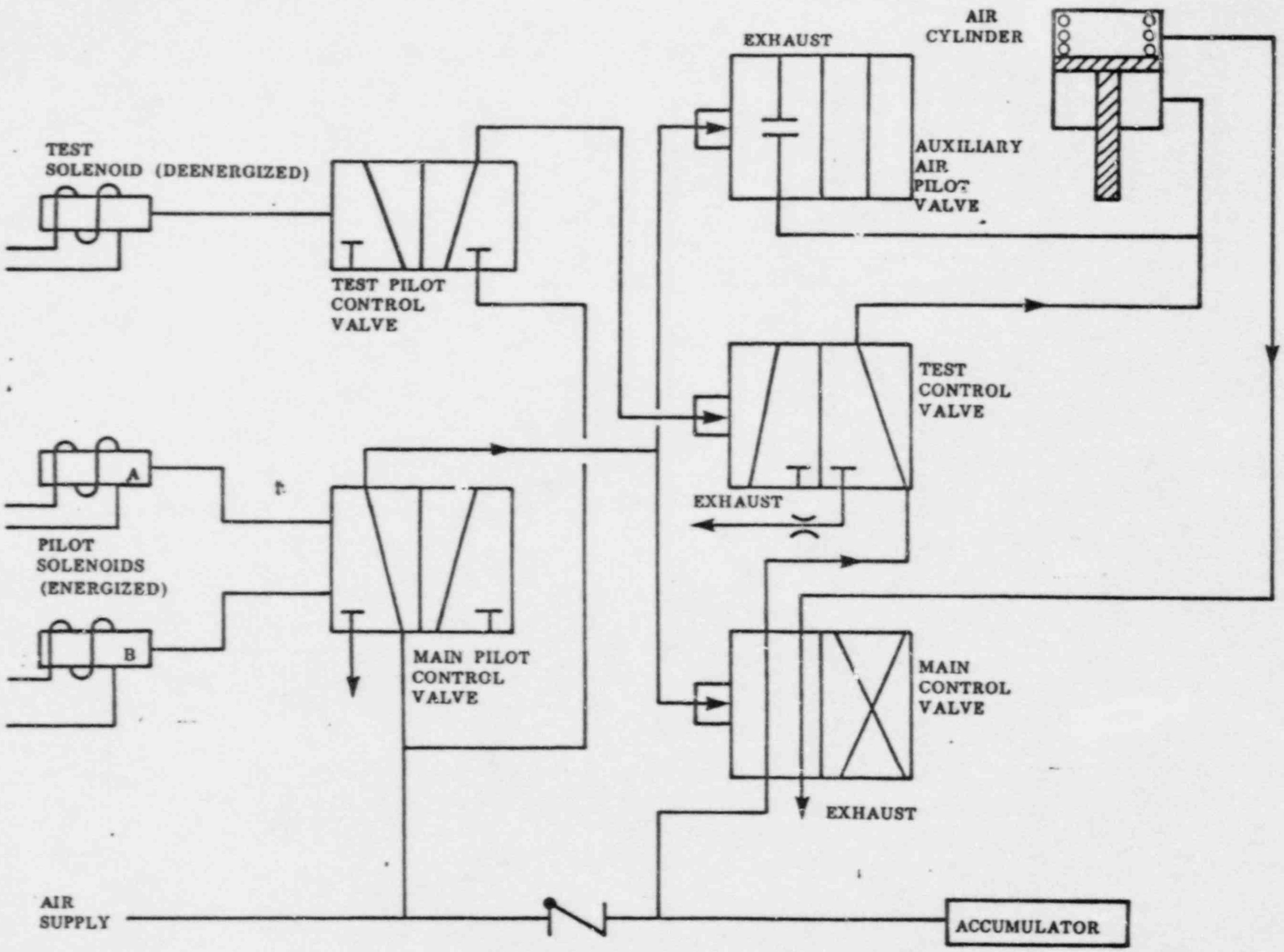


Maintained Contact

Manual Control Switch (S2A)

Position	Contacts 1-2	Contacts 3-4	Contacts 7-8
Test	X		X
Auto			X
Closed		X	

Figure B21-11
Control Logic For MSIV F028A



Opening Operation

Figure B21-12A
MSIV Pneumatic Control

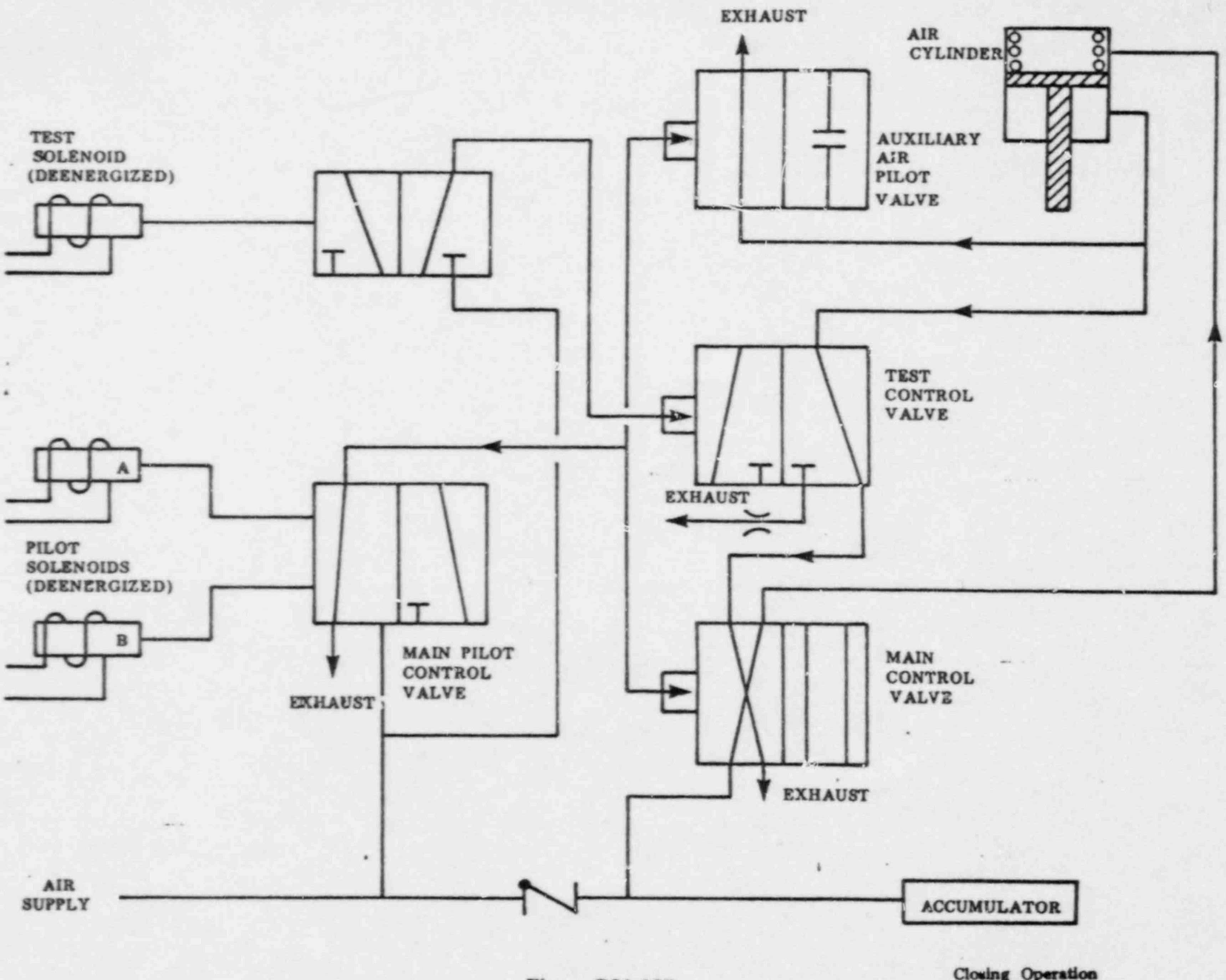


Figure B21-12B
MSIV Pneumatic Control

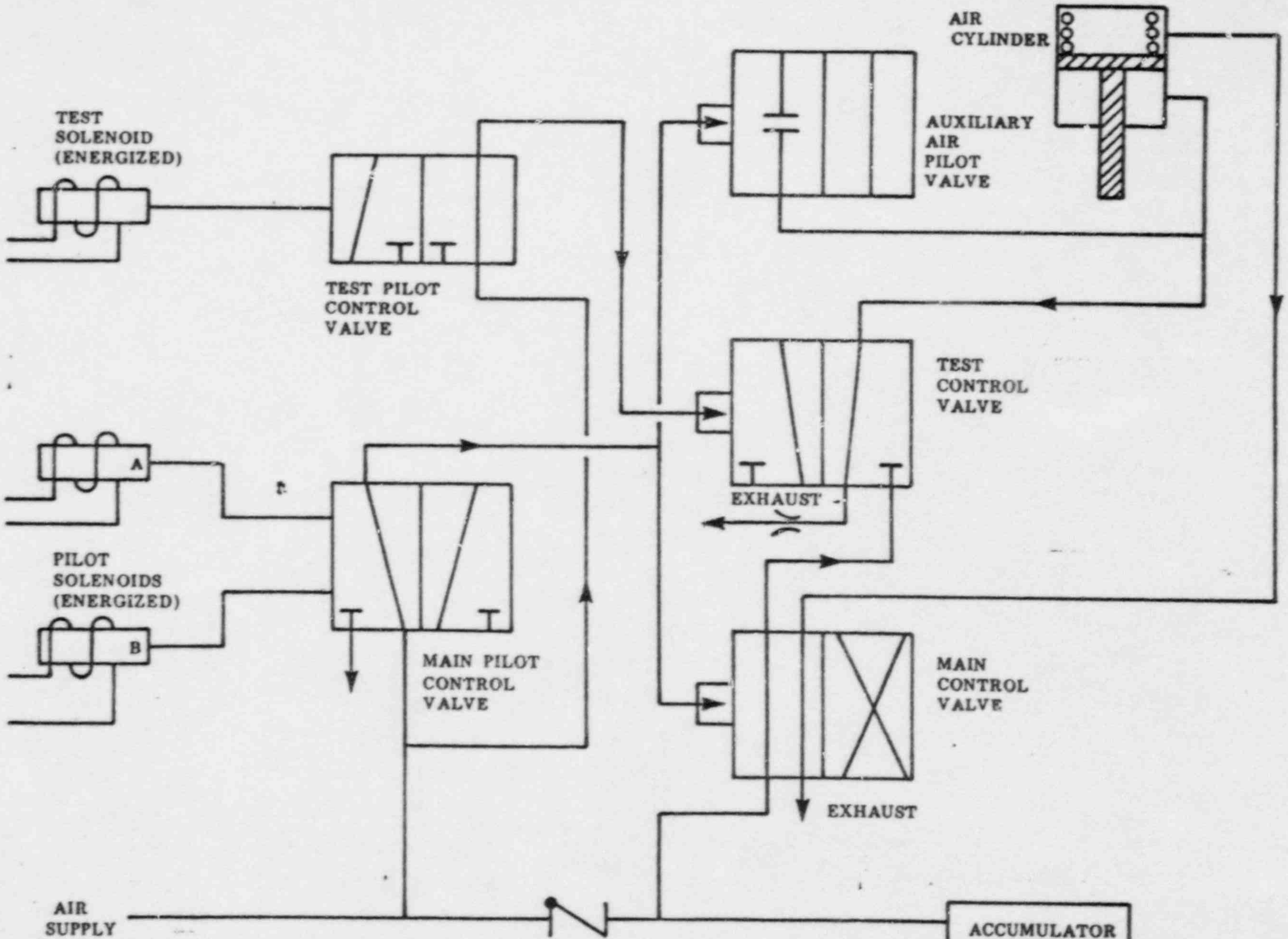


Figure B21-12C
MSIV Pneumatic Control

Testing Operation

INFORMATION/NOTICE LIST

78-1[illegible] Monticello, Big Rock, Pilgrim
- Buna-N Shelf Life limited to 7 yrs.

79-01A Acetal plastic material and Buna-N breakdown w/heat
- Remove all plastic parts, replace elastomers w/Viton or EPDM

80-11 Summer, oil on elastomers breakdown of EPDM (oil from thread lub)
- Change out to Viton

81-29 EQ test NP 8300 Viton breakdown 720 Mrad
- replace w/ EPDM

82-52 EQ test NP-1 Viton breakdown
- replace w/ EPDM

83-57 ASCO Assembly problems (diaphram reversed)

84-23 EQ test Elastomers stick to valve metallic parts

84-68 Cable insulation breakdown inside solenoid (Calloway/Wolf Creek)

SER 36-84 Cable deficiences voltage drop to solenoid

85-08 NP serices w/resilient seats & Viton elastomer not EQ > 20 Mrad

85-17 Grand Gulf elevated temp. >180^0 sticking lower core-to-plug nut faces Model HTX-8323-20V
- replaced w/NP8323A20E

85-84 Robinson 2, Turkey Point 3.4 Adequacy of accumulator volume.
- Fail Safe Test Methods

86-57 Brunswick 2 valve disk-to-seat sticking (EPDM) Hydrocarbon/temperature/excessive Lubricants (potential brass interaction)
- replace w/Viton

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February 12, 1988
PY-CEI/OIE-0303 L

Mr. A. Bert Davis
Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Perry Nuclear Power Plant
Docket No. 50-440
MSIV Solenoid Testing Update

Dear Mr. Davis:

This letter provides an update on the results of the physical and chemical testing of the MSIV solenoid elastomer materials as well as an interim report on the progress of environmental testing. Conclusions drawn from this data to date support the root cause evaluations performed for the recent solenoid failures documented in our letter dated December 30, 1987 (PY-CEI/OIE-0297 L).

Both the chemical and environmental testing re-substantiates the conclusion of heat degradation as the root cause for the November 3 event. Additionally, the recent information is considered to have no impact upon the conclusion of mechanical binding for the November 29 event. Completion of the physical and chemical analyses of the EPDM components concludes all investigations associated with both the November 3 and November 29 events. The only testing remaining is the Environmental qualification testing (EQ), as well as the solenoid inspection currently planned for October, will continue as originally scoped. A final report detailing the EQ results is expected to be submitted in April 1988.

Very truly yours,

M. D. Lyster for

Al Kaplan
Vice President
Nuclear Group

AK:cab

Enclosure

cc: T. Colburn
K. Connaughton
Document Control Desk

FEB 16 1988

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B/66

I. Main Steam Isolation Valve Stroke Testing

In accordance with our commitments following the November 29, 1987 event as documented in our letter dated December 30, 1987 (PY-CEI/NRR-0297 L), the modified monthly slow closure surveillance was performed weekly on a staggered basis until the January 1988 outage. Each test was completed satisfactorily. The mc ed surveillance verified proper operation of the dual solenoid by fully c. .ng each Main Steam Isolation Valve (MSIV) utilizing the test solenoid, followed by taking the control switch to close. Stroke testing will be performed once every two weeks on a staggered basis until February 28, 1988 at which time the testing frequency will return to monthly, and continue until the first refueling outage.

II. Physical and Chemical Testing

Analysis of the MSIV elastomers taken from those failed solenoids in the November 3 event was completed on January 29, 1988 by a local contractor laboratory, Ricerca Incorporated. Attachment 1 is the final report detailing the testing performed and conclusions drawn concerning the failure mechanism of the MSIV solenoid valves.

This report summarizes the analytical investigation of the MSIV Pilot Solenoid failure, which caused the MSIV's to fail a fast closure test on November 3, 1987. The purpose of the investigation was to determine the reason the Ethylene Propylene Diene Monomer (EPDM) exhaust port seats did not release from the exhaust port when the pilot solenoids were de-energized.

Elastomer parts from failed, nonfailed, and "never used" pilot solenoid valves were examined. Two components, o-rings and elastomer exhaust port seats, from each of the solenoid valves were examined. The instrument air supply to the containment building, to the solenoid and to the two MSIV solenoid inch actuator line were analyzed for the presence of hydrocarbons.

The o-rings and the exhaust port seats are composed of EPDM, and were both in contact with brass valve components. They were exposed to the same instrument air and at the same temperature. The investigation focused on the o-rings (vs. the elastomer seats) because of their accessibility and advanced degree to degradation. Changes occurring at the o-ring are considered comparable to changes occurring to the elastomer seats.

Two hypotheses were proposed as causes for the MSIV failure. The first hypothesis proposed that a hydrocarbon contaminant in the instrument air supply affected the o-rings and seats. The second hypothesis proposed that excessive heat caused degradation of the EPDM which changed its properties and caused the failure of the valve.

A. Analysis Plan

The approach to determining the cause of the failure included both nondestructive and destructive tests.

All nondestructive tests were performed first to minimize loss of limited sample size. These tests included:

1) Optical Microscopy to record the appearance of the components,
2) Gas Chromatography analysis of the air supply,
3) Hardness and Compression Set of the o-rings and/or seats to record physical changes in the samples.

Once these results were reviewed, the destructive tests were performed. These included:

1) Infrared Spectroscopy of the o-rings to identify chemical changes,
2) Scanning Electron Microscopy and Energy Dispersive X-ray microanalysis to record physical and elemental differences between the o-rings and seats, and
3) Thermal analysis of a control o-ring to determine the effects of temperature.

Differences between the failed, nonfailed and "never used" valve components were compared.

B. Observations

Physical Changes

The compression set and hardness of the o-rings and seats progressively increased from control to nonfailed to failed valve components. This indicated that the EPDM components became less elastic. The indentations in the energized solenoid elastomer seats were deeper in the failed MSIV valves than in the nonfailed valve. The outside (100-150 micrometers) layer of the failed o-ring had changed and appeared more porous than the outside layer of either the nonfailed or control o-ring.

Chemical Changes

Several (3) failed o-rings showed evidence of a stearate material on their surface (an additive utilized in manufacturing EPDM to allow the molecules to be mobile against each other [rubber characteristic]). Copper and oxygen were present on the surface and 100-150 micrometers into the interior of the failed o-rings. Copper was also present on the surface of the failed seats.

C. Conclusions

Heat degradation of the EPDM caused the valve seats to deform, extruding the seat into the valve port. This provided additional seat-to-port surface area which increased the force necessary to separate the two when the valves were actuated. In addition, stearate compounds were found on the surface of the EPDM material inside the failed valves. Ricerca postulates that the presence of stearate compounds would probably act like glue and further increase the force necessary to separate the seat and port during valve actuation. The stearate had migrated as a result of the heat degradation of the EPDM.

The second possible cause, hydrocarbon degradation of the EPDM material, was discounted because no condensable hydrocarbons were found in the valves' air supply and the EPDM did not exhibit a "spongy" appearance. Hydrocarbon attack of EPDM would typically produce swelling of the EPDM. Instrument air analysis for hydrocarbons indicated only trace levels, far below concentrations considered to be harmful to EPDM material. Further, analysis of the EPDM materials from the pilot solenoids provided no indication that high levels of hydrocarbons were present to attack the o-rings and elastomer seats.

III. Environmental Testing

A. Background

The environmental testing of the ASCO dual coil solenoids began on December 30, 1987. The purpose of this testing at various oven temperatures is to further confirm the root cause of the failures experienced, establish a threshold temperature for EPDM degradation and perform a comparison with Viton material. The test procedure is proprietary in nature and is available for review upon request.

The environmental testing is conducted by thermally aging ASCO solenoid valves with EPDM components both with and without the Dow Corning 550 lubricant added as well as Viton components.

These valves are aged in three separate ovens at varied temperatures, 140°F, 225°F and one at a temperature to obtain a valve body temperature of 284°F (hottest oven). The solenoids are cycled at various intervals of 30, 42 and 92 days. This frequency was chosen to best represent the current monthly testing as well as the original Technical Specification quarterly frequency. The parameters monitored during the test are pressure decay (upon de-energization), voltage and current, and in-rush current during cycling and air leakage.

Test Configuration

Group #	Sample Number	Seat	Oven Temp	Cycle (Days)
1	20226-02-01-14	EPDM	140°F	0,30,60,90,92
	20226-02-02-14	EPDM	140°F	0, 92
	20026-02-03-14	VITON	140°F	0,30,60,90,92
	20226-02-04-14	VITON	140°F	0, 92
2	20226-02-05-14	EPDM (Dow Corning 550 removed)	284°F Body	0,30,60,90,92
	20226-02-06-14	EPDM	284°F Body	0, 42,84,92
	20226-02-07-14	EPDM	284°F Body	0,30,60,90,92
	20226-02-08-14	EPDM (Dow Corning 550 removed)	284°F Body	0, 42,84,92
	20226-02-09-14	VITON	284°F Body	0,30,60,90,92
	20226-02-10-14	VITON	284°F Body	0, 42,84,92

3	20226-02-11-14	EPDM	$225^{\circ}F$	0,30,60,90,92
	20026-02-12-14	EPDM	$225^{\circ}F$	0, 92
	20226-02-13-14	VITON	$225^{\circ}F$	0,30,60,90,92
	20226-02-14-14	VITON	$225^{\circ}F$	0, 92

Acceptance criteria is based upon the satisfactory operation of the valves upon demand without sticking or binding. When de-energized, the valves are monitored and required to vent a 27 cubic inch air tank from 90 to 30 psig in 2.0 seconds or less. These conditions simulate those required in the plant in order to achieve a satisfactory MSIV closure time.

B. Test Progress

Test preparation was completed on December 28, 1987 with actual test initiation on December 30. This included the collection of baseline data such as visual inspection and functional tests. The test configurations were finalized and ovens brought up to temperature to begin the thermal soak. Data collection continued with no problems until January 22, 1988 when it was noted that the air supply to the test specimens had been depleted. The air supply was immediately restored with pressure decay closely monitored. On January 25, the ovens were shutdown in order to determine the location of apparent leakage. All of the solenoids remained energized throughout this evolution. No leaks were identified in the $140^{\circ}F$ oven. In the oven with the $284^{\circ}F$ solenoid body temperature, leaks were identified through the exhaust port on specimen numbers 5 and 6. A leak at the junction between coil A and the valve body was also discovered on specimen 11 in the $225^{\circ}F$ oven.

To monitor the leakage, the exhaust port effluent for specimens 5 and 6 were piped to the exterior of the test oven and flow elements installed. The ovens were the re-energized and testing continued. The total lost time was approximately 24 hours. Following the thermal cycle and with the exhaust port effluent directed outside of the oven, the total leakage was measured to be 95 milliliters per minute for specimen 5 and 1 milliliter per minute for specimen 6. These leakages are considered minimal and would not affect the functional operation of the valve.

On February 1, 1988, the first 30 day cycle of the required solenoid valves was performed. All test specimens operated upon demand with the exception of numbers 5 and 7 (both from the hottest oven).

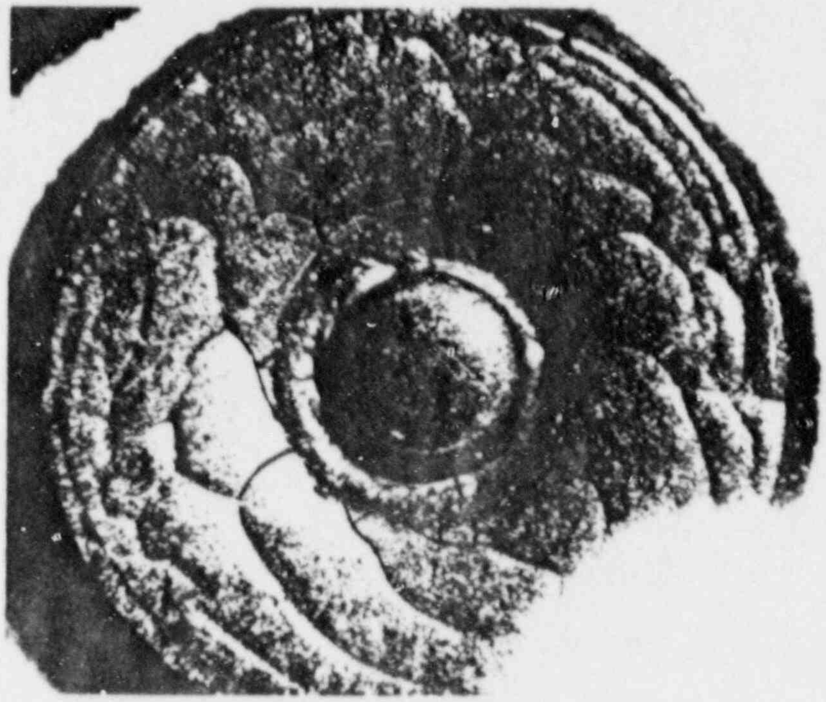
Test specimen 5 was cycled twice. During the first cycle, it failed to operate until approximately 30-60 seconds after de-energization. During the second cycle, test specimen 5 operated on demand and vented the air tank in 1.56 seconds. Considering the above, the test specimen remained in the test program for further analysis.

Three attempts were made to cycle test specimen 7. Test specimen 7 failed to operate and did not vent the air tanks. As a result, different combinations of de-energizing/energizing the two solenoid coils were tested, and radiographs were taken to determine where the sticking or binding of the solenoid may be occurring. However, during the last mode when both solenoid coils were de-energized, test specimen 7 operated and vented the air tank as required. Test specimen 7 was then removed from the test program for analysis of parts.

The radiographs from test specimen 7 ("A" coil was energized and "B" coil de-energized) indicated sticking or binding had occurred on the core to the solenoid base sub-assembly. Visual inspection during disassembly was conducted at Ricerca utilzing the troubleshooting work order previously developed and microscopic photos indicates that sticking may have occurred on the disc holder seat to the "B" side port hole of the solenoid body (See attached photos of the solenoid internals). Further evaluation/anlaysis is planned for the solenoid elastomers and results will be included in a future update or the final report.

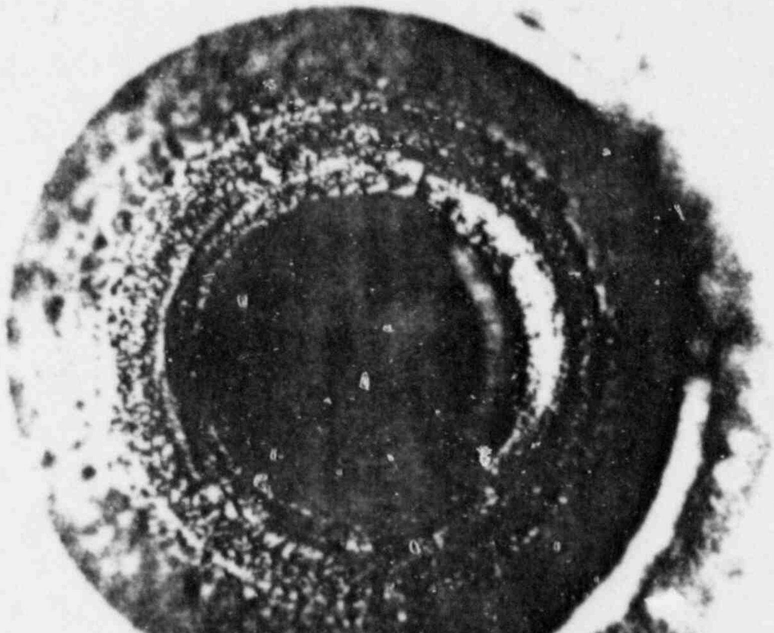
C. Conclusions

Both failures are considered to be the result of degredation due to the elevated test temperature. The temperatures at which the anomalies occurred are at the threshold of EPDM material and are considered to have no operability impact upon the valves in the plant. The temperature in the plant is significantly cooler than this test temperature (as monitored under our temporay temperature element program. All tests performed at representative temperatures of the plant (140°F) successfully operated upon demand. In addition, the samples that are not functioning properly are being tested at more severe conditions than the qualification test conducted by GE.



DISC HOLDER SEAT

"B" SIDE



SOLENOID PORT HOLE

"B" SIDE

FINAL REPORT

MAIN STEAM ISOLATION VALVE

SOLENOID VALVE FAILURE

ANALYTICAL CHEMISTRY RESULTS

January 29, 1988

File No. 8702342M
Notebook Ref.: 20294, p. 106

~~8802180054~~ 200 pp.

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Executive Summary

SECTION I
Executive Summary

Introduction

This report summarizes the analytical investigation of the Main Steam Isolation Valve (MSIV) Pilot Solenoid failure, which caused the MSIV's to fail a fast closure test on November 3, 1987. The purpose of the investigation was to determine the reason the EPDM exhaust port seats did not release from the exhaust port when the pilot solenoids were de-energized.

Elastomer parts from failed, nonfailed, and "never used" pilot solenoid valves were examined. Two components, o-rings and elastomer exhaust port seats, from each of the solenoid valves were examined. The instrument air supply to the containment building, to the solenoid and to the two inch actuator line were analyzed for the presence of hydrocarbons.

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Several (3) failed o-rings showed evidence of a stearate material on their surface. Copper and oxygen were present on the surface and 100-150 micrometers into the interior of the failed o-rings. Copper was also present on the surface of the failed seats.

Conclusions

Instrument air analysis for hydrocarbons indicated only trace levels, far below concentrations considered to be harmful to EPDM material. Further, analysis of the EPDM materials from the pilot solenoids provided no indication that high levels of hydrocarbons were present to attack the o-rings and elastomer seats.

Both the chemical and physical changes which did occur to the o-rings and seats could be explained by the presence of excessive heat (Hypothesis 2). At higher temperatures, the EPDM material will soften which would allow a deeper indentation to occur in the seats. Higher temperatures would also encourage chemical interactions between the EPDM and the brass valve body. The temperature and the probable presence of a stearate compound on the valve seats could result in some bonding which would retard the operation of the valves.

Root Cause Hypotheses

SECTION II
Root Cause Hypotheses

Statement of Hypotheses

Hypothesis 1

The first hypothesis states that a contaminant in the instrument air could have affected the EPDM o-rings and elastomer seats within the failed valves. If hydrocarbons were present, they would absorb into the EPDM, making it spongy. If the instrument air contained significant quantities of hydrocarbons, all of the MSI pilot solenoids would have been exposed. The hydrocarbons would not induce migration of copper or oxygen into the EPDM material. If a solid material contaminated the instrument air, an accumulation of these particles would be expected on the o-rings and at the elastomer seats.

Hypothesis 2

The second hypothesis states that elevated temperatures affected the EPDM material of the o-rings and elastomer seats in the failed valves. The elevated temperatures changed the EPDM material, causing the elastomer seats to stick to the brass valve body. Physical and chemical changes would have occurred at both the o-ring and the elastomer seats. Interactions between the brass and the rubber would be possible if temperatures were high enough to cause the components in the EPDM formulation to migrate.

Sequence of Analyses

The study was organized into two basic types of analyses: nondestructive and destructive. The nondestructive tests were performed first, to minimize the loss of limited sample. Once these results were reviewed by CEI personnel, decisions were made on how to proceed. The destructive tests were first performed on the o-rings, and then on the seats.

Three types of samples were compared: components from a failed valve, a nonfailed valve, and a "never used" control. the investigation focused on the o-rings (vs. the elastomer seats) because of their accessibility, larger sample size and advanced degree of degradation. Changes occurring at the o-rings were believed to be correlate to changes occurring at the elastomer seats.

A few tests were also performed on the solenoid valve bodies.

The instrument air was sampled at the following locations: the air supply to the containment building, the air supply to the solenoid, and the air supply to the two-inch actuator line.

Table I lists the samples, identifications, descriptions and the applied analysis methods. Samples MSIV24, 27, and 28 were identified by CEI as components removed from "failed" pilot solenoid valves. Sample MSIV26 was identified as components from a pilot solenoid which was in service, but did not fail.

Within the main steam isolation valve pilot solenoids, two component types were examined. The first was the o-rings. The o-ring was determined to be EPDM, which was compressed between two components of the brass pilot solenoid valve body (see Diagrams I & II). The second compoment was an elastomer seat, which provided the sealing surface at the exhaust port when the pilot solenoid is energized. The seats were also composed of EPDM, and were in constant contact with the brass cone-shaped exhaust port, within the same pilot solenoid body as the o-rings (Diagrams I & II). The o-rings and seats, having endured the same physical service conditions within the same valve bodies, were considered to be of equal value for evidence of failure mechanisms. The o-rings have more surface area in contact with the brass valve body. They are also compressed between two metal surfaces to form a seal. Therefore, they were considered to be advanced cases of elastomer degradation providing direct evidence to root cause. The o-rings, however, are a passive component of the pilot solenoid, and their degraded condition did not contribute to the failure of the seat to release from the exhaust port orifice when the solenoid was de-energized.

Analytical Methodology

Gas chromatography was used to evaluate the quality of the instrument compressed air system. Samples of compressed air from the Plant system were collected and submitted for analysis to determine if hydrocarbons were present, which could have caused elastomer degradation, leading to sluggish valve performance.

Durometer hardness tests were conducted. The elastomer hardness is an important property in valve applications. The elastomer must be soft enough to conform and thereby seal pneumatic ports. The hardness test measures the resistance to indentation which is dependent on elastomer modulus and viscoelasticity.

Compression set was evaluated. The compression set test is intended to measure the ability of an elastomer to retain elastic properties after prolonged compression. Elastomers in valve applications must be resilient enough to "take up the slack" due to thermal expansion/ contraction of valve components and provide an effective seal.

Optical and scanning electron microscopy were used to examine physical (morphological) changes which occurred to the o-rings and seats. Energy dispersive x-ray microanalysis spectroscopy (EDS) was used to examine chemical changes which occurred at specific locations in the sample. The exterior surfaces of the seats and o-rings were examined using the above mentioned techniques. In order to examine interior changes, cross-sections of the samples were also prepared and the same techniques were applied.

Infrared spectroscopy (IR) was used to examine various EPDM o-rings from various MSIV pilot solenoids. The purpose of the examinations was to detect possible chemical changes which might be related to the failure of elastomer seats to release from exhaust ports of pilot solenoids when de-energized.

Differential scanning calorimetry (DSC) and thermal gravimetric analyses (TGA) were conducted. The thermal characteristics of virgin (control) o-rings were investigated by these techniques. The purpose of the investigations was to determine the thermal stability of the o-rings and the effect of copper on this stability.

Analysis Results

Gas Chromatography

No significant quantities of condensable hydrocarbons were found within the instrument air (Appendixes A & B).

Durometer Hardness Tests

O-rings and valve seats from operational MSIV26 were slightly harder than unused rings and seats. However, o-rings and valve seats from failed MSIV24, 27, and 28 were significantly harder than unused counterparts (Appendixes C & D).

Compression Set

O-rings from operational MSIV26 displayed very little compression set. However, o-rings from failed MSIV24, 27, and 28 had significant compression set (Appendix E).

Optical Microscopy

The o-rings from the failed pilot solenoid valves (MSIV24, 27, 28) have flattened and are more brittle than the nonfailed (MSIV26) or control o-rings (Appendix F, Figures 9, 10 & 12).

Within the failed valves, the rubber o-rings have adhered to the brass of the valve body itself (Appendix F, Figure 13).

The exhaust port seats from the failed pilot solenoids have an indentation which is deeper than the nonfailed seat (Appendix H, Figure 8).

Scanning Electron Microscopy/Energy Dispersive X-ray Microanalysis

A significant quantity of copper can be found on the failed o-ring surface, as well as penetrating 100-150 micrometers into the failed o-rings (Appendix G, Tables I & II).

A secondary layer has formed on the outside of the failed o-rings. This layer, in addition to containing copper, is more porous and contains oxygen (Appendix G, Figures 13, 17, 19).

The amount of calcium is significantly less in the failed and nonfailed o-rings (MSIV24, 26, 27, & 28) than in the control (Appendix G, Tables I & II).

More copper is present at the surface of the indentation of the failed seats than in the nonfailed and control seats (Appendix H, Table I, Figure 6).

No morphological changes have occurred to the rubber beneath the indented areas of the seats (Appendix H, Figures 10 & 14).

Infrared Spectroscopy

Several of the o-rings have stearate based organic acid salts such as calcium stearate on their surfaces. Excessive levels of an organic acid salt at the surface of the o-ring is believed to be the result of heat on the EPDM (Appendix I, Page 2).

Stearate salts at temperatures above 250°F would liquefy and when cooled, could act as a glue between the EPDM and the brass valve body (Appendix I, Page 3).

Thermal Analysis

The EPDM thermal analysis results show that a weight loss degradation begins near 300°C (572°F). No significant change in this degradation temperature was observed when the o-rings were allowed to be in contact with copper metal. Additional experiments (DSC) to 200°C (392°F) showed no evidence for a catalytic effect of copper on the oxidation of the o-rings. In the absence of copper, the o-rings show evidence of oxidation near 270°C (518°F) (Appendix J, Page 2).

The above experiments were dynamic in that a temperature increase of either 10° or 20°/minute was used. As a result, the above tests are very accelerated and provide little information as to the long-term stability of the o-rings.

Evaluation of Results

There are two possible explanations for the failure of the solenoids to provide sufficient air flow to the MSIVs to allow adequate rapid closure times. The two hypotheses, stated briefly, are:

Hypothesis I: Contaminants from the air system were absorbed by the EPDM, which caused a significant change in its elastomeric properties. Or, contaminants from the air system deposited in the valve which caused physical jamming.

Hypothesis II: The solenoids were exposed to some sort of a transient elevated temperature, which resulted in elastomer degradation.

Ricerca performed physical and chemical tests on the failed, nonfailed and "never used" o-rings and elastomer seats. We drew conclusions as to the cause of failure based on observations from both EPDM o-rings and EPDM valve seats. Failure of the valve was caused exclusively by degradation of the seat. However, as stated earlier, valuable and parallel information can be drawn from the observations of changes to the o-rings, since the o-rings were subjected to the same environment as the seat.

All the evidence generated supports the second hypothesis for failure. Namely, excessive heat caused a degradation of the EPDM components in the failed valves. No evidence was observed which would support the contaminated air hypothesis (Hypothesis 1). The results and their implications are discussed in the next two sections.

Instrument Air Contamination (Hypothesis 1)

There was some question regarding possible contaminants in the instrument air and their contribution to the failure of the elastomers. No particulates were found on the o-rings or seats which could cause a physical jamming of the valve mechanisms. This effectively eliminates airborne particulates as a cause.

The extensive elemental analyses which were performed on the EPDM materials involved did not disclose any elements associated with the introduction of hydrocarbons. If hydrocarbon contaminants were present, a "leaching process" would occur by absorbing and desorbing cycles. Material would then be expected to migrate from the EPDM rubbers. This leaching process could cause the EPDMs to harden. The spectral results show no evidence for unexpected hydrocarbons on any pieces removed from service. Silicon lubricants were present. But, no foreign hydrocarbons were present on elastomer surfaces or on residual EPDM material scraped from the valve bodies. In GC analyses performed on instrument air, hydrocarbon levels were very low. Hydrocarbons would be suspected of causing oil components within the EPDM to migrate but not necessarily induce migration of a material such as the calcium stearate. Hydrocarbons fail to explain either the observations about copper or oxygen, or why the most extensive degradation occurred in portions of the parts physically in contact with the valve body. In fact, more severe degradation was observed in those areas most protected from hydrocarbons in the air. This is exactly the opposite from what we would expect if contamination of the plant air were the source of the failure. In short, no analytical results or service circumstances support EPDM failure as a result of hydrocarbon attack.

Elastomer Degradation Due To Elevated Temperature (Hypothesis 2)

While no analytical results support the attack of elastomer material by hydrocarbon contaminants, all observations support failure as a result of heat degradation. Evidence supports this failure mode in the form of embrittlement, cracking, and physical adherence of the elastomer parts to the metal valve body. This evidence is corroborated by the severe physical and morphological changes observed in elastomers from the failed pilot solenoids. Both physical and chemical evidence also supports copper catalysis as a contributor to elastomer degradation.

Evidence from Valve Seats

The EPDM valve seats actually provide the sealing surface in the valve body. Valves failed because the seats adhered to the valve body and prevented air flow.

We observed all of the same degradation characteristics in the valve seats that we saw in the o-rings. Likewise, we found a buildup of copper in the portion of the valve seat which was in direct contact with the sealing area. The elastomer seats from the three failed solenoids exhibited an increase in durometer hardness. Based on actual plant performance, this increase in the hardness of seats correlates to a loss of solenoid performance. As observed in the o-rings, the same type of calcium depletion from the interior of the seats and resultant buildup of stearate on the surfaces was discovered.

The last major observation is that the indentation in the valve seats is in direct correlation with the performance of that valve seat. The greater the indentation (usually called compression set) the poorer the performance of the solenoid valve. However, the seats from a given valve were not degraded as badly as the corresponding o-rings. If heat alone was responsible for degradation, seats and o-rings should be degraded equally. This difference in degradation supports copper catalyzed oxidation as an important effect that occurs after temperature excursions. The difference in degradation is a result of the ratio between the area of elastomer in contact with the brass valve body to total elastomer in a part. The o-rings had a large portion of its surface in contact with the brass, while the seats did not. This allows a higher portion of the o-ring elastomer to undergo degradative oxidation reactions.

Effects Expected from Elastomer Oxidation

When oxidation occurs in an elastomer material, bonds are broken and bonds are reformed. When a mechanical force is applied to an elastomer material, the rubber part can be deformed. Normally when the mechanical force is released, the part returns to its original shape. But, if the elastomer is locked in a deformed state when oxidation occurs, the part may be permanently deformed.

After chemical degradation, adhesion can develop between an elastomer and a solid pressed against it. All solids have roughness. The valve bodies in this case show machining marks so there is certainly some roughness associated with the metal. The longer an elastomer is pressed against the metal, the more probable it is that some adhesion will occur. This is particularly true if either oxidation reactions are occurring or if formulation ingredients are migrating to the surface of the elastomer.

Evidence from O-rings

The o-rings removed from failed valve bodies showed significant morphological (cracking, as well as adhesion to the valve body), chemical and physical changes. The chemical changes included migration of copper into the first 100-150 micrometers where the o-rings contacted the valve body. In this layer, there was a buildup of oxygen which is chemically attached to the elastomer. Depletion of calcium level from within the body of the o-ring was observed. The surface of the o-ring shows the presence of stearate salt. Stearates are common components of EPDM rubbers. The only source of copper was from the brass valve body itself. Metallic copper is not prone to migration through elastomers. It must have been removed chemically from the valve body as a salt and then diffused through the rubber. The buildup of stearate salts on the surface of the rubber and the loss of calcium from within the rubber, can be explained by calcium stearate diffusing to the surface of the o-ring. After trace amounts of etching of the brass body occurred, copper stearates could form which were free to back diffuse into the rubber. The rate of this phenomenon would be strongly governed by temperature. At higher temperatures, faster diffusion takes place, the more likely the etching of the brass, and subsequent back migration of the copper stearates will occur.

Physical testing of the o-rings has shown that their measured durometer hardness increased as a function of degradation. That is, the worse the physical appearance of an o-ring and the poorer the performance of the valve in service, the higher the durometer hardness measured. This physical result fits with the observations above. One of the possible functions of calcium stearate in an elastomer formulation is to provide internal lubrication or to mildly soften the material. If a substantial portion of the stearate has migrated to the surface, the part would be expected to harden. The presence of oxygen in the surface of the failed o-rings would be consistent with a hardening of this surface. Oxidation of elastomers makes them harder and more brittle.

Brown et.al. investigating the Brunswick shut down have concluded that some EPDM formulations undergo rapid exothermic reactions in the presence of oxygen and copper. Copper is a well-known catalyst for organic reactions and it frequently has been used to catalyze oxidation types of reactions. We did find a higher level of copper in the failed samples versus the nonfailed samples. Higher levels of copper existed in the most degraded areas of failed o-rings, specifically the surface 100 micrometers. The excess copper in these severely degraded elastomer regions correlates well with observed oxygen content in these same areas. Therefore, it is reasonable to conclude from all of the evidence that copper was involved in a catalytic oxidation process.

Summary

SECTION III
Summary

We believe that failure resulted from the following sequence of events:

a) The valves which failed experienced an excursion above their rated use temperature. Without this excursion, the ensuing events would either not have occurred or would have taken much longer to occur.

b) Stearate salts, most probably the calcium salt, migrated to the surface of the elastomer much more rapidly than normal due to the high temperature.

c) Copper salts derived from very minor attack on the valve body diffused back into the elastomer. The salt was most probably copper stearate.

d) Oxygen from the air in the valve diffused through the elastomer and caused oxidation reactions of the elastomer. These oxidation reactions were most probably catalyzed by copper.

e) As a result of the oxidation reactions, the elastomer lost its "rubber-like" properties. This could have caused it to stick to the valve seat.

f) When solenoid pressure was removed from the seat, it failed to draw back from the valve body and allow adequate air flow to actuate down stream equipment.

TABLE I

Sample	Date/Time	Description	Analysis
MSIV10	11/7/87:0730	P52-F556:Instr. Air at containment Penetration (outside), 10 min. blow down, 15 min. purge of sampler	GC
MSIV11	11/7/87:0745	P52-F556:Instr. Air at containment Penetration (outside) 10 min. blow down, 15 min. purge of sampler	GC
MSIV20	11/16/87:1600	B21-F028D:Solenoid valve body	IR, OM
MSIV21	11/16/87:1600	B21-F022A:Solenoid valve body (test solenoid)	IR, OM
MSIV22	11/16/87:1600	B21-F028A:O-ring, elastomer seat	CS, H, IR, & OM
MSIV24	11/16/87:1600	B21-F028B:O-ring, elastomer seat	CS, H, OM, SEM/EDX, & IR
MSIV25	11/16/87:1600	B21-F022C:O-ring, elastomer seat	CS, H, OM, & IR
MSIV26	11/16/87:1600	B21-F028C:O-ring, elastomer seat	CS, H, OM, SEM/EDX, & IR
MSIV27	11/16/87:1600	B-21-FO22D:O-ring, elastomer seat	CS, H, OM, SEM/EDX, & IR
MSIV28	11/16/87:1600	B-21-FO28D:O-ring, elastomer seat	CS, H, OM, SEM/EDX, & IR
MSIV Control	---	Neve. Used O-ring, elastomer seat	CS, H, OM, SEM/EDX, IR, & T
MSIV33	11/30/87:2200	B21-F022B:Instr. Air grab sample from 2" supply	GC

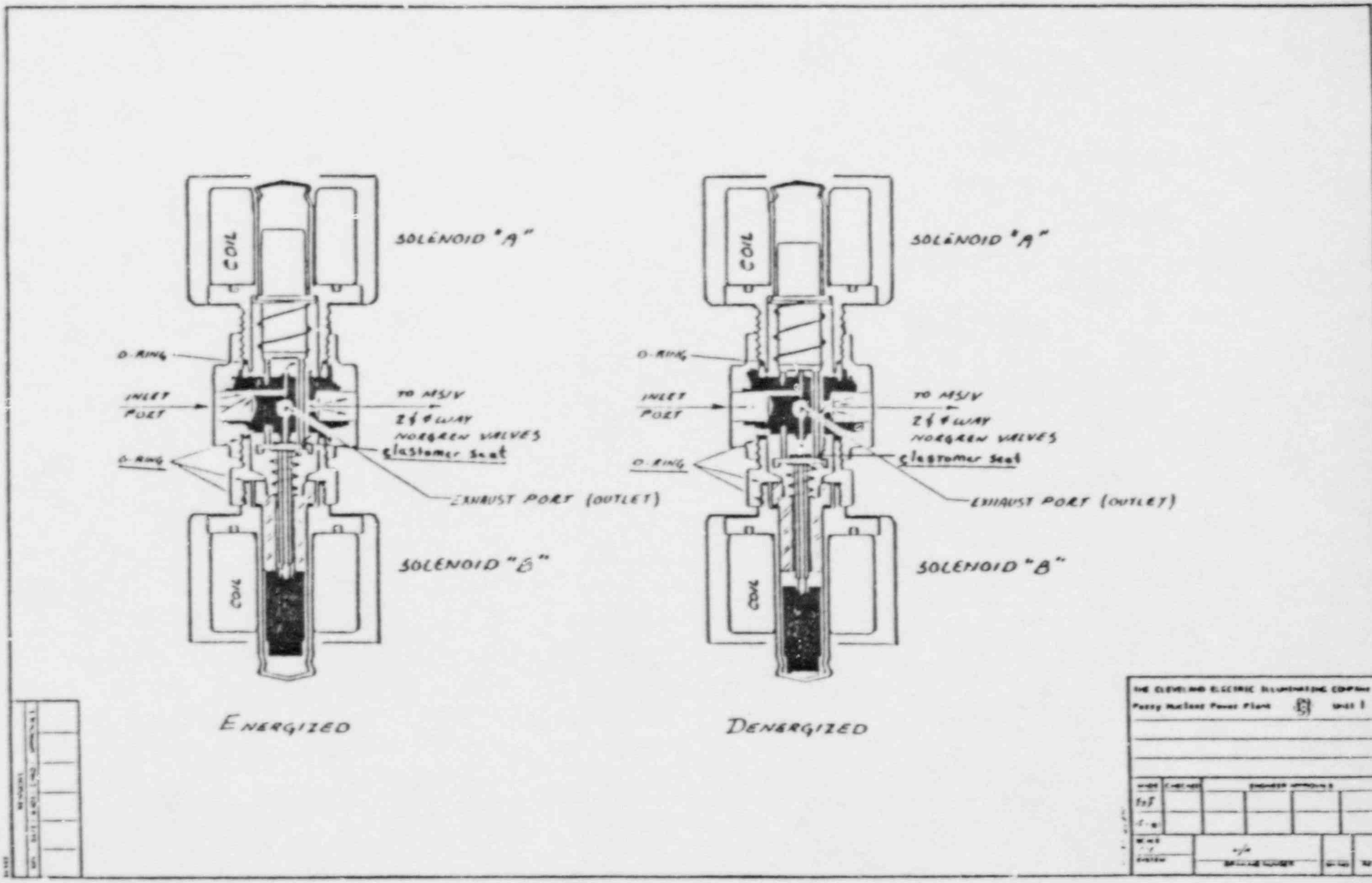
TABLE I (cont'd)

Sample	Date/Time	Description	Analysis*
MSIV34	11/30/87:2215	B21-F022B:Instr. Air grab sample from solenoid supply line	GC

*The abreviations used to identify the analysis were as follows:

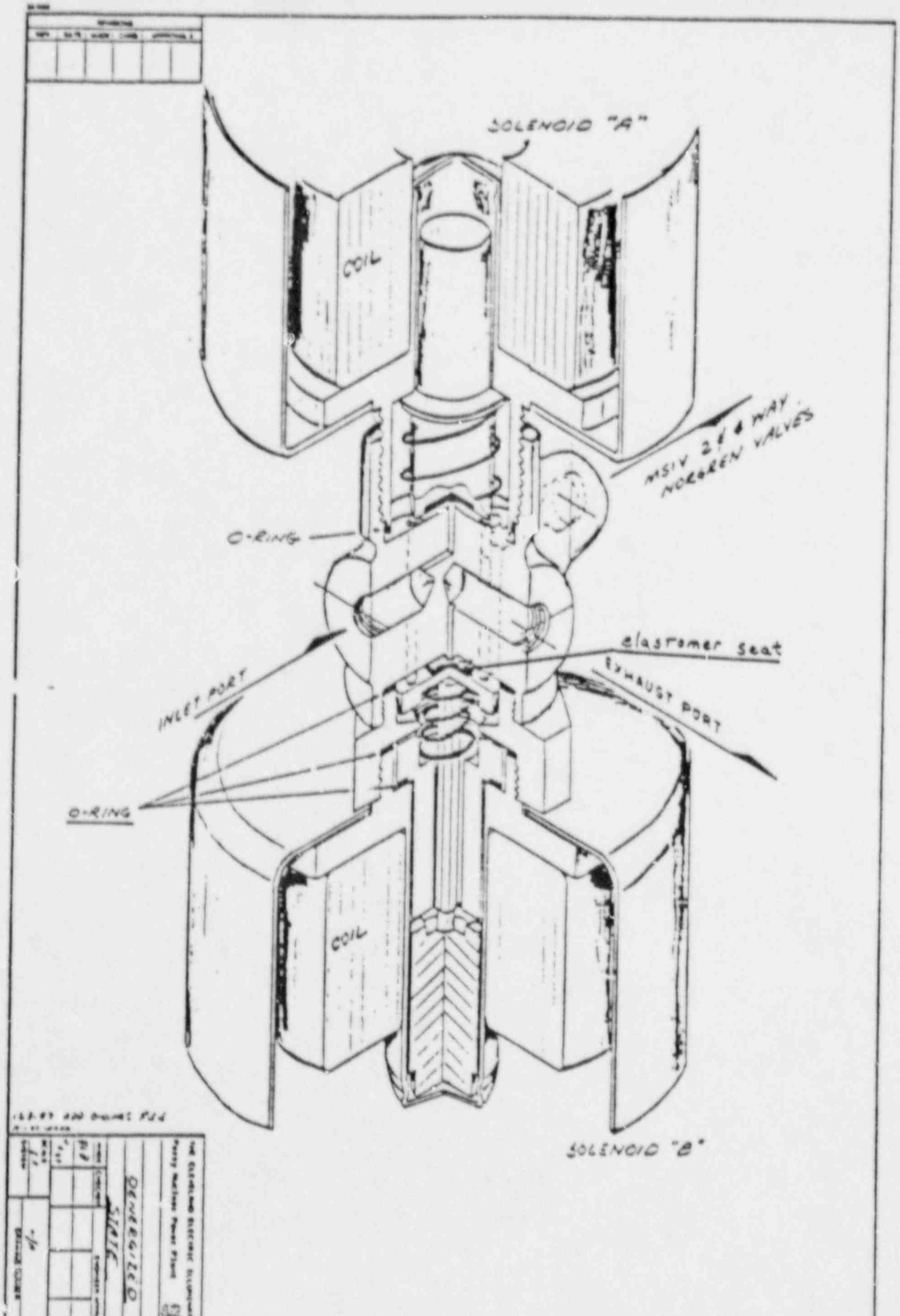
GC - Gas Chromatography; CS - Compression Set; H - Hardness; OM - Optical Microscopy; IR - Infrared Spectroscopy; T - Thermal Analysis; SEM - Scanning Electron Microscopy; EDX - Energy Dispersive X-ray Analysis

DIAGRAM I



SOLENOID "A"
COIL
O-RING
INLET PORT
TO MSIV
2 & 4 WAY
NORGREN VALVES
Elastomer Seat
O-RING
EXHAUST PORT (OUTLET)
SOLENOID "B"
COIL
ENERGIZED
SOLENOID "A"
COIL
O-RING
INLET PORT
TO MSIV
2 & 4 WAY
NORGREN VALVES
Elastomer Seat
O-RING
EXHAUST PORT (OUTLET)
SOLENOID "B"
COIL
DENERGIZED
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY
Perry Nuclear Power Plant
Unit 1

DIAGRAM 11



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APPENDIX A

Gas Chromatographic Analysis of Instrument Air Samples for Residual Hydrocarbons

TO: J. J. Grimm - CEI
FROM: G. E. Walls
DATE: November 13, 1987

SUBJECT: GAS CHROMATOGRAPHIC ANALYSIS OF INSTRUMENT AIR SAMPLES FOR RESIDUAL HYDROCARBONS

OVERVIEW

The quality of the Perry Nuclear Power Plant instrument compressed air system is maintained in accordance with a number of technical specifications. One specification states that the air system shall not contain hydrocarbons in excess of 1 ppm, quantified as methane. During a recent NRC inspection at the Plant, one or more air-actuated valves failed to operate properly. Two samples of compressed air from the Plant system were collected and submitted for analysis to determine if hydrocarbons were present.

RESULTS

Sample	Time	Area	ppm
	Noncondensable Hydrocarbons		
MSIV-10	1.54 min.	148,714	10.4
	Condensable Hydrocarbons		
	12.91 min.	10,226	0.7
MSIV-11	Noncondensable Hydrocarbons		
	1.54 min.	123,689	8.7
	2.58 min.	2,250	0.2
	Condensable Hydrocarbons		
	12.92 min.	5,756	0.4

7528 Auburn Road • Box 1000 • Painesville, Ohio 44077
216/357-3300

CONCLUSIONS

The results reported for condensable hydrocarbons are based on the chromatographic peak at 12.9 minutes exclusively. The fact that this peak occurs in the standard and blank, as well as in the samples, suggests the possibility of a chromatographic anomaly rather than the presence of a hydrocarbon. For this reason, the reported values of 0.7 ppm and 0.4 ppm for condensable hydrocarbons in samples MSIV-10 and MSIV-11, respectively, should be considered maximums rather than absolutes. It is my judgment that the instrument air samples submitted are, in fact, "clean" with respect to your specification.

PREPARATION AND ANALYSIS

A gas chromatographic system was assembled consisting of the following:

GC:	Varian 3760-5407
Detector:	Flame ionization
Injector:	Heated, flash vaporizing
Column:	18' x 3/16" OD stainless steel packed with SP-2100, 20%, on Chromosorb P, AW, DMCS treated, 60-80 mesh.
Data System:	Varian DS-654

Gas chromatographic operating conditions were as follows:

Injector Temp:	250°C
Detector Temp:	300°C
Column Temp:	50°C at injection, hold 2 min. at 50°C, program 10° per min. to 200°C, hold 3 min. at 200°C
Carrier Gas:	Helium at 40 mL per min.
FID Electrometer:	10^{-12} amps per mv
Injection:	2.5 mL gas

Preparation of Calibration Standard

Master Standard:	Methane in Nitrogen, 1.000% (vol.) Scott Specialty Gases Troy, Michigan 48083

A 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. Using a gas tight syringe, 2.5 mL of master standard were injected into the gas sample tube.

Concentration: $1\% \times \frac{2.5\ mL}{250\ mL} = 0.01\%$
$= 100\ ppm$

A second 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. Using a gas tight syringe, 2.5 mL of the 100 ppm standard were injected into the gas sample tube.

Concentration: $100\ ppm \times \frac{2.5\ mL}{250\ mL} = 1.0\ ppm$

A third 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. This sample represented a blank for instrument calibration.

Calibration

2.5 mL 1.0 ppm methane standard analyzed using conditions above.

Result: Chromatographic peak at 1.55 min.
Peak area 28,832

2.5 mL blank nitrogen standard analyzed using conditions above.

Result: Chromatographic peak at 1.51 min.
Peak area 14,609

Calibration Factor (CF) = $\frac{1\ ppm}{(28,832-14,609)}$

$= 7.03^{-5}$

Sample Analysis

	Peaks Detected Time	Area
MSIV-10	1.54 min.	148,714
	12.91 min.	10,226
		158,940

CF x 158,940 = 11.2 ppm, v/v, total hydrocarbons

Ricerca, Inc.

	Peaks Detected Time	Area
MSIV-11	1.54 min.	123,689
	2.58	2,250
	12.92	5,756
		131,695

CF x 131,695 = 9.3 ppm, v/v, total hydrocarbons

	Peaks Detected Time	Area
Lab Air		
Lab-48		
Ricerca HQ	1.54	116,747
	12.89	11,295
		128,042

CF x 128,042 = 9.0 ppm, v/v

Attachments:
1) Chromatogram of calibration standard
2) Chromatogram of nitrogen blank
3) Chromatogram of sample MSIV-10, Atten: 16
4) Chromatogram of sample MSIV-10, Atten: 128
5) Chromatogram of sample MSIV-11, Atten: 16
6) Chromatogram of sample MSIV-11, Atten: 64
7) Chromatogram of laboratory air

Gregory E. Walls

Gregory E. Walls

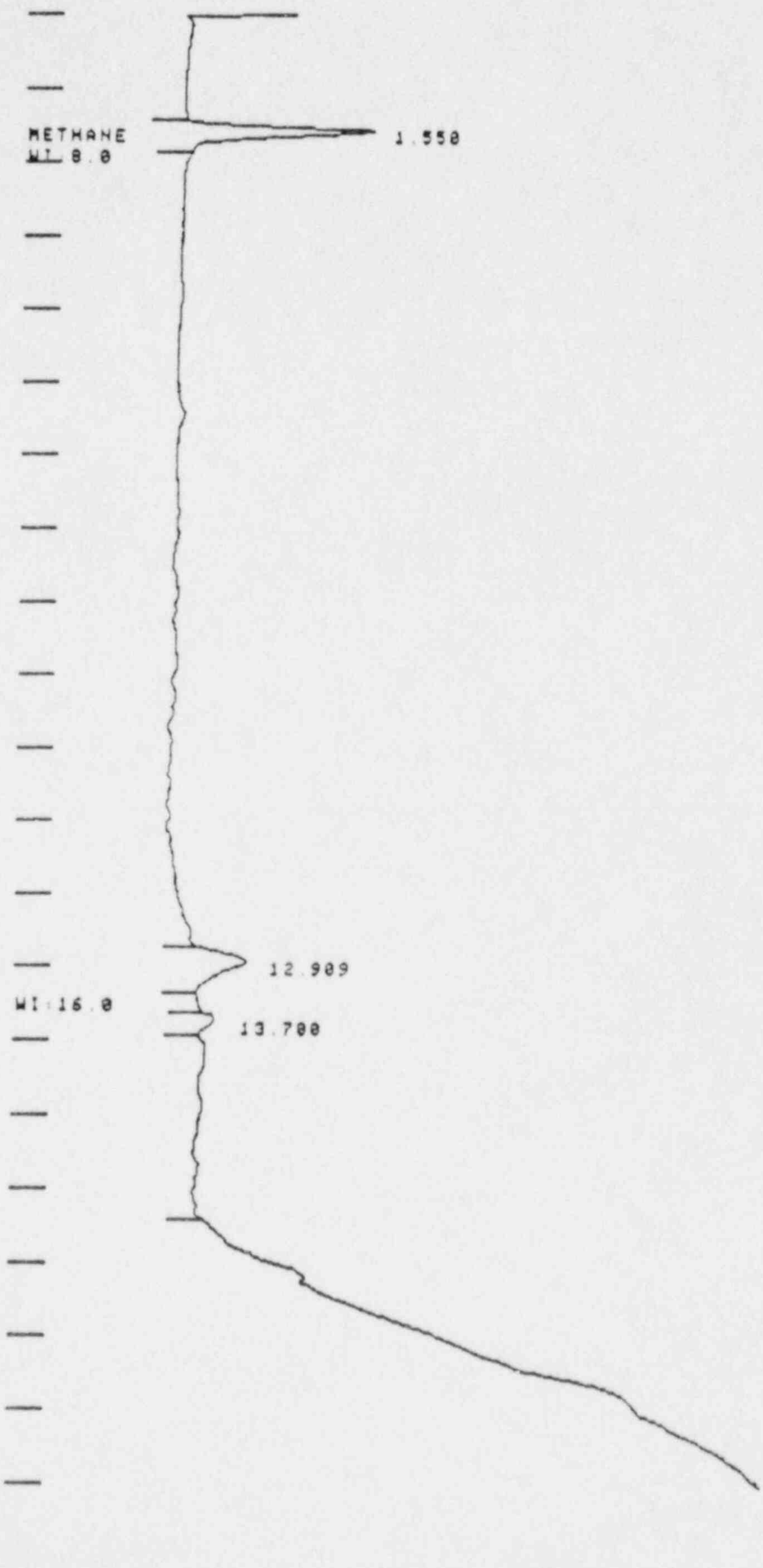
jsb
Atts.

File No.: 8702037G
Notebook Ref.: 20342-41/56-58

Reviewed By: L. Dvargya

CHART SPEED 1.1 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK

ATTACHMENT ①
PAGE 1



RECALCULATE ON FILE: HYDROC3

CHANNEL: 1A - 1   TITLE: HC IN PERRY PLANT COMP AIR   13:27   7 NOV 87

SAMPLE: 1 PPM CH4   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	57.9002	1.550	0.000	28832	BB	8.00
2		36.5150	12.909		18183	BB	? 18.75
3		5.5848	13.700		2781	BB	11.00

TOTALS: 100.0000   49796

DETECTED PKS: 3   REJECTED PKS: 0

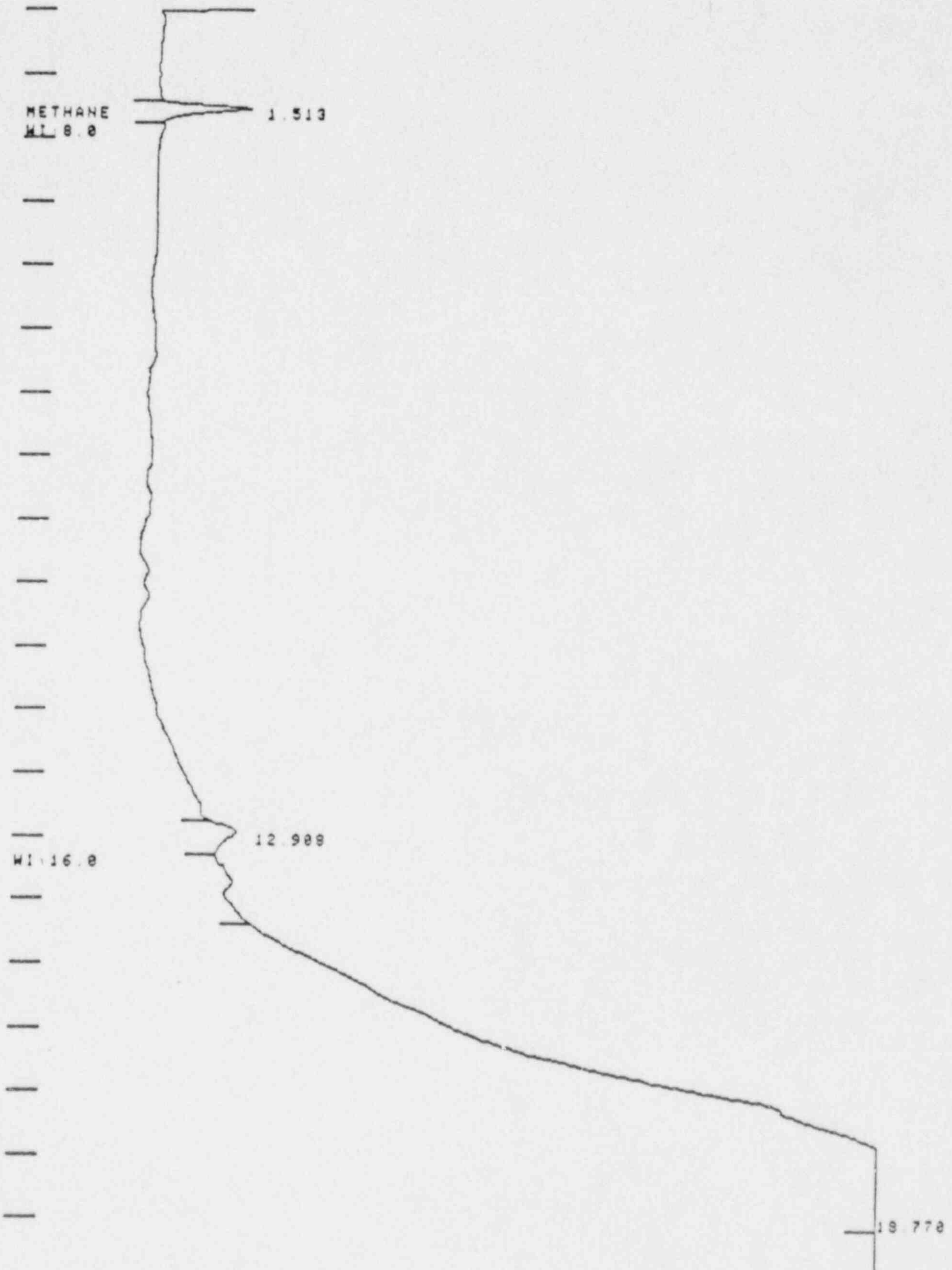
DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 12.6   OFFSET: 1960

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR TEMP 250^ ; DETECTOR TEMP 300^
ELECTROMETER 10-12 AMPS PER MV.
COLUMN TEMP: 50^, HOLD 2 MIN, 10^ PER MIN TO 200^
** G C SYSTEM 3760-5407 **

CHART SPEED 1.1 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK

ATTACHMENT ②
PAGE 1



RECALCULATE ON FILE: [illegible]

CHANNEL: 1A - 1   TITLE: HC IN PERRY PLANT COMP AIR   13:59   7 NOV 87

SAMPLE: HOUSE N2 BLK   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	58.5742	1.513	-0.037	14609	BB	7.06
2		41.4258	12.908		10332	BB	? 20.19
TOTALS:		100.0000		-0.037	24941		

DETECTED PKS: 3   REJECTED PKS: 1

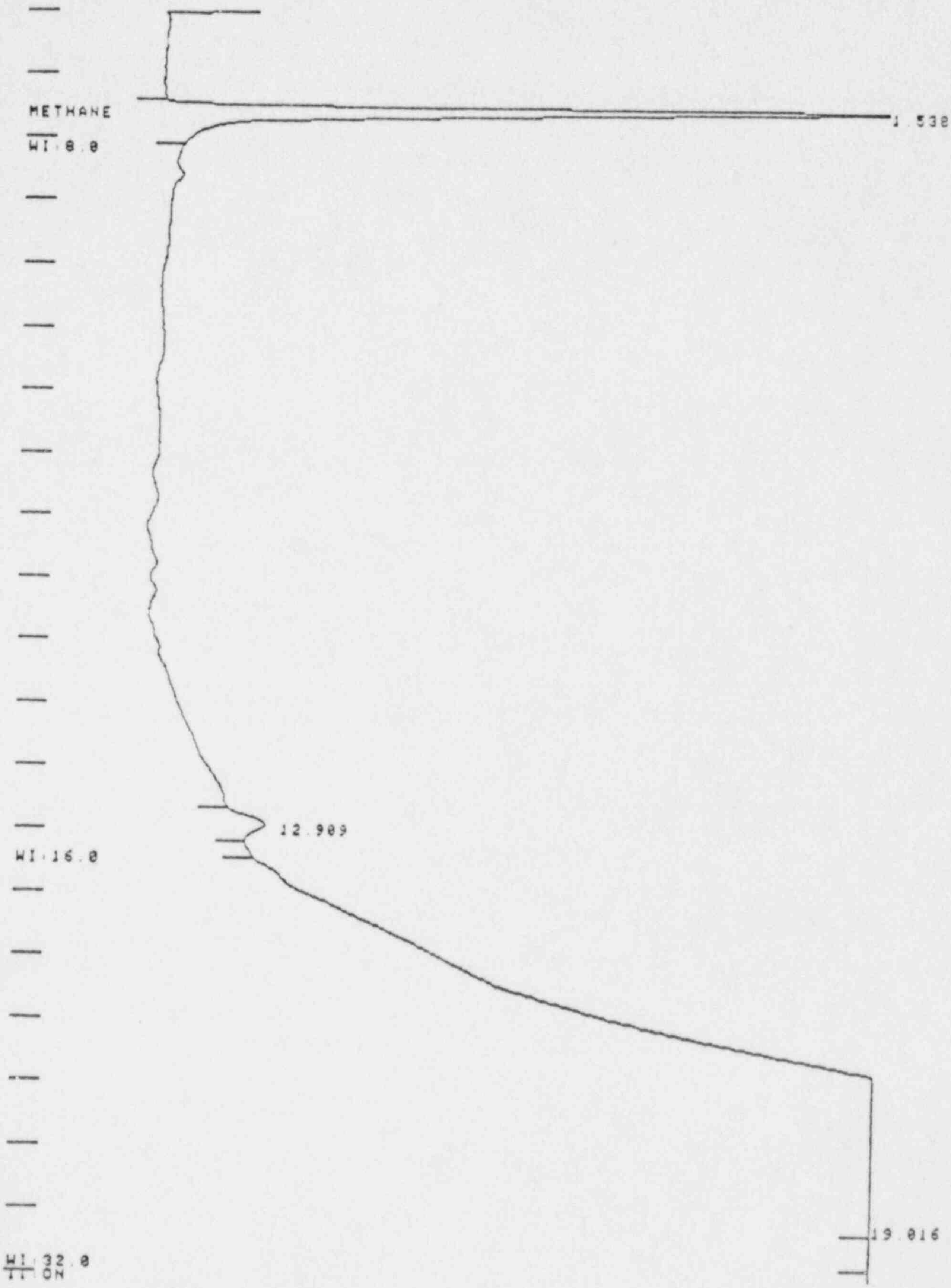
DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 12.6   OFFSET: 1940

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR TEMP 250^ ; DETECTOR TEMP 300^
ELECTROMETER 10-12 AMPS PER MV.
COLUMN TEMP: 50^, HOLD 2 MIN, 10^ PER MIN TO 200^
**   6 C SYSTEM 3760-5407   **

ATTACHMENT (3)
PAGE 1

CHART SPEED 1.1 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



CHANNEL: 1A - 1   TITLE: HC IN PERRY PLANT COMPR. AIR   14:31   7 NOV 87

SAMPLE: M S I V - 10   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	38.7885	1.538	-0.002	148174	BB	6.56
2		2.6769	12.909		10226	BB	? 22.50
3		58.5346	19.016		223605	BB	?111.00
TOTALS:		100.0000		-0.002	382005		

DETECTED PKS: 3   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

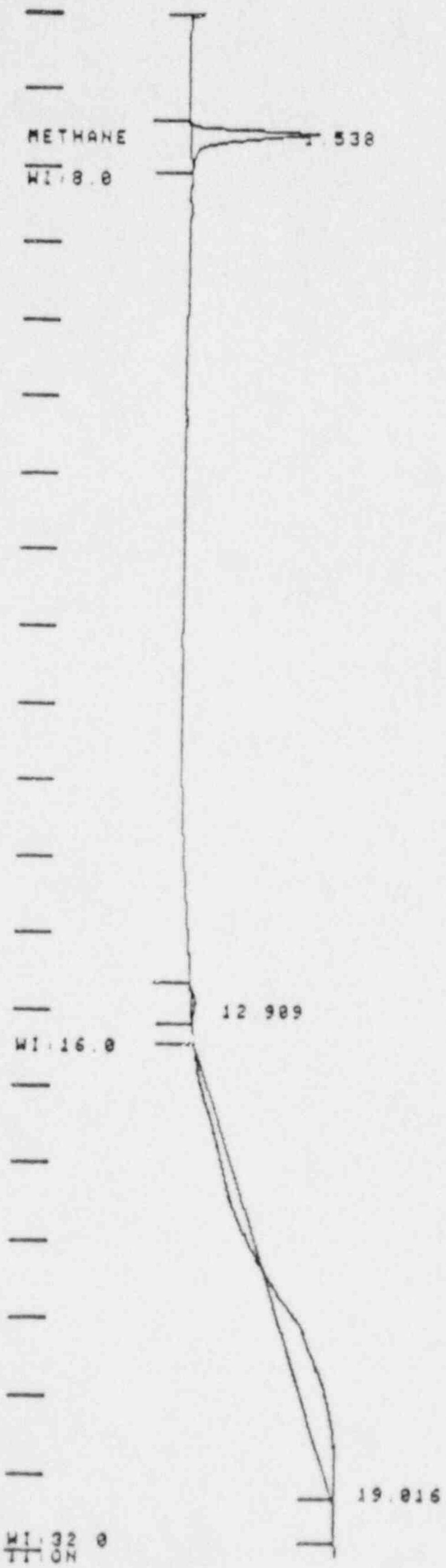
NOISE: 5.7   OFFSET: 2007

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR 250^, DETECTOR 300^
FID ELECTROMETER 10-12 AMPS PER MV.
COL TEMP: 50^, HOLD 2 MIN, PROG 10^ PER MIN TO 200^ *
** G C SYSTEM 3760-5407 **

POST RUN:
SAVE FILE: RAW   HYDRC3017

ATTACHMENT (4)
PAGE 1

CHART SPEED 1.1 CM/MIN
ATTEN: 128 ZERO: 5% 1 MIN/TICK



CHANNEL: 1A - 1   TITLE: HC IN PERRY PLANT COMPR. AIR   14:31   7 NOV 87

SAMPLE: M S I V - 10   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	39.5970	1.538	-0.002	148174	BB	6.56
2		2.7327	12.909		10226	BB	? 22.50
3		57.6703	19.016		215805	BB	?111.00
TOTALS:		100.0000		-0.002	374205		

DETECTED PKS: 3   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

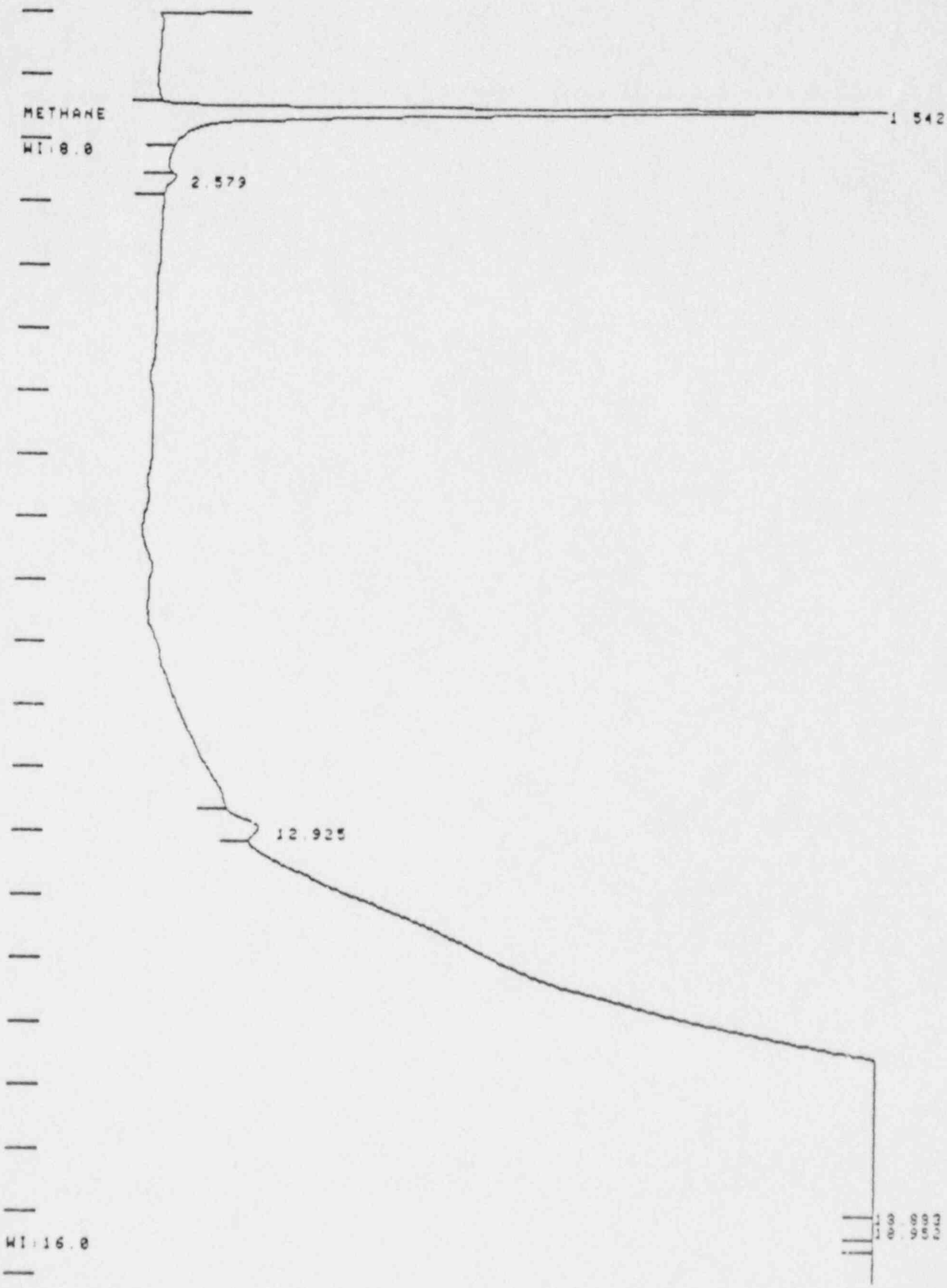
NOISE: 5.7   OFFSET: 2007

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR 250^, DETECTOR 300^
FID ELECTROMETER 10-12 AMPS PER MV.
COL TEMP: 50^, HOLD 2 MIN, PROG 10^ PER MIN TO 200^   *
**   G C SYSTEM 3760-5407   **

ATTACHMENT (5)

PAGE 1

CHART SPEED 1.1 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



CHANNEL: 1A - 1 TITLE: HC IN PERRY PLANT COMPR. AIR 15:02 7 NOV 87

SAMPLE: M S I V - 11 METHOD: HYDROC-3 CALCULATION: A% - ANALYS - OF

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE		W1/2 (SEC)
1	METHANE	29.5798	1.542	0.002	123689	BB		6.63
2		0.5381	2.579		2250	BB	?	8.44
3		1.3765	12.925		5756	BV	?	16.56
4		63.7159	18.883		266430	VV	?	16.63
5		4.7896	18.952		20028	VB	?	
TOTALS:		100.0000		0.002	418153			

DETECTED PKS: 5 REJECTED PKS: 0

DIVISOR: 1.00000 AMT STD: 1.00000 MULTIPLIER: 1.00000

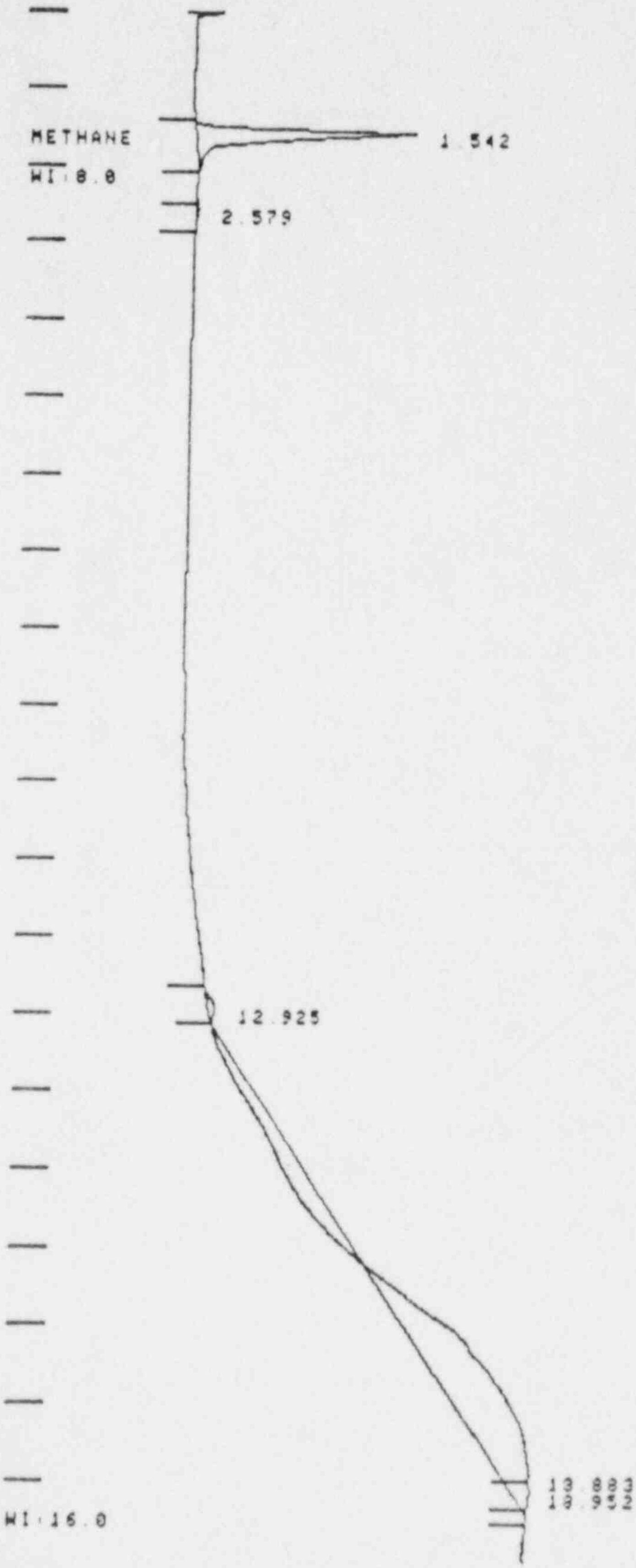
NOISE: 4.6 OFFSET: 2011

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR 250^, DETECTOR 300^
FID ELECTROMETER 10-12 AMPS PER MV.
COL TEMP: 50^, HOLD 2 MIN, PROG 10^ PER MIN TO 200^ *
** G C SYSTEM 3760-5407 **

POST RUN:
SAVE FILE: RAW HYDPC3018

ATTACHMENT ⑥
PAGE 1

CHART SPEED 1.1 CM/MIN
ATTEN: 64 ZERO: 5% 1 MIN/TICK



CHANNEL: 1A - 1   TITLE: HC IN PERRY PLANT COMPR. AIR   15:02   7 NOV 87

SAMPLE: M S I V - 11   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE		W1/2 (SEC)
1	METHANE	29.5798	1.542	0.002	123689	BB		6.63
2		0.5381	2.579		2250	BB	?	8.44
3		1.3765	12.925		5756	BV	?	16.56
4		63.7159	18.883		266430	VV	?	16.63
5		4.7896	18.952		20028	VB	?	
TOTALS:		100.0000		0.002	418153			

DETECTED PKS: 5   REJECTED PKS: 0

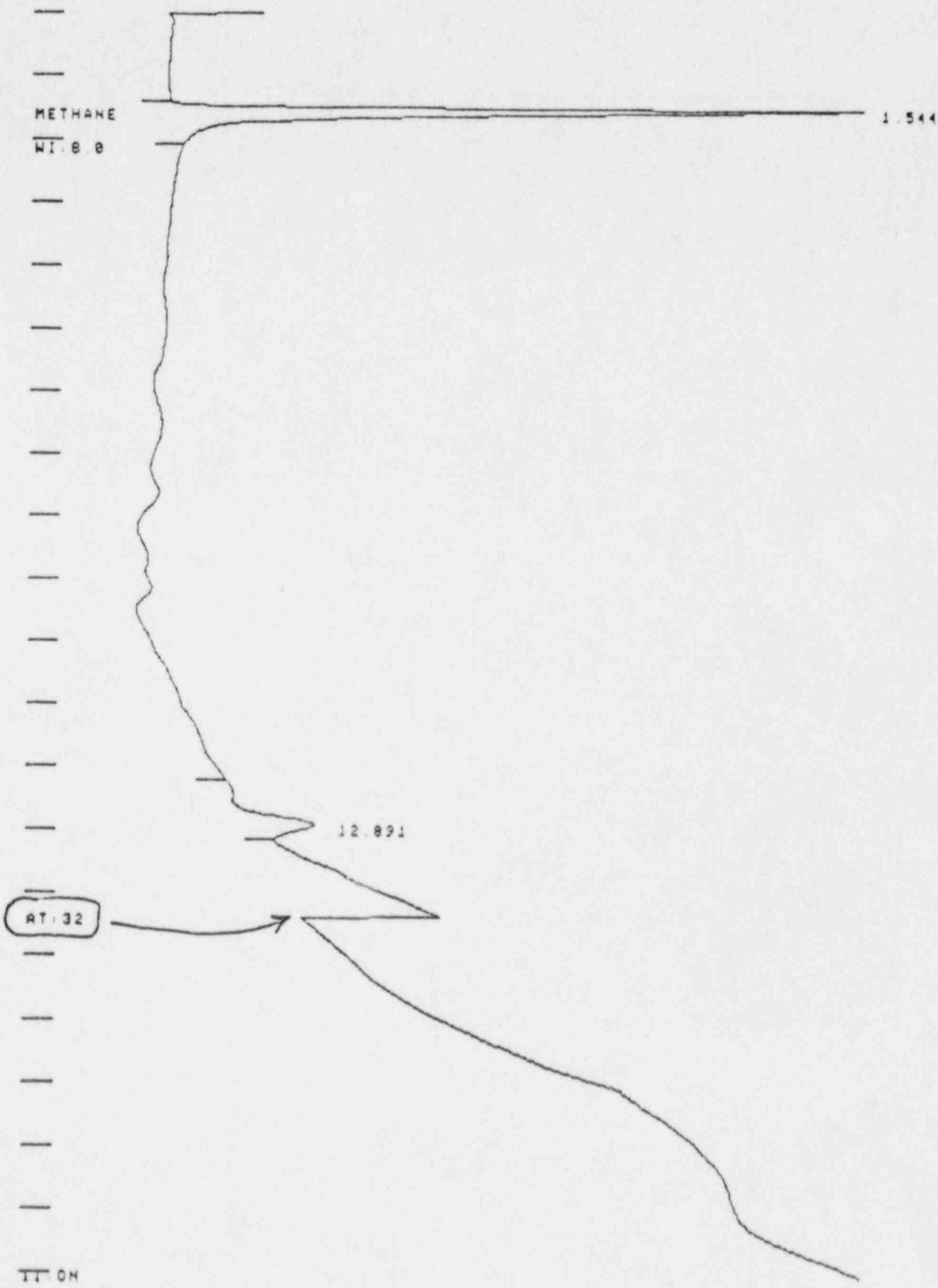
DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 4.6   OFFSET: 2011

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR 250^, DETECTOR 300^
FID ELECTROMETER 10-12 AMPS PER MV.
COL TEMP: 50^, HOLD 2 MIN, PROG 10^ PER MIN TO 200^   *
**   G C SYSTEM 3760-5407   **

ATTACHMENT ⑦
PAGE 1

CHART SPEED 1.1 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



SAMPLE: LAB AIR   METHOD: HYDROC-3   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	91.1787	1.544	0.004	116747	BB	6.53
2		8.8213	12.891		11295	BB	? 17.94
TOTALS:		100.0000		0.004	128042		

DETECTED PKS: 2   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 4.6   OFFSET: 1986

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 40 ML PER MIN
INJECTOR 250^, DETECTOR 300^
FID ELECTROMETER 10-12 AMPS PER MV.
COL TEMP: 50^, HOLD 2 MIN, PROG 10^ PER MIN TO 200^
** 6 C SYSTEM 3760-5407 **

POST RUN:
SAVE FILE: RAW   HYDPC3019

Ricerca

APPENDIX B

Analytical Report - Instrument Air

TO: J. J. Grimm - CEI
FROM: G. E. Walls
DATE: December 4, 1987

SUBJECT: ANALYTICAL REPORT - INSTRUMENT AIR

INTRODUCTION

A recent malfunction of one air-operated solenoid valve again raised suspicions of hydrocarbon contamination in the Plant instrument air system. Two air samples, collected by you, were analyzed by gas-chromatography to determine if hydrocarbons were present.

Samples

	Ricerca Number
MSIV-33 11/30/87 2200 B21:F022B, Instrument Air at 2" Supply Line (Grab Sample)	20342-042-10
MSIV-34 11/30/87 2215 Instrument Air at Solenoid Supply Line:B21:f022B (Grab Sample)	20342-042-20

RESULTS

Sample	Time	Area	ppm
	Noncondensable Hydrocarbons		
20342-042-10	1.38 min.	177,682	11.6 ✓
	Condensable Hydrocarbons		
	7.89 min.	9,037	0.6
	Noncondensable Hydrocarbons		
20342-042-20	1.39 min.	156,885	9.5 ✓
	1.78 min.	11,778	0.7
	Condensable Hydrocarbons		
	7.89 min.	16,227	1.0

Ricerca, Inc.

CONCLUSIONS

The results reported for condensable hydrocarbons are based on the chromatographic peak at 7.89 minutes exclusively. The fact that this peak occurs in the standard and blank, as well as in the samples, suggests the possibility of a chromatographic anomaly rather than the presence of a hydrocarbon. For this reason, the reported values of 0.6 ppm and 1.0 ppm for condensable hydrocarbons in samples 20342-042-10 and 20342-042-20, respectively, should be considered maximums rather than absolutes. It is my judgment that the instrument air samples submitted are, in fact, "clean" with respect to your specification.

PREPARATION AND ANALYSIS

A gas chromatographic system was assembled consisting of the following:

GC:	Varian 3760-5407
Detector:	Flame ionization
Injector:	Heated, flash vaporizing
Column:	18' x 3/16" OD stainless steel packed with SP-2100, 20%, on Chromosorb P, AW, DMCS treated, 60-80 mesh
Data System:	Varian DS-654

Gas chromatographic operating conditions were as follows:

Injector Temp.:	250°C
Detector Temp.:	300°C
Column Temp.:	100°C at injection, hold 2 min. at 100°C, program 10° per min. to 230°C, hold 3 min. at 230°C
Carrier Gas:	Helium at 45 mL per min.
FID Electrometer:	10^{-12} amps per mv
Injection:	2.5 mL gas

Preparation of Calibration Standard

Master Standard:	Methane in Nitrogen, 1.000% (vol.) Scott Specialty Gases Troy, Michigan 48083

A 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. Using a gas tight syringe, 2.5 mL of master standard were injected into the gas sample tube.

Concentration: $1\% \times \frac{2.5 \text{ mL}}{250 \text{ mL}} = 0.01\%$
$= 100 \text{ ppm}$

Ricerca, Inc.

A second 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. Using a gas tight syringe, 2.5 mL of the 100 ppm standard were injected into the gas sample tube.

Concentration: $100 \text{ ppm} \times \frac{2.5 \text{ mL}}{250 \text{ mL}} = 1.0 \text{ ppm}$

A third 250 mL gas sample tube was purged with dry, hydrocarbon free nitrogen for 10 minutes. This sample represented the blank for instrument calibration.

ATTACHMENTS

1. Chromatogram of calibration standard
2. Chromatogram of nitrogen blank
3. Chromatogram of sample 20342-042-10
4. Chromatogram of sample 20342-042-20

During our telephone conversation of Dec. 3, 1987, you expressed an interest in the chromatographic peak a retention time 7.9 minutes. Please let me know if you would like us to attempt to identify it by GC-MS.

Gregory E. Walls

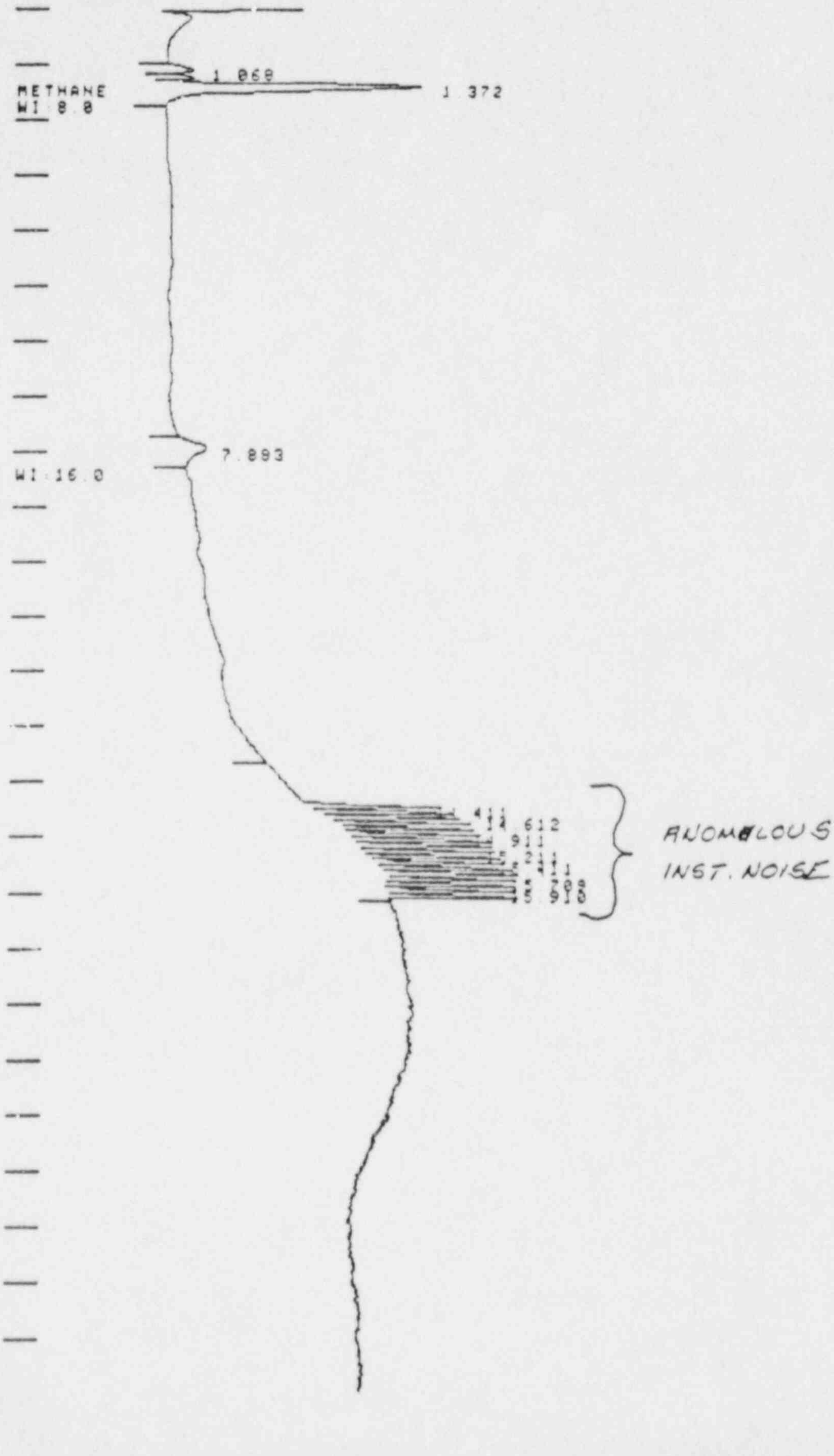
Gregory E. Walls

jsb
Atts.

File No.: 8702173G
Notebook Ref.: 20342-42

Reviewed By: [signature]

CHART SPEED 0.9 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



RECALCULATE ON FILE: TOTAL-HC010

CHANNEL: 1A - 1   TITLE: HC IN PERRY PLNT INST AIR   9:15   3 DEC 87

SAMPLE: 1.0 PPM STD   METHOD: TOTAL-HC   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE		W1/2 (SEC)
1		1.78	1.068		3767	BV		6.81
2		1.28	1 212		2706	VV	?	5.56
3	METHANE	18.95	1.372	-0.048	40177	VB		7.06
4		4.18	7.883		8856	BB		19.31
5		3.52	14.411		7459	BV		4.88
6		4.08	14.512		8653	VV	?	2.94
7		4.34	14.612		9195	VV	?	2.94
8		4.54	14.712		9620	VV	?	3.00
9		4.62	14.810		9796	VV	?	3.00
10		4.63	14.911		9822	VV	?	3.00
11		4.65	15.011		9854	VV	?	5.69
12		4.66	15.110		9873	VV	?	5.63
13		4.68	15.211		9924	VV	?	5.81
14		4.67	15.310		9911	VV	?	6.00
15		4.77	15.411		10124	VV	?	6.06
16		4.79	15.510		10149	VV	?	6.00
17		4.71	15.610		9981	VV	?	6.00
18		4.51	15.709		9560	VV	?	6.39
19		4.19	15.809		8889	VV	?	6.13
20		3.97	15.910		8418	VV	?	6.19
21		2.51	16.006		5313	VB	?	6.36
TOTALS:		100.00		-0.048	212047			

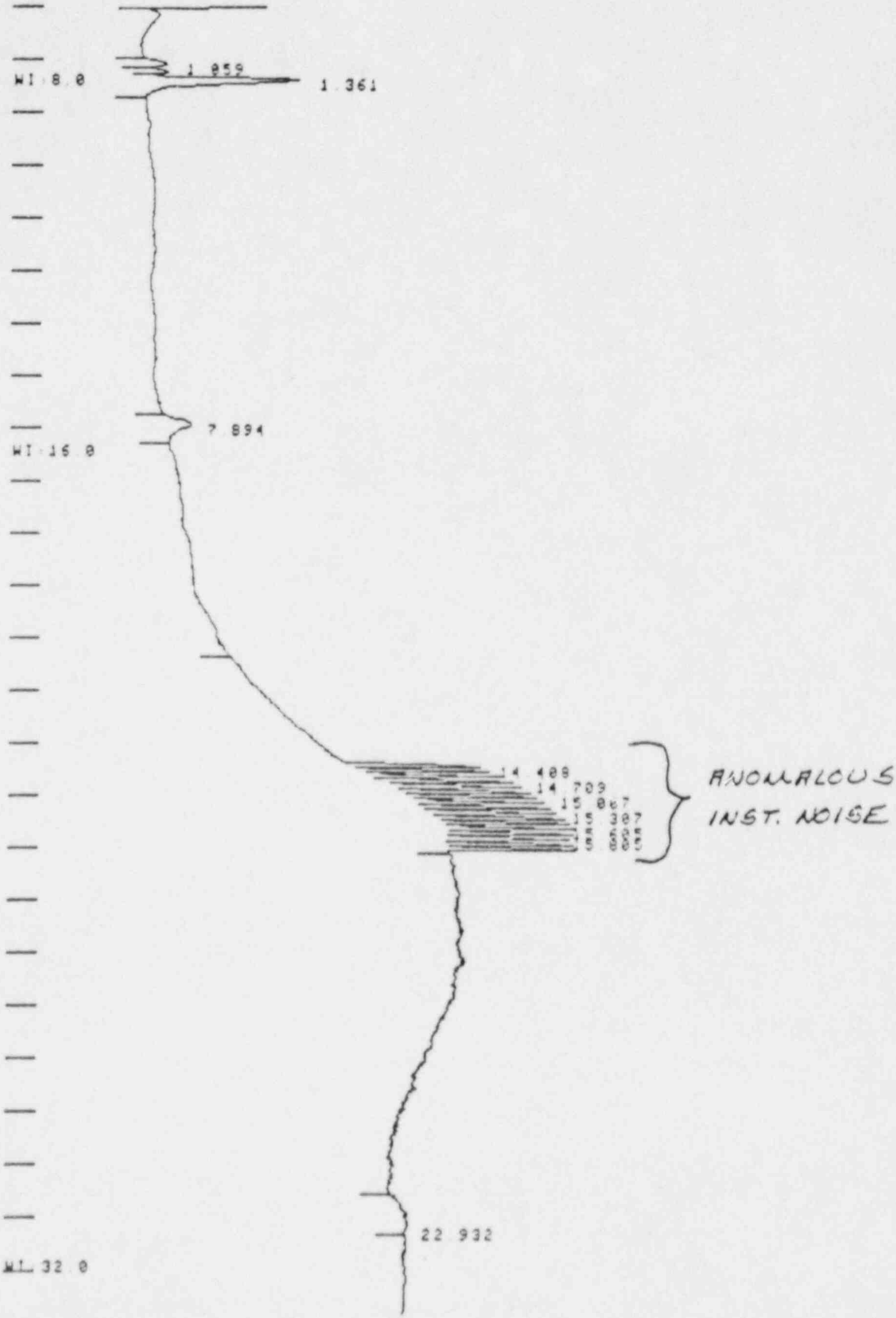
DETECTED PKS: 21   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 13.7   OFFSET: 2743

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 45 ML PER MIN
INJECTOR TEMP 250^ ; DETECTOR TEMP 300^
ELECTROMETER 10-12 AMPS PER MV./ 2.5 ML INJECTIONS
COLUMN TEMP: 100^, HOLD 2 MIN, 10^ PER MIN TO 230^
**   G C SYSTEM 3760-5407   **

CHART SPEED 0.9 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



RECALCULATE ON FILE: TOTAL-HC011

CHANNEL: 1A - 1 TITLE: HC IN PERRY PLNT INST AIR 9:48 3 DEC 87

SAMPLE: NIT. BLANK METHOD: TOTAL-HC CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE		W1/2 (SEC)
1		1.73	1.059		3559	BV		6.88
2		1.49	1.213		3064	VV	?	7.56
3	METHANE	11.99	1.361	-0.059	24739	VB		6.69
4		4.17	7.894		8605	BB		16.19
5		3.94	14.508		8132	VV	?	6.25
6		2.95	14.608		6075	VV	?	4.63
7		5.94	14.709		12257	VV	?	4.69
8		4.87	14.807		10048	VV	?	6.69
9		4.98	14.907		10273	VV	?	6.94
10		5.12	15.007		10569	VV	?	6.94
11		5.17	15.107		10667	VV	?	7.13
12		5.22	15.207		10775	VV	?	7.19
13		5.32	15.307		10965	VV	?	7.19
14		5.36	15.407		11058	VV	?	7.19
15		5.36	15.507		11050	VV	?	7.19
16		5.20	15.605		10730	VV	?	7.44
17		4.89	15.705		10081	VV	?	7.38
18		4.53	15.805		9334	VV	?	7.38
19		4.20	15.906		8673	VV	?	7.44
20		2.40	16.002		4960	VB	?	7.44
21		5.16	22.932		10653	BB	?	55.00
TOTALS:		100.00		-0.059	206267			

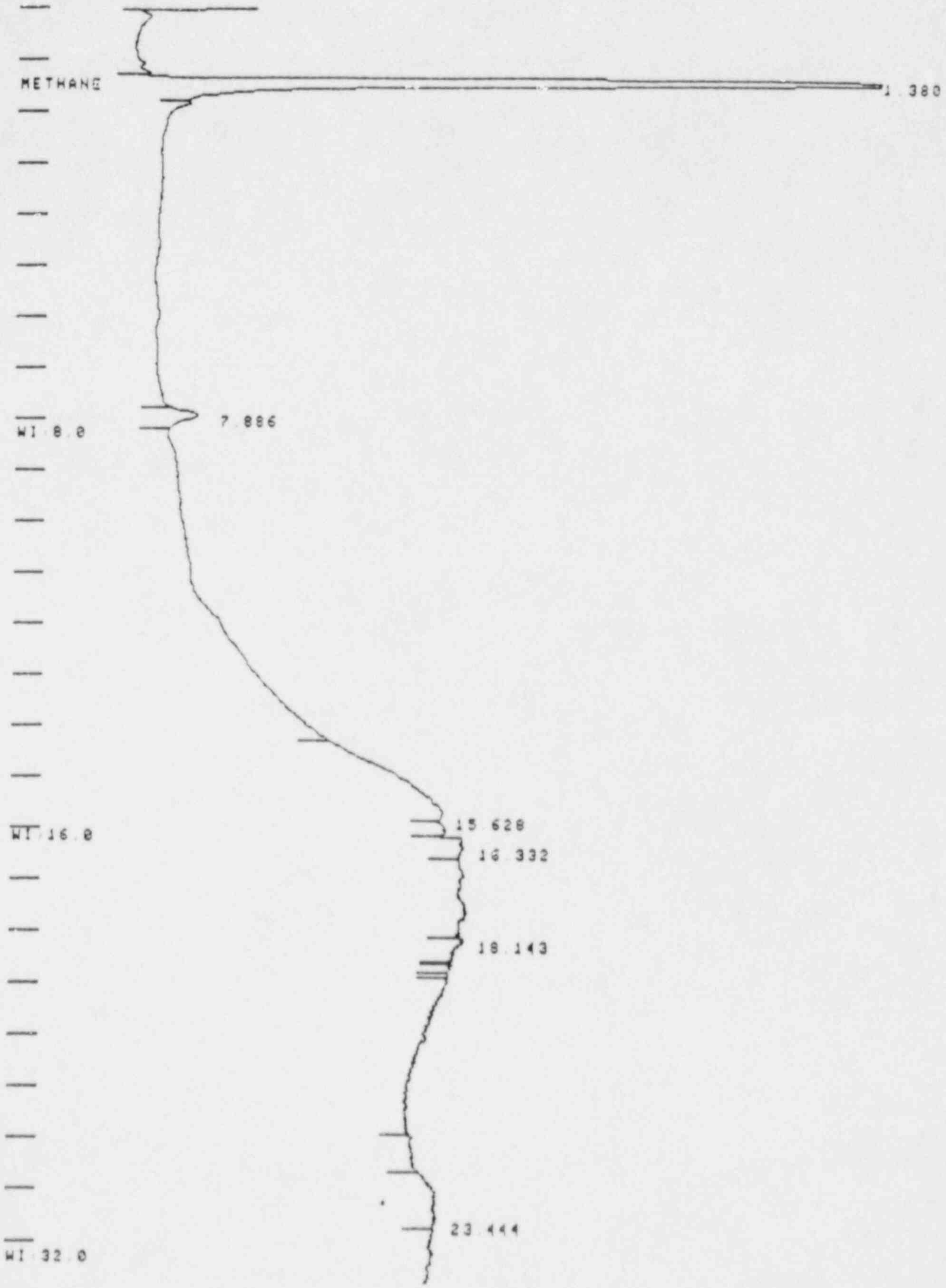
DETECTED PKS: 22 REJECTED PKS: 1

DIVISOR: 1.00000 AMT STD: 1.00000 MULTIPLIER: 1.00000

NOISE: 13.7 OFFSET: 2404

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 45 ML PER MIN
INJECTOR TEMP 250^ ; DETECTOR TEMP 300^
ELECTROMETER 10-12 AMPS PER MV./ 2.5 ML INJECTIONS
COLUMN TEMP: 100^, HOLD 2 MIN, 10^ PER MIN TO 230^
** G C SYSTEM 3760-5407 **

CHART SPEED 0.9 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



RECALCULATE ON FILE: TOTAL-HC012

CHANNEL: 1A - 1   TITLE: HC IN PERRY PLNT INST AIR   10:20   3 DEC 87

SAMPLE: 20342-042-10   METHOD: TOTAL-HC   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	72.99	1.380	-0.040	177682	BB	5.88
2		3.71	7.886		9037	BB	? 14.06
3		13.14	15.628		31992	BB	?128.00
4		1.52	16.332		3696	BB	? 23.69
5		0.67	18.14[illegible]		1638	BB	6.56
6		7.96	23.444		[illegible]383	BB	? 59.13

TOTALS: 100.00   -0.040   [illegible]428

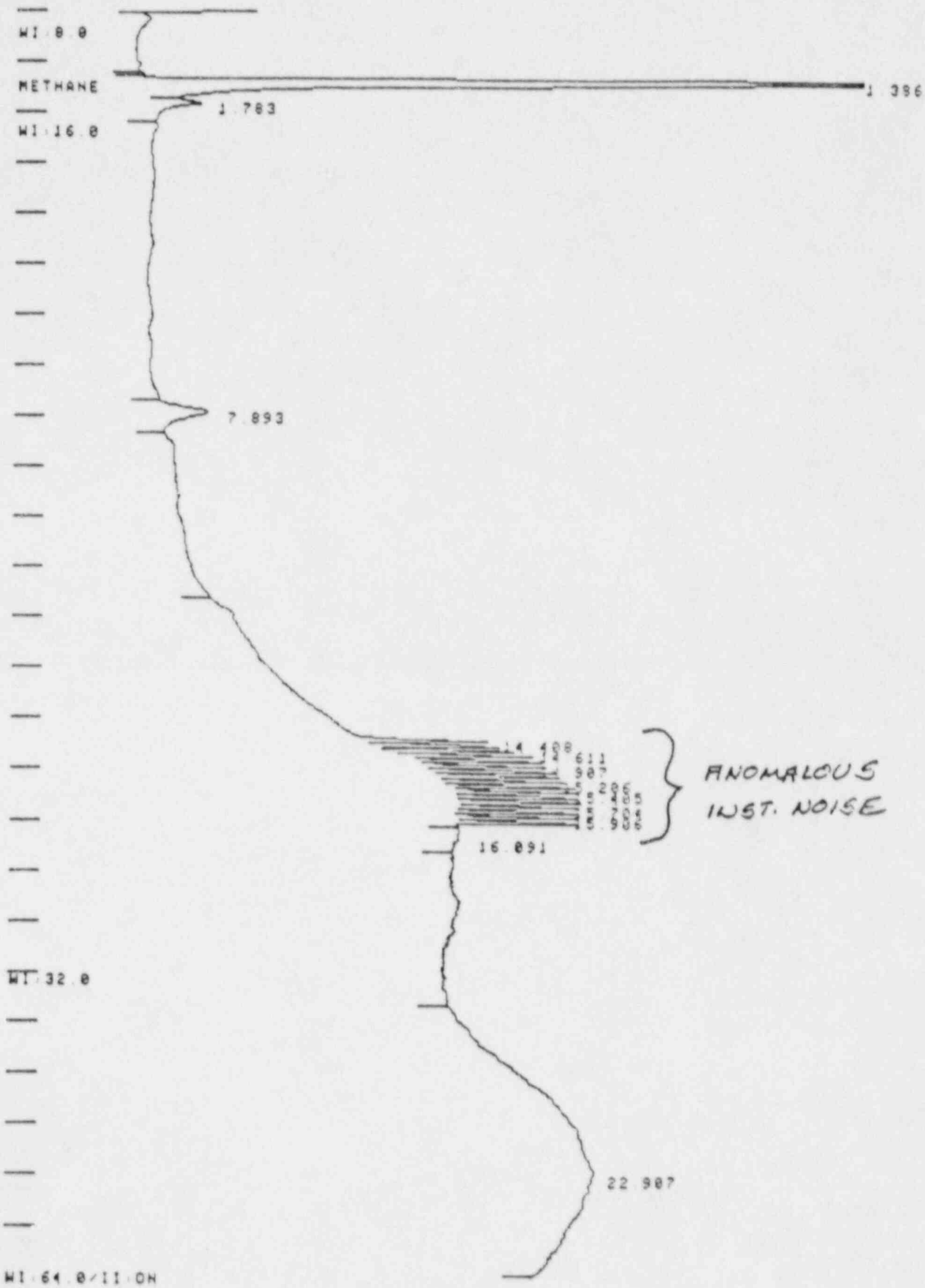
DETECTED PKS: 6   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: [illegible]   OFFSET: 2177

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 45 ML PER MIN
INJECTOR TEMP 250° ; DETECTOR TEMP 300°
ELECTROMETER 10-12 AMPS PER MV./ 2.5 ML INJECTIONS
COLUMN TEMP: 100°, HOLD 2 MIN, 10° PER MIN TO 230°
** G C SYSTEM 3760-5407 **

CHART SPEED 0.9 CM/MIN
ATTEN: 16 ZERO: 5% 1 MIN/TICK



RECALCULATE ON FILE: TOTAL-HC013

CHANNEL: 1A - 1   TITLE: HC IN PERRY PLNT INST AIR   10:53   3 DEC 87

SAMPLE: 20342-042-20   METHOD: TOTAL-HC   CALCULATION: A% - ANALYS - OP

PEAK NO	PEAK NAME	RESULT AREA%	TIME (MIN)	TIME OFFSET	AREA COUNTS	SEP CODE	W1/2 (SEC)
1	METHANE	19.34	1.386	-0.034	156885	BV	5.69
2		1.45	1.783		11778	VB	? 11.63
3		2.00	7.893		16227	BB	15.75
4		0.76	14.408		6202	BV	? 31.00
5		1.47	14.510		11954	VV	? 4.88
6		1.62	14.611		13179	VV	? 5.94
7		2.18	14.711		17706	VV	? 6.19
8		1.88	14.806		15218	VV	? 7.44
9		1.91	14.907		15504	VV	? 7.50
10		1.94	15.007		15700	VV	? 7.50
11		1.96	15.106		15884	VV	? 7.75
12		1.98	15.206		16035	VV	? 7.75
13		2.01	15.308		16345	VV	? 7.88
14		2.00	15.405		16214	VV	? 7.75
15		1.97	15.506		15995	VV	? 7.75
16		1.91	15.606		15515	VV	? 8.06
17		1.82	15.704		14797	VV	? 8.00
18		1.73	15.804		14038	VV	? 8.06
19		1.67	15.905		13525	VV	? 8.06
20		1.34	16.002		10876	VV	? 7.75
21		2.26	16.091		18300	VB	?
22		44.79	22.907		363408	BB	?230.44
TOTALS:		100.00		-0.034	811285		

DETECTED PKS: 22   REJECTED PKS: 0

DIVISOR: 1.00000   AMT STD: 1.00000   MULTIPLIER: 1.00000

NOISE: 13.7   OFFSET: 2295

NOTES:
COL: 18' X 3/16" OD SS, 20% SP-2100
HELIUM CARRIER GAS AT 45 ML PER MIN
INJECTOR TEMP 250^ ; DETECTOR TEMP 300^
ELECTROMETER 10-12 AMPS PER MV./ 2.5 ML INJECTIONS
COLUMN TEMP: 100^, HOLD 2 MIN, 10^ PER MIN TO 230^
** G C SYSTEM 3760-5407 **

APPENDIX C

Hardness of O-rings

TO: J. J. Grimm - CEI
FROM: G. G. Sweetapple
DATE: December 14, 1987

SUBJECT: HARDNESS OF O-RINGS

Twelve used o-rings and four unused o-rings were analyzed for Shore A hardness using the Shore Micro O-ring Hardness Tester, Model 714M. The calibration of the microtester was verified with seven ASTM D2240 standards. Samples were mounted in a 0.07 inch o-ring fixture, conditioned and tested at 22 ± 0.5°C. Both sides of the used o-rings were measured due to visual differences observed. Four readings of each o-ring side were made; the mean value and standard deviation are summarized below.

O-ring ID		Shore A Hardness (Mean)	(SD)
Unused #1		77.5, 78.0*	0.5, 0.7*
#2		77.5, 77.8*	1.1, 0.4*
#3		78.5, 79.0*	0.9, 0.7*
#4		78.2, 78.5*	0.4, 0.5*
MSIV 22 #1	Side A	96.0	0.7
	Side B	87.2	1.9
MSIV 22 #2	Side A	94.0	0.7
	Side B	88.8	0.8
MSIV 24 #1	Side A	88.8	1.3
	Side B	89.0	1.6
MSIV 24 #2	Side A	89.8	0.8
	Side B	92.2	1.3
MSIV 25 #1	Side A	80.8	0.4
	Side B	82.2	1.1
MSIV 25 #2	Side A	83.2	0.8
	Side B	81.0	0.7

*Retested on 12-14-87
Initial Test 12-6-87

7528 Auburn Road • Box 1000 • Painesville, Ohio 44077
216/357-3300

Received

O-ring ID	Hardness (Mean)	(SD)
MSIV 26 #1 Side A	81.2	0.8
Side B	82.8	0.8
MSIV 26 #2 Side A	80.8	1.1
Side B	81.0	1.6
MSIV 27 #1 Side A	84.8	0.8
Side B	94.0	2.3
MSIV 28 #2 Side A	95.5	1.6
Side B	91.0	1.6

NOTE: MSIV 27 #2 and MSIV 28 #1 were not tested. One inch o-rings from stock #1465253.

Gary G. Sweetapple

Gary G. Sweetapple

jsb

File No.: 8702145
Notebook Ref.: 12907-71

Reviewed By: W. R. Bramstedt R. L. Cryberg

W R Bramstedt R L Cryberg

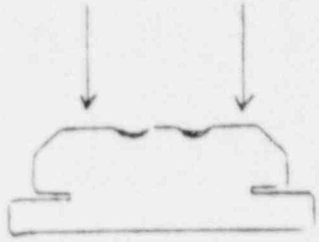
APPENDIX D

Hardness of Valve Seats

TO: J. J. Grimm - CEI
FROM: G. G. Sweetapple
DATE: December 14, 1987

SUBJECT: **HARDNESS OF VALVE SEATS**

Seven used valve seats and four unused valve seats (from #1465253) were analyzed for Shore A hardness with the Shore microdurometer. Calibration was verified with seven ASTM D-2240 standards. The samples were conditioned and tested at 22 $\pm$ 0.5°C. Used valve seats were analyzed on the "active" surface, carefully avoiding areas of compression set as shown in figure below. Four measurements of different spots were made on each seat; the mean hardness and standard deviation are summarized below.



Seat ID	Shore A Hardness (mean)	(SD)
Unused #1	83.5, 83.0*	0.5, 0.7*
#2	83.8, 83.2*	0.8, 0.8*
#3	84.0	0.7
#4	83.8	0.8
MSIV 22	85.2	0.4
MSIV 24	85.5	1.1
MSIV 25	84.5	1.1
MSIV 26	83.8	0.8
MSIV 27	85.5	0.9
MSIV 28	85.5	1.1

*Retested 12-14-87
Initial Test 12-6-87

Gary G. Sweetapple

Reviewed By: W. R. Bramstedt R. L. Cryberg

Notebook Ref.: 12907-72
File No.: 8702197

7528 Auburn Road • Box 1000 • Painesville, Ohio 44077
216/357-3300

APPENDIX E

Compression Set of O-rings

TO: J. J. Grimm - CEI
FROM: G. G. Sweetapple
DATE: November 24, 1987

SUBJECT: COMPRESSION SET OF O-RINGS

Fourteen used o-rings were measured for existing compression set per ASTM D-395. Six unused o-rings were measured to calculate the original thickness. Four measurements were made on each o-ring and averaged. Compression set was then calculated using the formula:

$$C_A = [(to-ti) \div to] \times 100\%$$

C_A is compression set as a percent of original thickness
to is the average original thickness
ti is the average final thickness

Sample		Compression Set, %
MSIV 22	#1	17.3
	#2	15.8
MSIV 24	#1	21.9
	#2	16.2
MSIV 25	#1	12.2
	#2	11.1
MSIV 26	#1	9.5
	#2	9.4
MSIV 27	#1	16.5
	#2	17.2
MSIV 28	#1	23.4
	#2	14.1

If you have any questions about this work, please call me at 357-3256.

Gary G. Sweetapple

jsb

Reviewed By: W R Bronstedt

Notebook Ref.: 12907-68
File No.: 8702125

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APPENDIX F

Main Steam Isolation Valves - Nondestructive Evaluation by Optical Microscopy

TO: J. J. Grimm - CEI
FROM: K. A. Krutyholowa
DATE: December 1, 1987

SUBJECT: MAIN STEAM ISOLATION VALVES - NONDESTRUCTIVE EVALUATION BY OPTICAL MICROSCOPY

SAMPLE NO.

Sample numbers MSIV 20, 21, 22, 24, 25, 26, 27, 28 and controls were received for examination by optical microscopy. The components of the valve in each sample set were photographed prior to examination (Figures 1-3).

METHODS

All samples were examined under Zeiss Universal stereo widefield optical microscope, equipped with indirect reflected light. Magnifications from 7.9X - 24.6X were used. Micrographs are presented in Figures 4-14.

RESULTS

Energized Elastomer Seat (Figures 4-5)

The control energized elastomer seat is smooth and uniform. There are no indentations or impressions on the surface (Figure 4a).

The "used" energized seats have a deep "doughnut shaped" indentation in the center (Figures 4b & c, & 5). The rubber surface at the indentation is glassy in appearance. A small bubble is located in the center area of samples MSIV 22 & MSIV 26 (Figs. 4b & 5b).

De-energized Elastomer Seats (Figures 6 & 7)

The control de-energized elastomer seat is relatively smooth and uniform (Figure 6a).

The used de-energized elastomer seats also have doughnut shaped indentations in the center of the seat (Figures 6b & c, and 7). These indentations are not as severe as those on the energized

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seats. The rubber surfaces of the used seats are rougher than the surface of the control.

O-Rings (Figures 8-12)

The control o-rings are rounded and smooth (Figure 8).

The surfaces of the used o-rings have three basic appearances:

1. Flattened with little or no distortions (Figs. 11a & b).
2. Flattened with distortion of the o-rings' edges (Figs. 9a, 10a, 12b).
3. Flattened with major changes at the o-rings' edges and center (Figs. 9b, 10b, 12a & c).

One side of one o-ring in samples MSIV 22, MSIV 24, MSIV 27, MSIV 28 has major changes occur across the o-ring. The edges are glassy in appearance and the centers are buckled and folded (Figures 9b, 10b, 12a & c). The opposite sides of the same o-rings have only slight distortions at the o-rings' edge (Figures 9a, 10a, 12b).

Flow Control Valves (Fig. 13)

Inside the valves (MSIV 20, 21), a dark ring of deposits can be seen visually. Examination of these rings (Fig. 13) reveals the complement of a degraded o-ring, such as that in Figure 12c. The o-ring residue appears to have adhered to the brass body of the valve. The opposite side of the valve also has a deposit, but it is less predominant.

Kathy A. Krutyholowa

jsb
Atts.

File Nos. 8702086M - 8702095M
Notebook Ref.: 20294-82

Reviewed By: W R Brumstedt

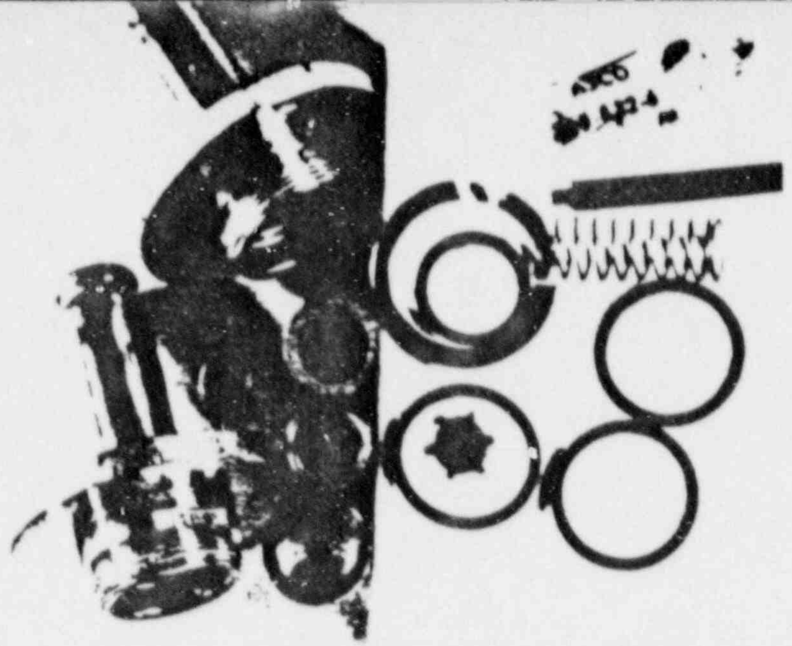
a. 0.8X MSIV 20

b. 0.8X MSIV 21

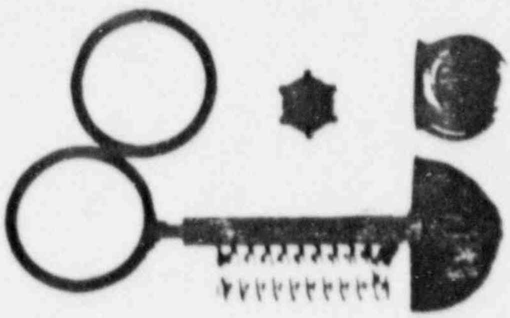
Figure 1. Flow Control Valve

Figure 2.

Main Steam Isolation Valve

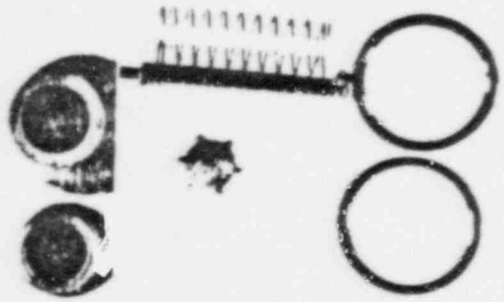


a. 0.8X
Control

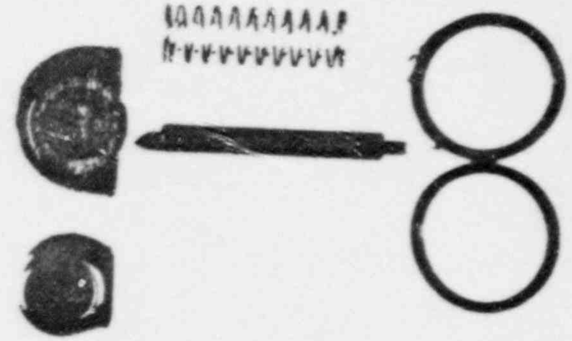


b. 0.8X
MSIV 22

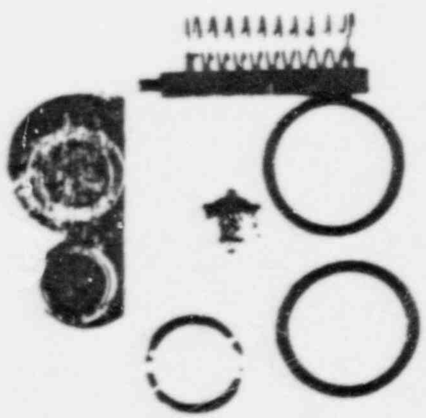
c. 0.8X
MSIV 24



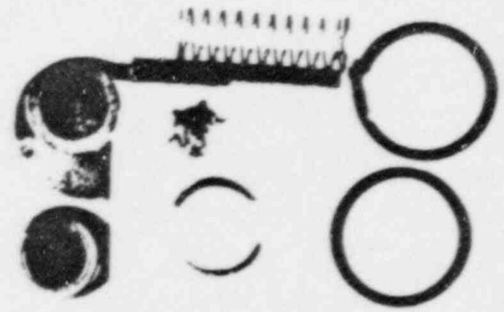
a. 0.8X MSIV 25



b. 0.8X MSIV 26
NOTE: No star



c. 0.8X MSIV 27



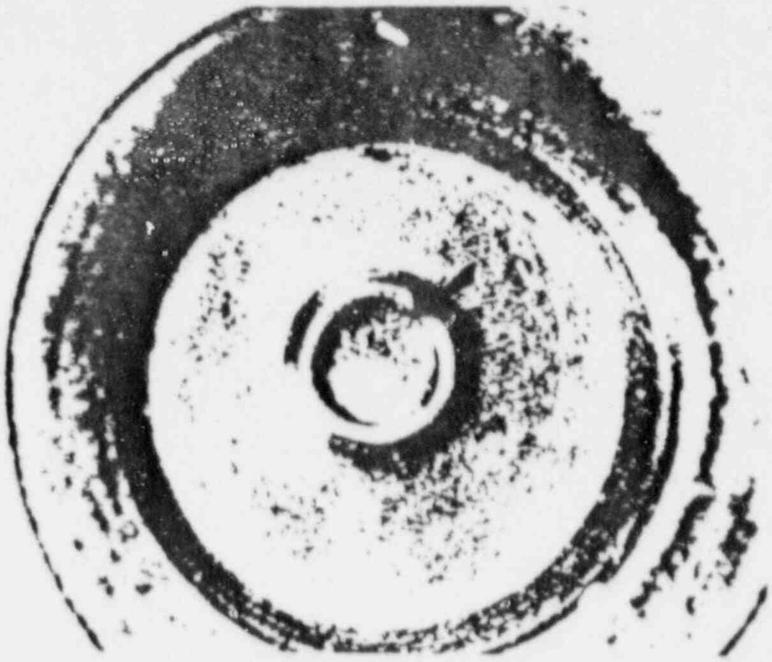
d. 0.8X MSIV 28

Figure 3. Main Steam Isolation Valve

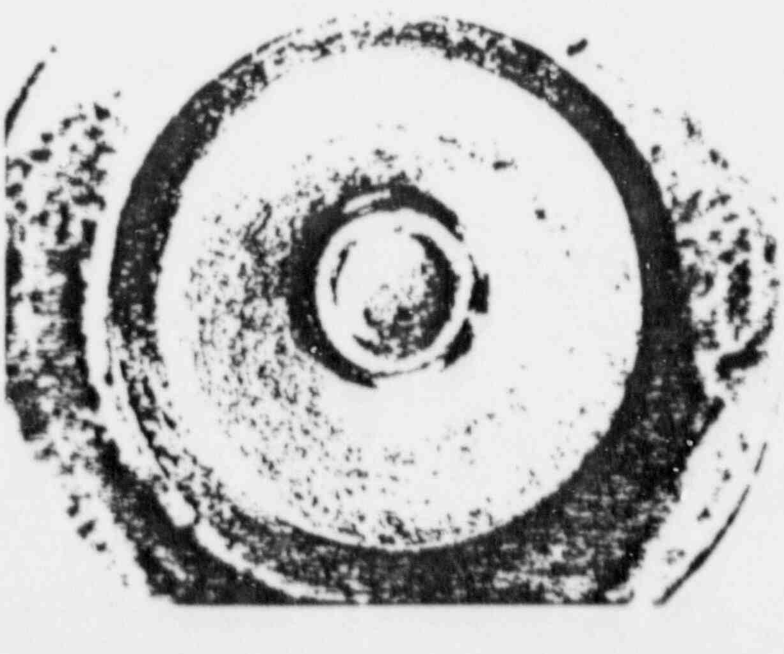
Figure 4.

Energized Elastomer Seat Doughnut Shaped Indentations

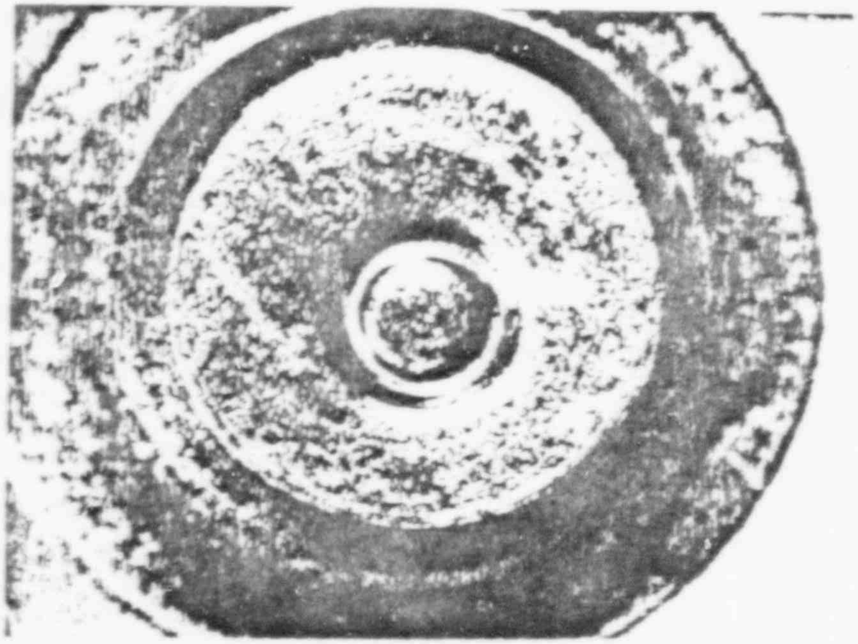
a. 9.5X
1mm=105µm
Control



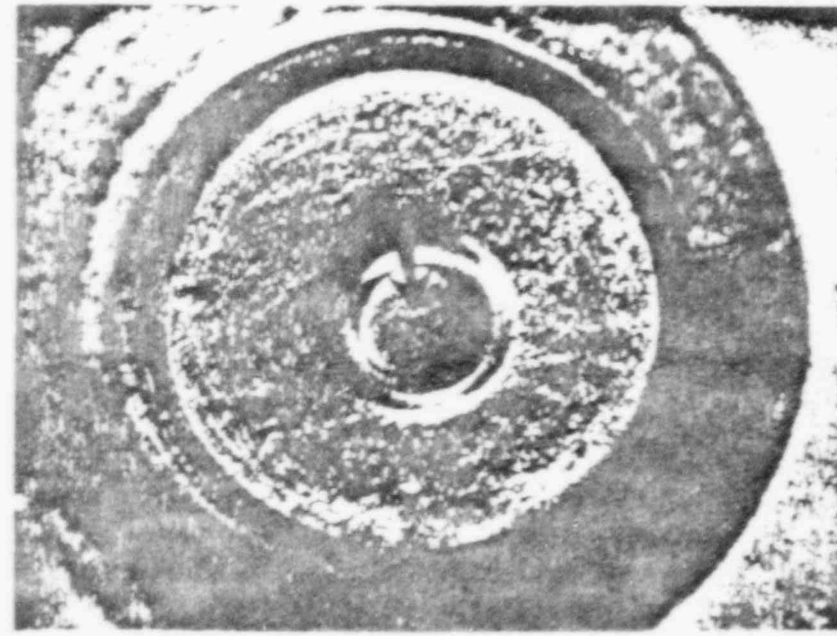
b. 9.5X
1mm=105µm
MSIV 22



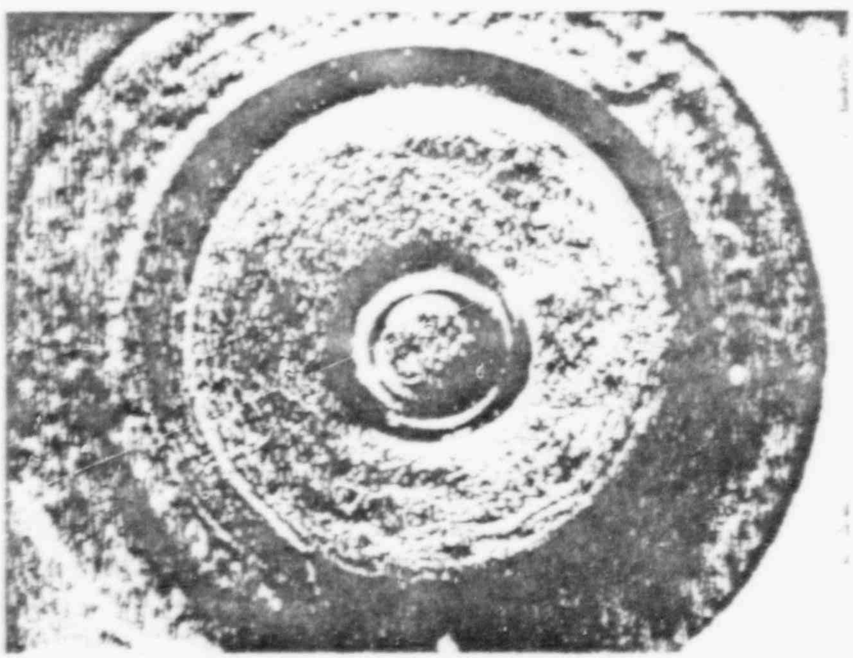
c. 9.5X
1mm=105µm
MSIV 24



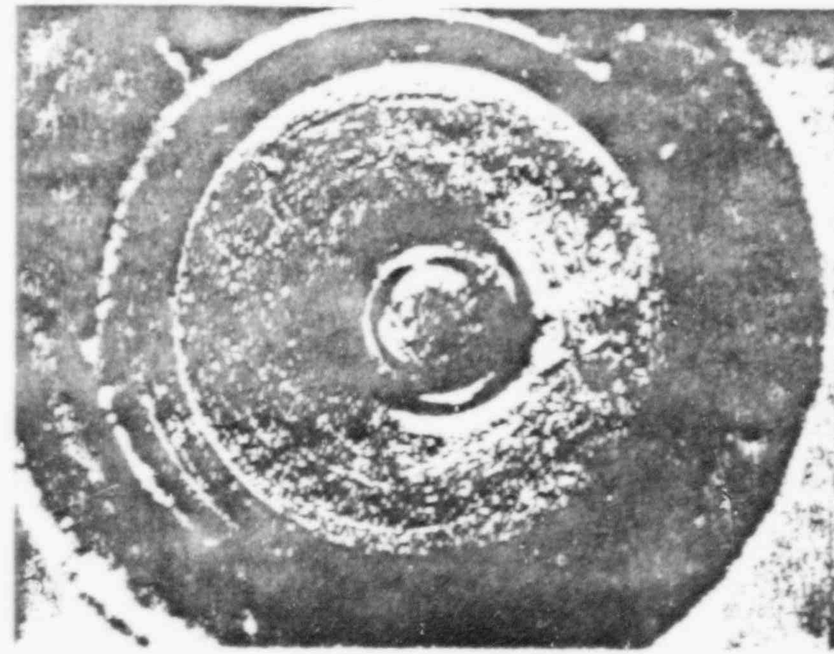
a. 9.5X 1mm=105μm MSIV 25



b. 9.5X 1mm=105μm MSIV 26
NOTE: Bubble



c. 9.5X 1mm=105μm MSIV 27

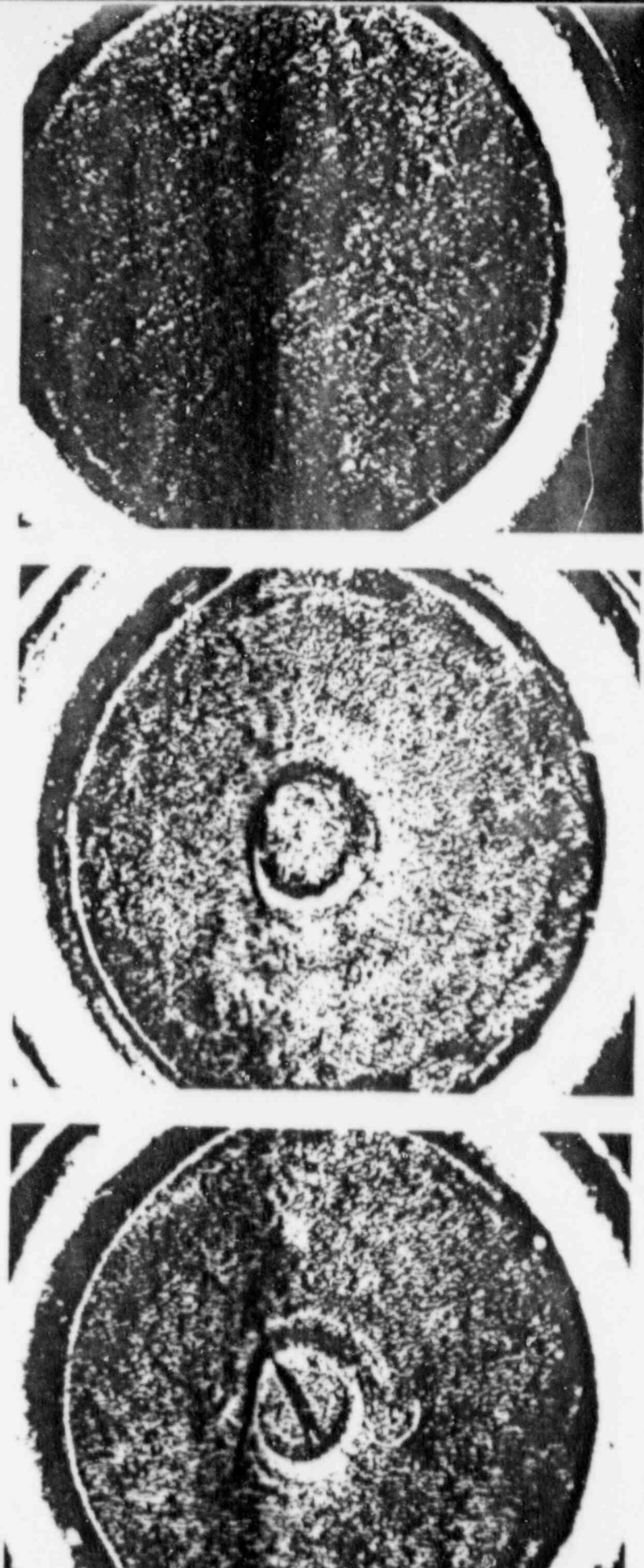


d. 9.5X 1mm=105μm MSIV 28

Figure 5. Energized Elastomer Seat Doughnut Shaped Indentations

Figure 6.

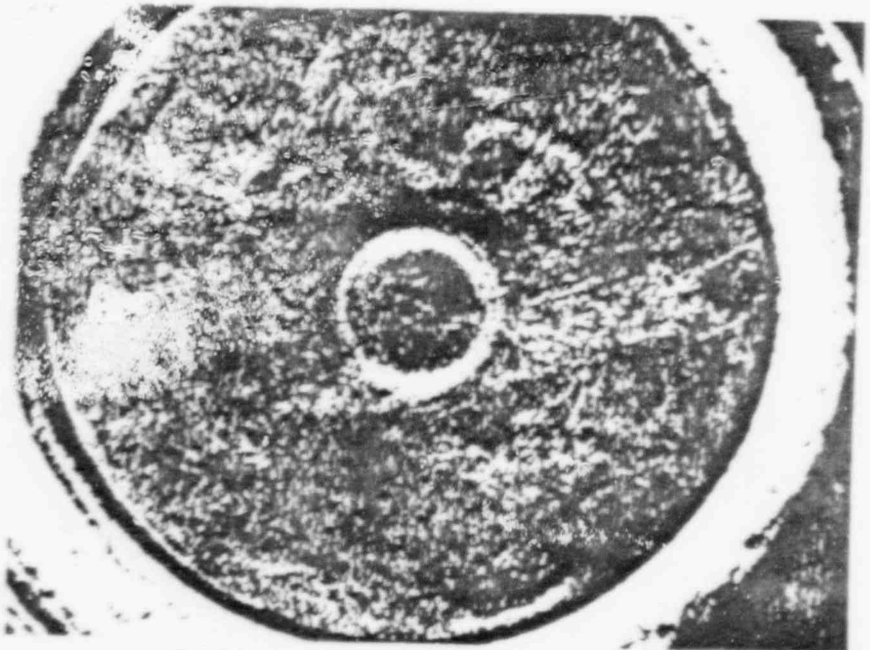
De-energized Elastomer Seat Indentations



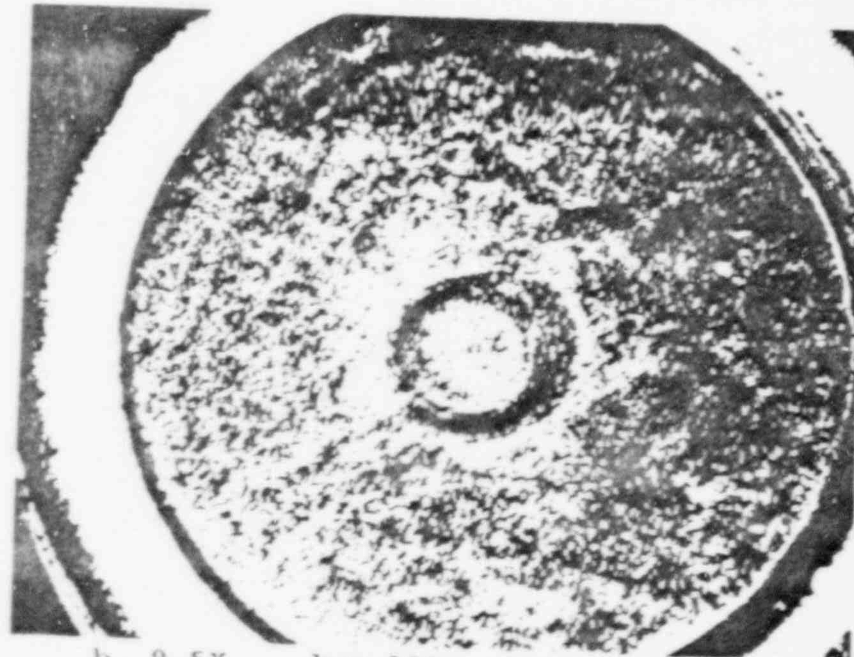
a. 9.5X
1mm=105µm
Control

b. 9.5X
1mm=105µm
MSIV 22

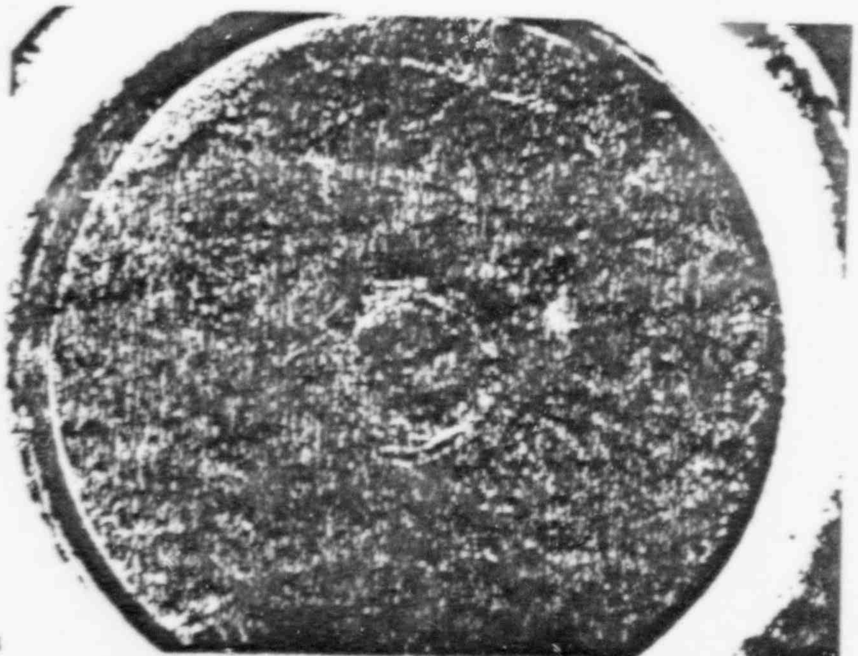
c. 9.5X
1mm=105µm
MSIV 24



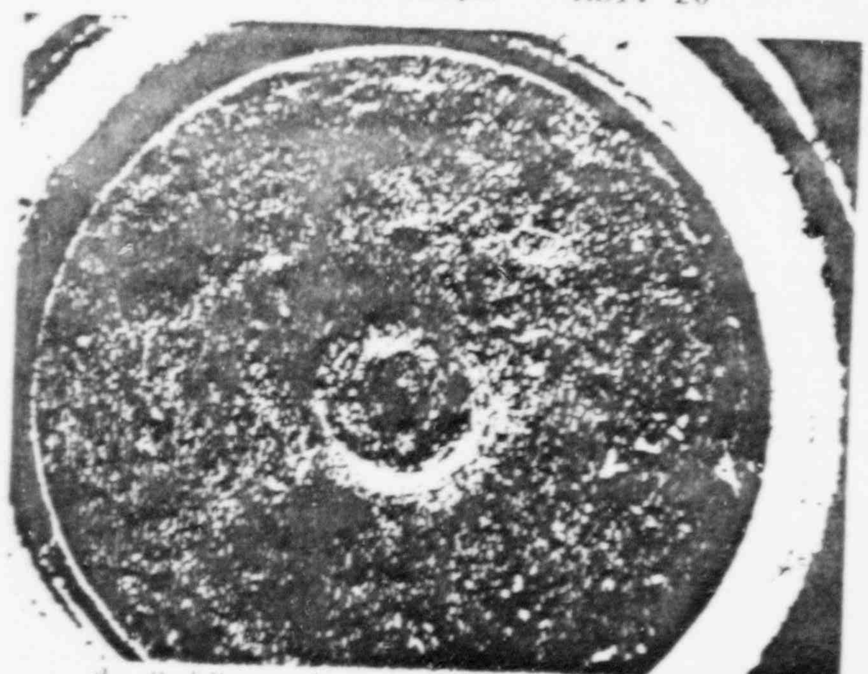
a. 9.5X 1mm=105μm MSIV 25



b. 9.5X 1mm=105μm MSIV 26



c. 9.5X 1mm=105μm MSIV 27



d. 9.5X 1mm=105μm MSIV 28

Figure 7. De-energized Elastomer Seat Indentations

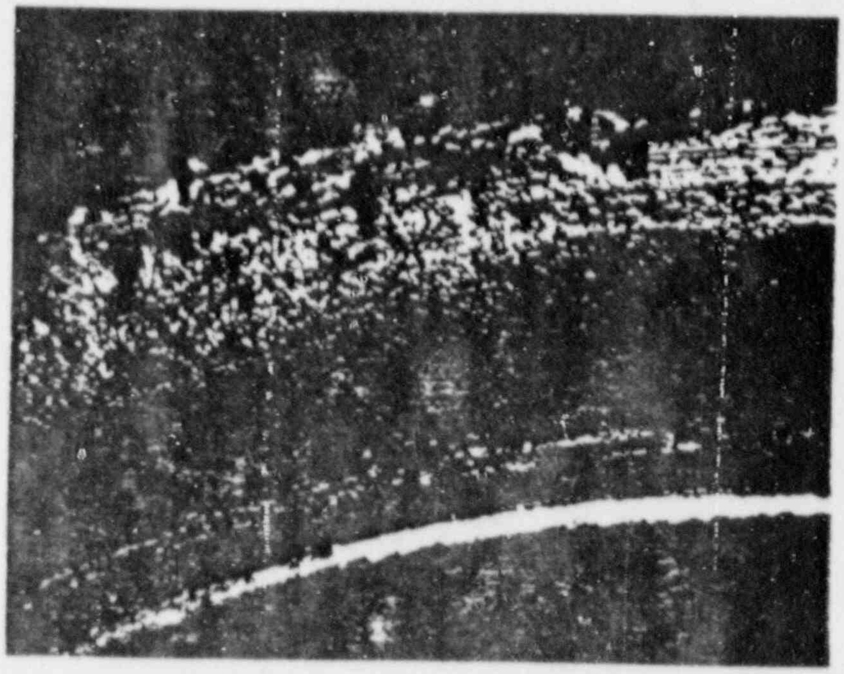
a. 24.6X 1mm=41μm
Control

Figure 8. O-ring

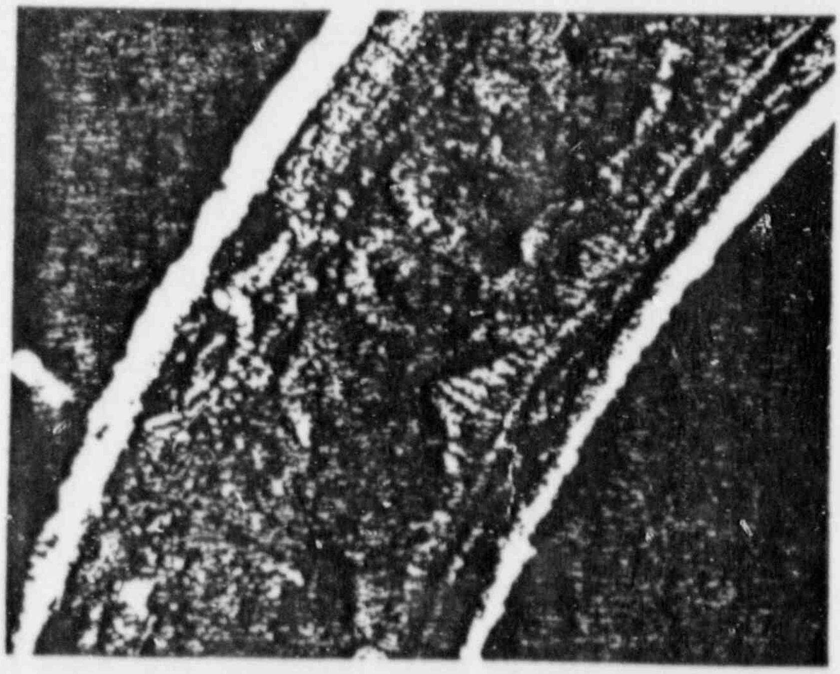
a. 24.6X 1mm=41μm
Side 1 (of o-ring 1) MSIV 22

b. 24.6X 1mm=41μm
Glassy Edge, Folded Center
Side 2 (of o-ring 1) MSIV 22

Figure 9. O-rings

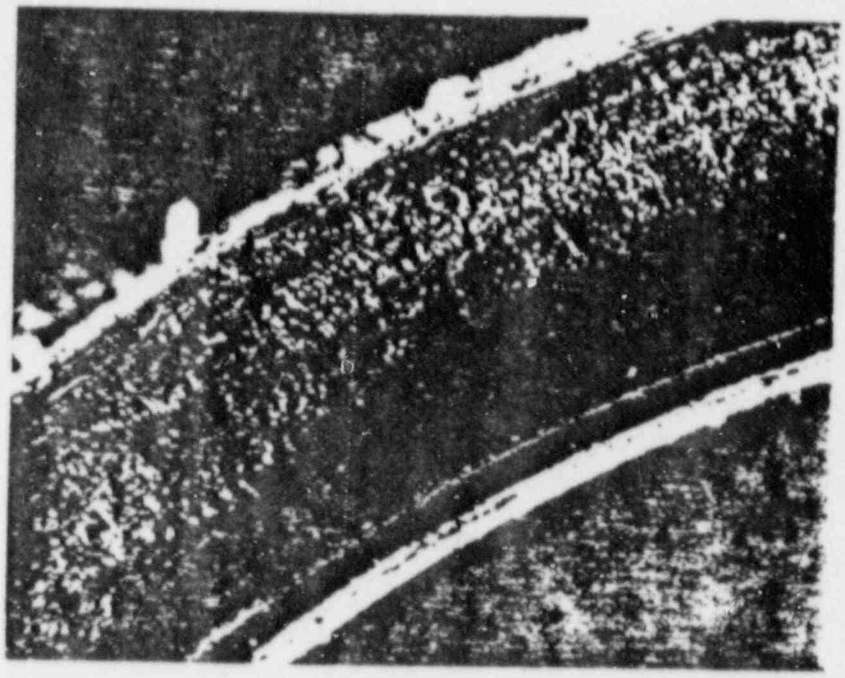


a. 24.6X   1mm=41µm
Side 1 (of o-ring 1) MSIV 24



b. 24.6X   1mm=41µm
Side 2 (of o-ring 1) MSIV 24
Glassy Edges, Folded Center

Figure 10. O-rings



a. 24.6X   1mm=41μm   Flattened
MSIV 25

b. 24.6X   1mm=41μm   Flattened
MSIV 26

Figure 11. O-rings

Figure 12.

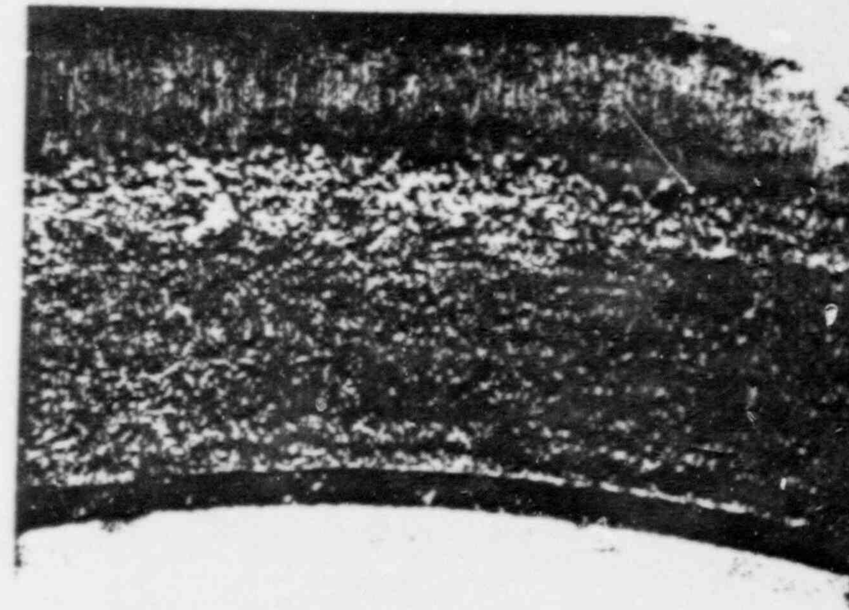
O-rings

a. 24.6X
1mm=41μm
MSIV 27
Glassy Edges,
Folded Center

b. 24.6X
1mm=41μm
Side 1 (of o-ring 1)
MSIV 28

c. 24.6X
1mm=41μm
Glassy Edges,
Folded Center
Side 2 (of o-ring 1)
MSIV 28

a. 24.6X 1mm=41μm
Side 1 MSIV 20



b. 24.6X 1mm=41μm
Side 2 MSIV 20

c. 24.6X 1mm=41μm
Side 1 MSIV 21
Degraded O-ring

d. 24.6X 1mm=41μm
Side 2 MSIV 21

Figure 13. Flow Control Valves (Inside)

APPENDIX G

Main Steam Isolation Valves - O-ring Destructive Evaluation by Scanning Electron Microscopy

TO: J. J. Grimm - CEI
FROM: K. A. Krutyholowa
DATE: January 7, 1988

SUBJECT: MAIN STEAM ISOLATION VALVES - O-RING DESTRUCTIVE EVALUATION BY SCANNING ELECTRON MICROSCOPY

SAMPLES

The surfaces and cross-sections of the o-rings in sample sets MSIV Control, -24, -26, -27, and -28 were examined by Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray (EDX) micro-analysis and Wavelength Dispersive X-ray (WDS) microanalysis.

CLIENT REQUESTS

1. To document any morphological changes in the o-ring surface.

2. To record changes in elemental composition of the o-ring surface.

3. To record any morphological or elemental changes in the cross-section of the o-ring.

METHODS

Scanning electron micrographs were taken on the JEOL 35C SEM, equipped with a Tracor Northern energy dispersive x-ray spectroscopy (EDS) detector and a wavelength dispersive x-ray spectroscopy (WDS) microprobe.

Before examination, the surfaces were mounted on carbon stubs and carbon coated. The cross-sections were cut with a razor blade, mounted in a vice clamp holder, and carbon coated. Elements from Na (Z=11) thru U (Z=92) can be detected by EDS. Carbon, nitrogen and oxygen can be detected by WDS.

Backscatter electron imaging (BEI) was used on both the surface and cross-sections of the o-rings. In this technique, the contrast is dependent upon the average atomic number. The brighter areas reflect the presence of relatively heavier elements. For example, Zn will have a brighter image than Cu which will have a brighter image than Si.

CONCLUSIONS

1. The o-rings from the failed main steam isolation valves have flattened and are more brittle than the nonfailed (MSIV26) or control o-rings.

2. A significant quantity of copper has penetrated approximately 100-150 μm into the failed o-ring. A secondary, more porous layer has formed at the edge. Within this layer (A), a significant quantity of oxygen is present.

3. Within the failed o-rings, portions of the o-ring have attached to the brass valve body and pulled away from the main portion of the o-ring.

RESULTS

I. SEM/EDS Evaluation of the O-ring Surface

A. Morphology & EDS of MSIV Control

1. O-ring Morphology (Figures 1 & 2)

The o-ring is rounded with a few deposits at the surface. These deposits contain primarily Ca and Zn and the deposits are scattered randomly across the o-ring surface (Figures 1b & d BEI, Plots 2, 3 & 4).

2. O-ring EDS (Plots 1-4)

All EDS data is summarized in Table I. Sulfur Ca and Zn are present in moderate quantities. Si, Cl, K, and Fe are present in minor quantities.

B. Morphology & EDS of MSIV26

1. O-ring Morphology (Figures 5 & 6)

The o-ring is still rounded. The inside edge has numerous score marks and has a flattened area (Figure 5).

Backscatter electron images of the o-ring surface indicate minor quantities of relatively heavier elements such as Cu scattered randomly.

2. O-ring EDS (Plots 9 & 10)

All EDS data is summarized in Table I. Elements which include Al, Si, S, K, Ca, Fe, Cu, and Zn are present in minor amounts on the o-ring surface. Near the inside edge of the o-ring, spot mode analysis of the particles identify these as primarily Cu (Figure 6d, Plot 10).

C. Morphology & EDS of MSIV24, 27, & 28 O-rings from Failed Valve

1. O-ring Morphology (Figures 3, 4, 7, 8, 9 & 10)

The o-ring has flattened; the surface appears to have been attached and peeled off. Backscatter electron images of the o-ring surface indicates large quantities of heavier elements such as Cu and Zn cover the surface.

2. O-rings EDS (Plots 5-8, 11-17)

All EDS data is summarized in Table I. Cu & Zn are present in major quantities. When comparing the copper counts in the three failed samples to the control, the copper counts are significantly higher in the failed samples. Conversely, the Ca counts are significantly lower in the failed samples in comparison to the control.

In sample MSIV24, moderate quantities of Si & S and minor quantities of Al, Ca, Fe, Ni & Pb are present. Plots 6, 7 & 8 are the result of spot mode analyses of individual areas a, b & c in Figure 4b.

In sample MSIV27, moderate quantities of Si and minor quantities of S, Cl, Ca, Fe, & Pb are present. Plots 12 & 13 are the result of spot mode analyses of individual areas b & d in Figure 8b.

In sample MSIV28, moderate quantities of Si, S & Pb and minor quantities of Ti & Al are present. Plots 15, 16 & 17 are the result of spot mode analyses of individual areas a, b & c in Figures 9 & 10. Lead (Pb) appears to have concentrated in specific areas as shown in Figure 10c and Plot 17.

II. SEM/EDX Evaluation of the O-ring Cross-sections

A. Morphology & EDS of MSIV Control (Figures 11 & 12)

1. Morphology

The cross-section is very uniform from the edge to the center of the o-ring. No morphological differences are noted in the control.

2. O-ring EDS/WDS Plots 18 & 19

The EDS/WDS data are located in Table II. No elemental differences were noted between areas A and B (Figure 13c) in the control. Both areas had a major quantity of C, S & Ca and a minor quantity of Si, Cu & Zn. Backscatter electron images of the cross-section only revealed a uniform distribution of relatively heavier elements such as Ca and Zn.

B. Morpholgoy & EDS of MSIV26

1. Morphology (Figures 15 & 16)

The cross-section is very uniform from the edge to the center of the o-ring. No morphological differences are present across the sample. The morphology is similar to the control.

2. EDS/WDS O-ring Cross-section (Plots 22-23)

The EDS/WDS data are located in Table II. No elemental differences were noted between areas A & B (Figure 15c). Both areas had major quantities of C, Si & S, and minor quantities of Ca, Zn & Cl. The number of Cu counts is significantly higher in sample MSIV26 than in the control. The Ca counts are significantly lower than in the control.

C. Morphology & EDS of MSIV24, 27 & 28
Cross-section of O-rings from Failed Valve

1. Morphology (Figures 13 & 14, 17-20)

The cross-section reveals two distinct areas, A and B (Figures 13c, 17c & 19c). Area A is approximately 100-150 μm deep at the edge of the o-ring. Area A is much rougher and appears to be more porous.

Samples MSIV24 & MSIV28 have 2 sides of the flattened o-ring containing area A. Sample MSIV27 has 3 sides of the flattened o-ring containing area A.

2. EDS O-ring Cross-section (Plots 20-21, 24-27)

The EDS data is located in Table II. There is a significant increase in copper counts when comparing the three failed samples to the control. In addition, area A in the three failed samples has a larger number of copper counts than in Area B.

The Si counts have increased significantly and the Ca counts have decreased compared to the control.

In sample MSIV28, there is a significant quantity of oxygen present. Relatively no oxygen was present in sample MSIV26 or in the control.

Kathy Krutyholowa
Kathy A. Krutyholowa

jsb
Atts.

File No.: 8702086, 8702091
8702094, 8702095
Notebook Ref.: 20294-88

Reviewed By: W R Bramstedt

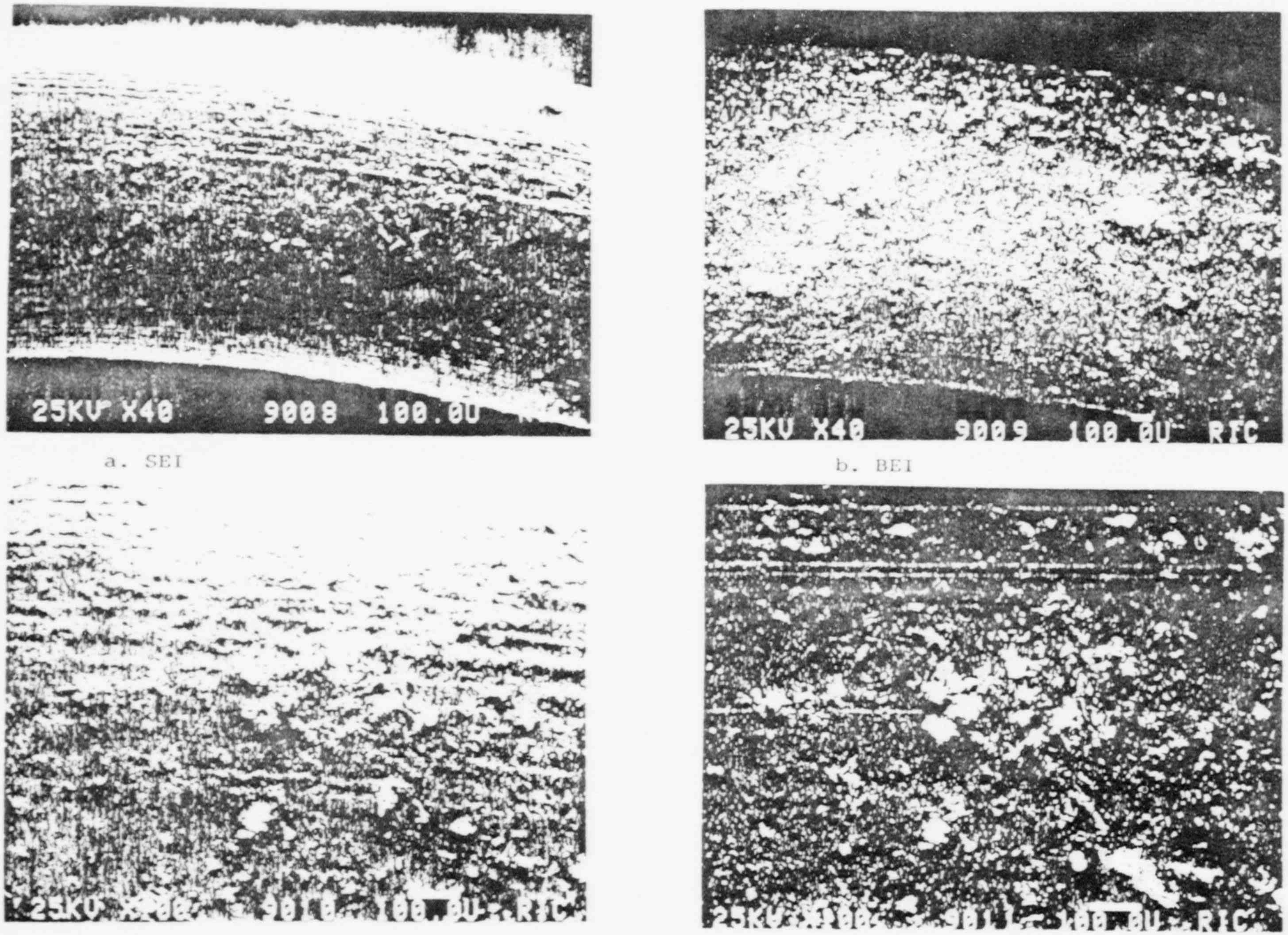
Table 1
O-ring Surface
Energy Dispersive X-ray (EDS) Microanalysis
Net Counts per Second
100X Area

		Si	S	Ca	Cu	Zn
Control	(Plot 1)	18	60	65	20	83
MSIV24	(Plot 5)	52	26	6	256	117
MSIV26	(Plot 9)	19	11	3	31	14
MSIV27	(Plot 11)	55	27	3	333	154
MSIV28	(Plot 14)	30	20	2	241	115

Table II
Cross-sections of O-ring
Energy Dispersive X-ray (EDS) Microanalysis
Wavelength Dispersive X-ray (WDS) Microanalysis
Net Counts per Second
2000X Area

Control	C	N	O	Si	S	Ca	Cu	Zn
Area A (Figure 11c)	5,057	0	0	11	118	91	26	47
Area B (Figure 11c)	4,896	0	7	10	111	76	24	49
MSIV24								
Area A (Figure 13c)	NA	NA	NA	89	74	7	97	48
Area B (Figure 13c)	NA	NA	NA	70	78	6	66	27
MSIV26								
Area A (Figure 15c)	4,381	0	0	103	89	5	66	25
Area B (Figure 15c)	3,834	0	0	91	87	9	64	25
MSIV27								
Area A (Figure 17c)	NA	NA	NA	186	66	5	124	58
Area B (Figure 17c)	NA	NA	NA	95	97	7	40	12
MSIV28								
Area A (Figure 19c)	4,584	0	281	177	77	5	159	84
Area B (Figure 19c)	4,576	0	52	89	82	3	42	14

NA = Not analyzed



a. SEI

b. BEI

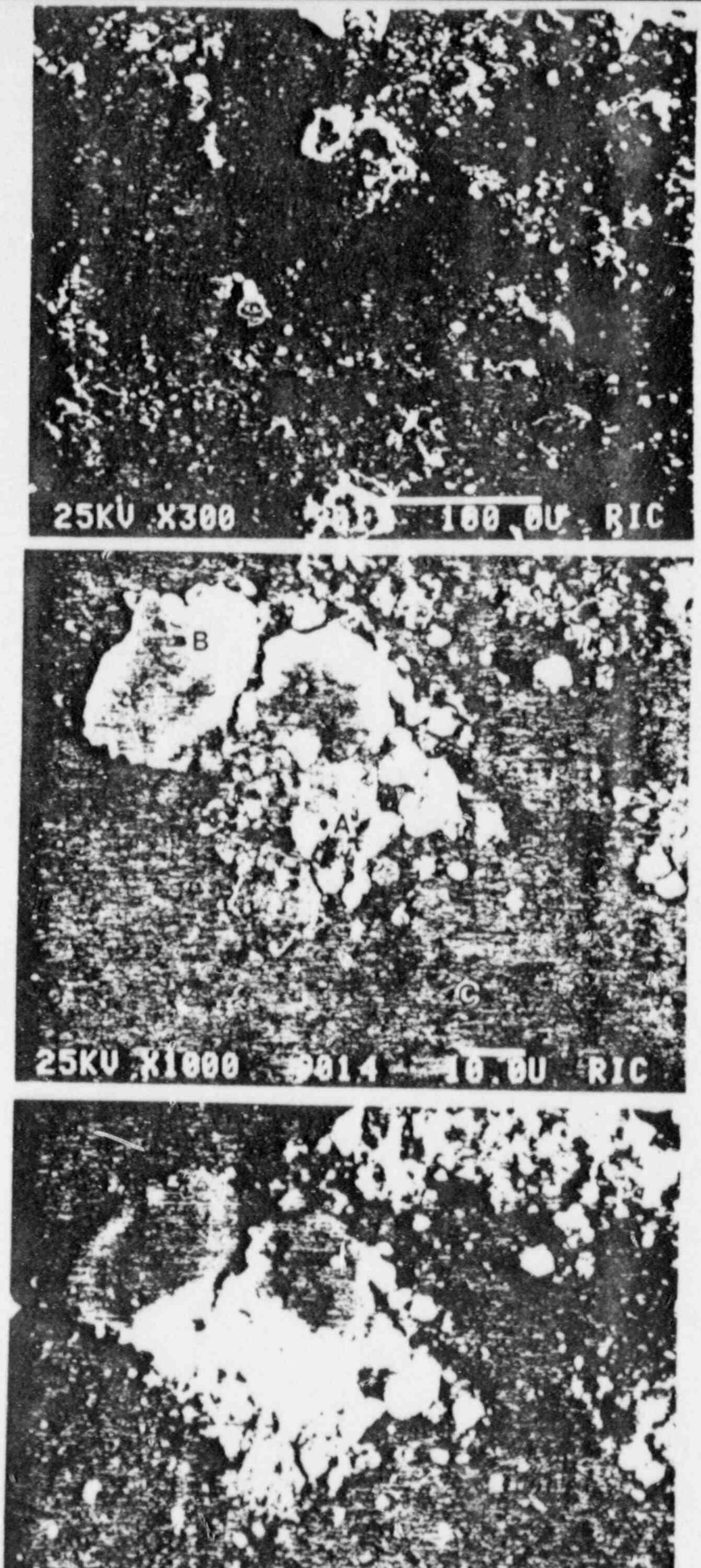
c. SEI

d. BEI

Figure 1. MSIV Control
O-ring Surface

Figure 2.

MSIV Control
O-ring Surface



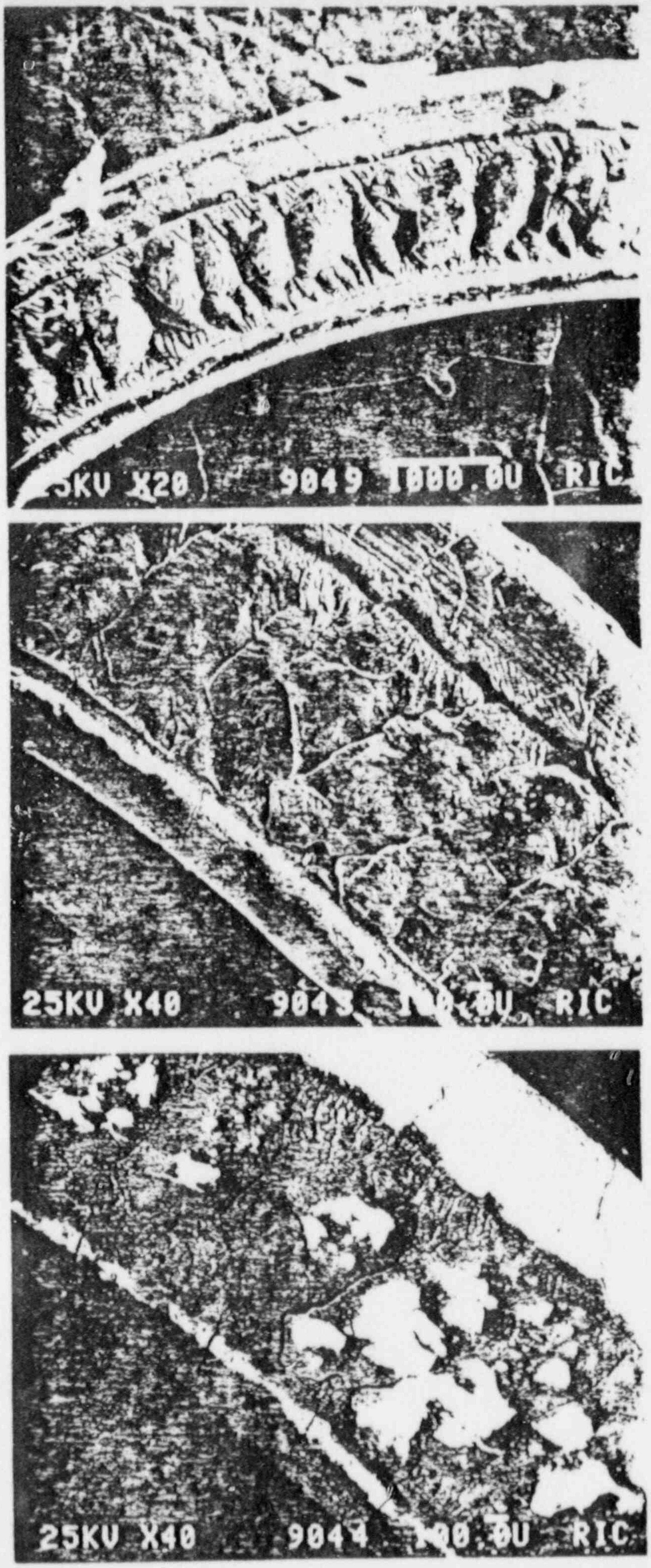
a. SEI

b. SEI
See Plots A=2; B=3; C=4

c. BEI

Figure 3.

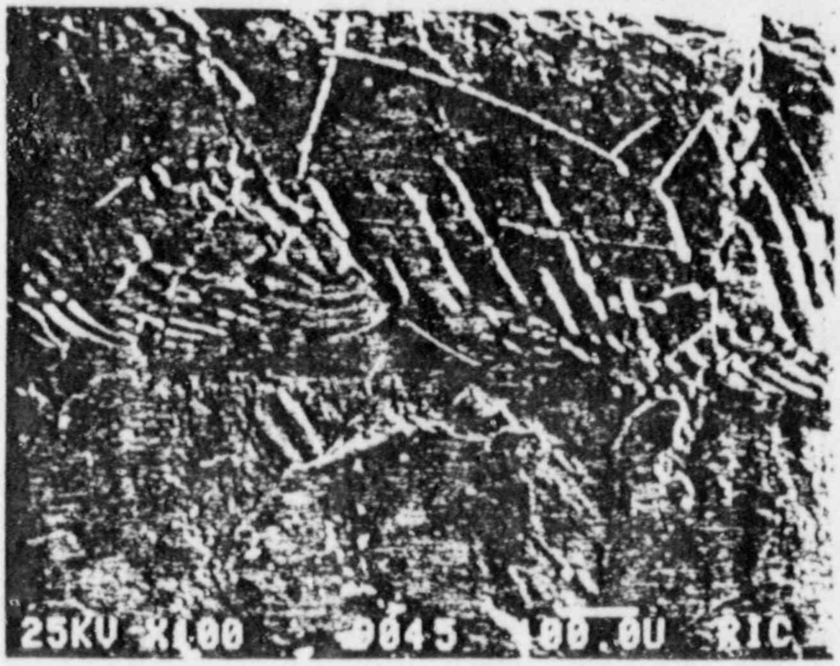
MSIV24
O-ring Surface
Failed



a. SEI

b. SEI

c. BEI



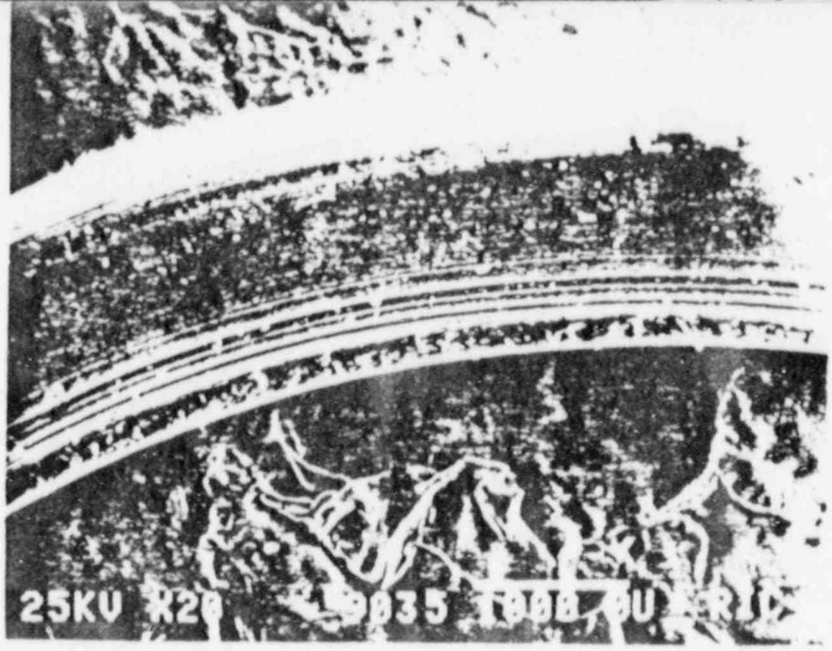
a. SEI

b. BEI See Plots A=6; B=7; C=8

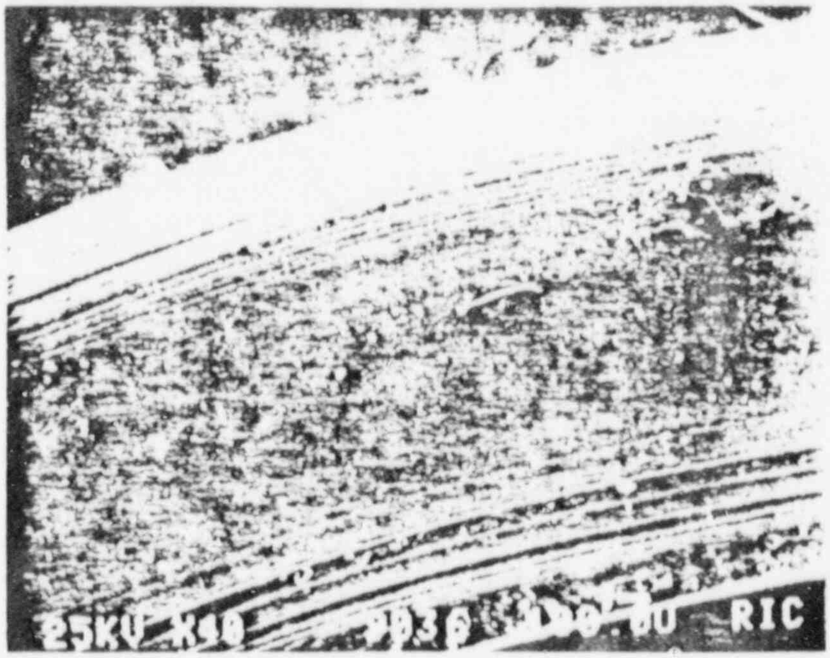
Figure 4. MSIV24
O-ring Surface; Failed

Figure 5.

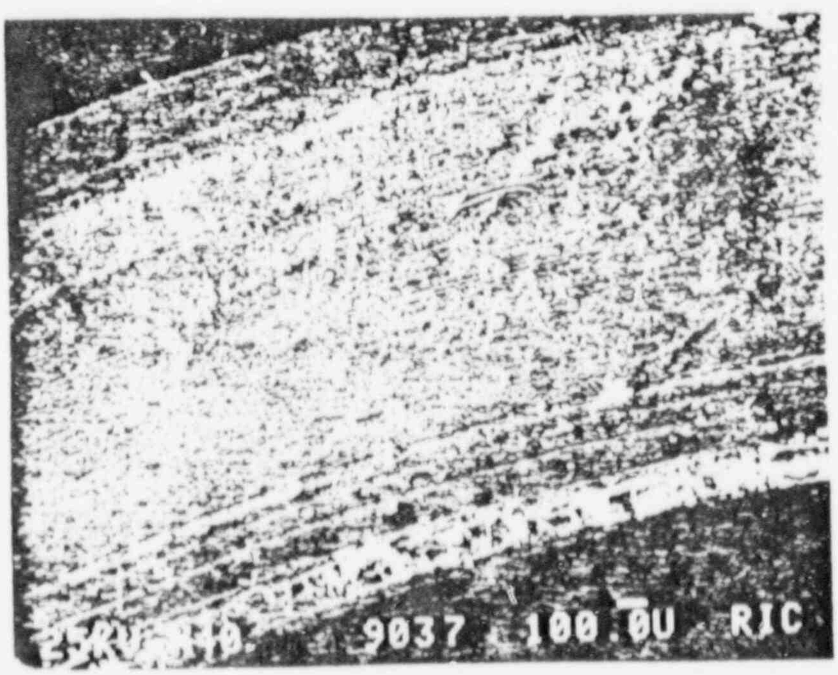
MSIV26
O-ring Surface
Not Failed



a. SEI



b. SEI



c. BEI

Figure 6.

MSIV26
O-ring Surface
Not Failed

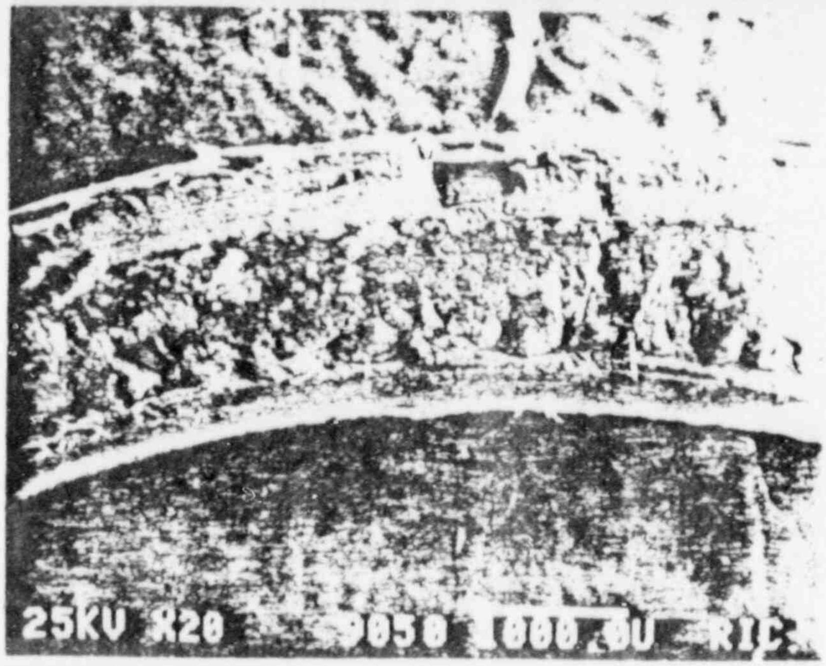
a. SEI

b. BEI
See Plot A=10

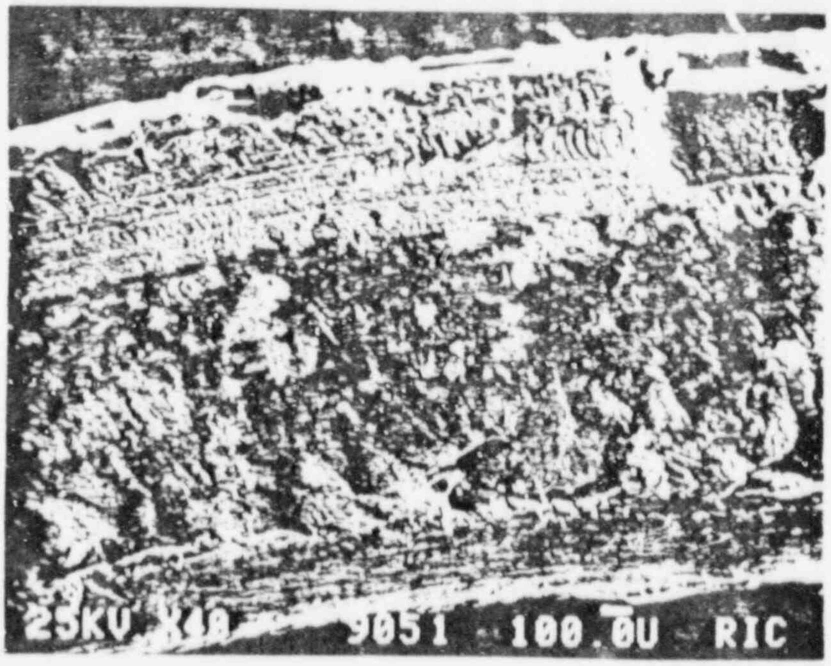
c. SEI

Figure 7.

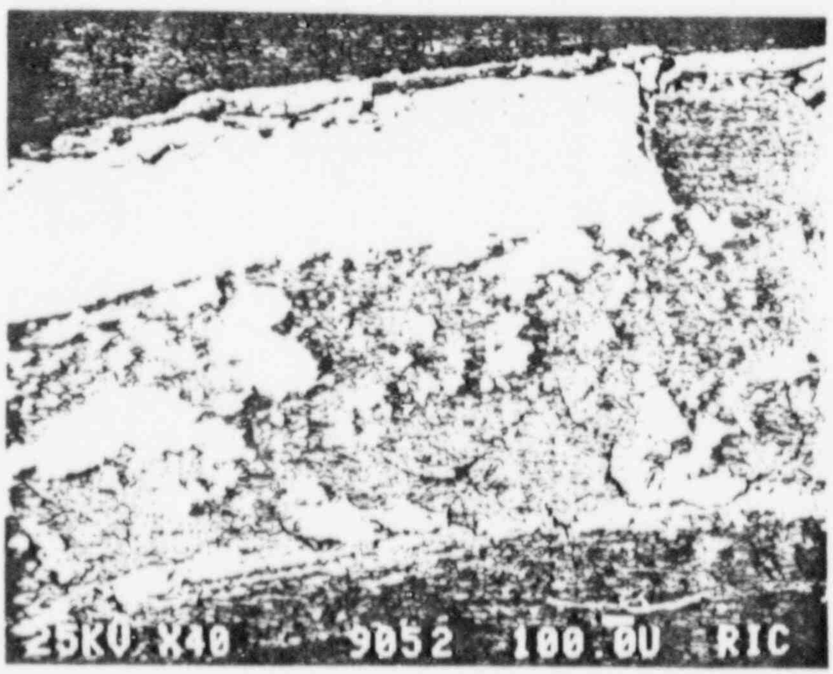
MSIV27
O-ring Surface
Failed



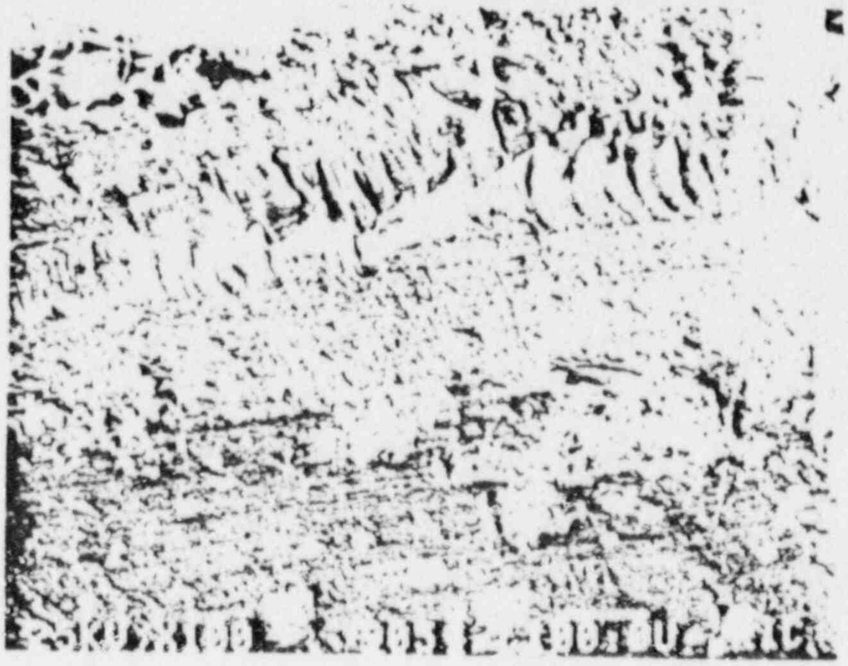
a. SEI



b. SEI



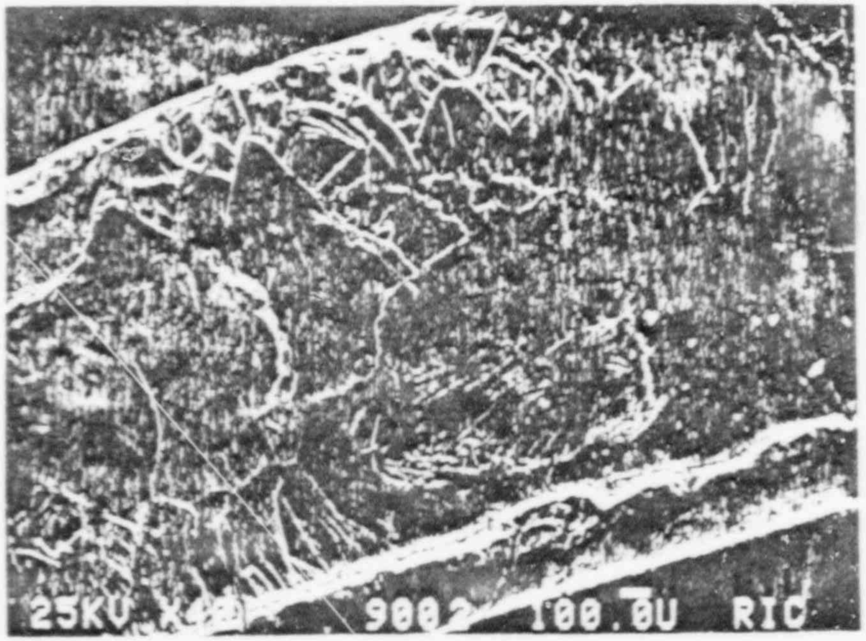
c. BEI



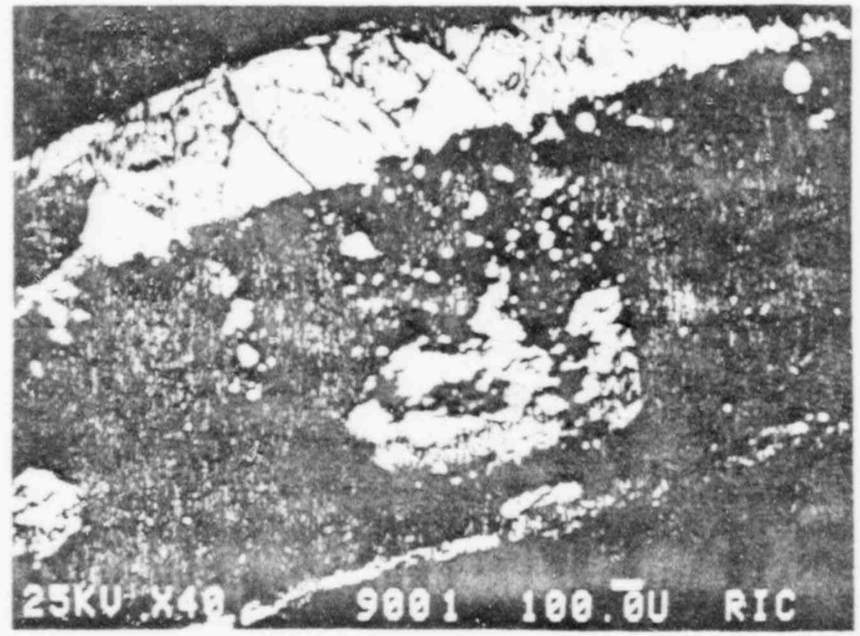
a. SEI

b. BEI See Plots B=12; D=13

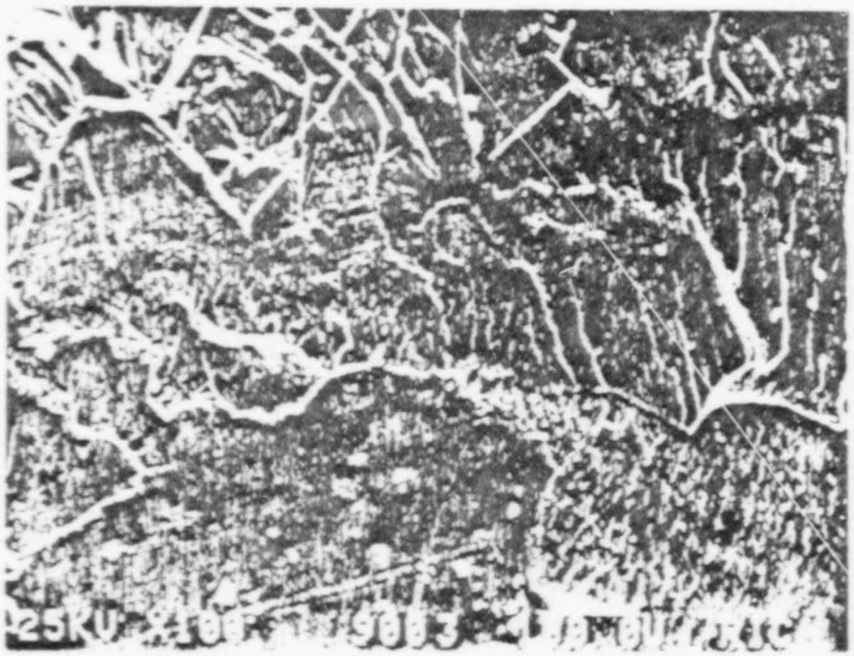
Figure 8. MSIV27
O-ring Surface; Failed



a. SEI



b. BEI



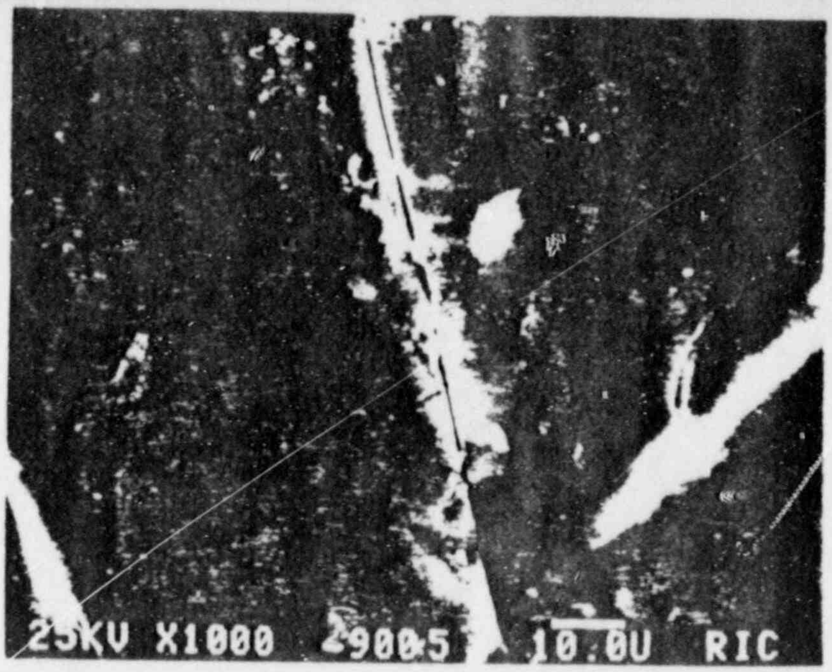
c. SEI

d. BEI See Plots A=15; B=16; C=17

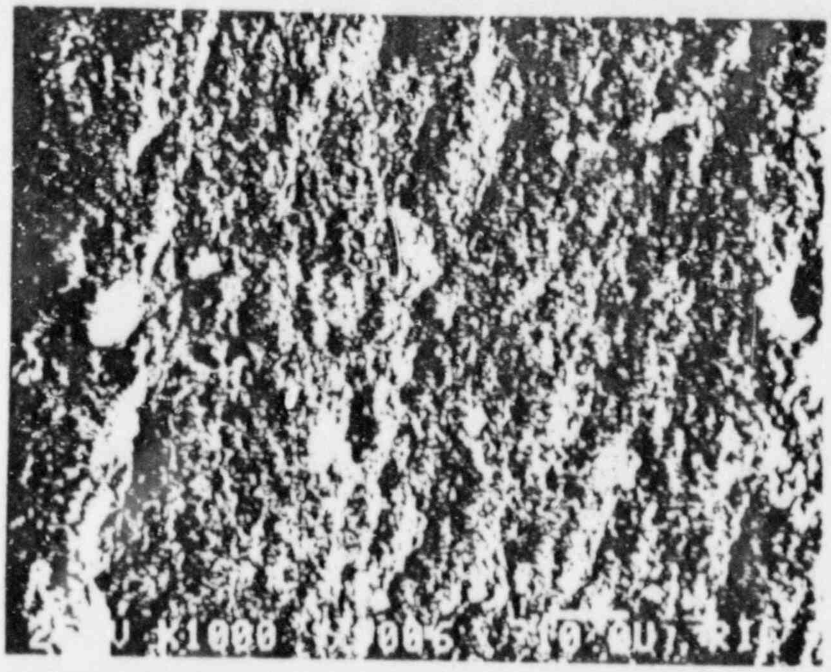
Figure 9. MSIV28
O-ring Surface Failed

Figure 10.

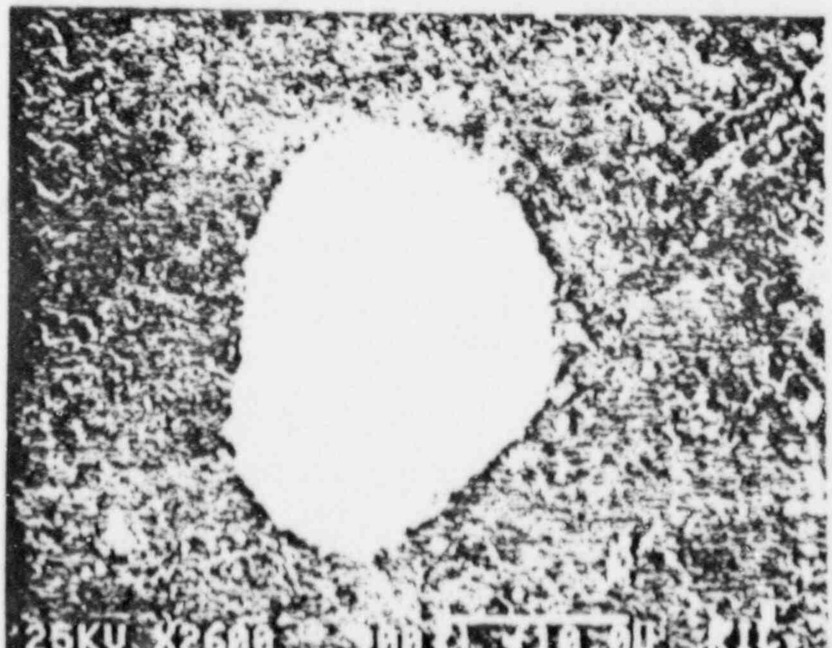
MSIV28
O-ring Surface
Failed



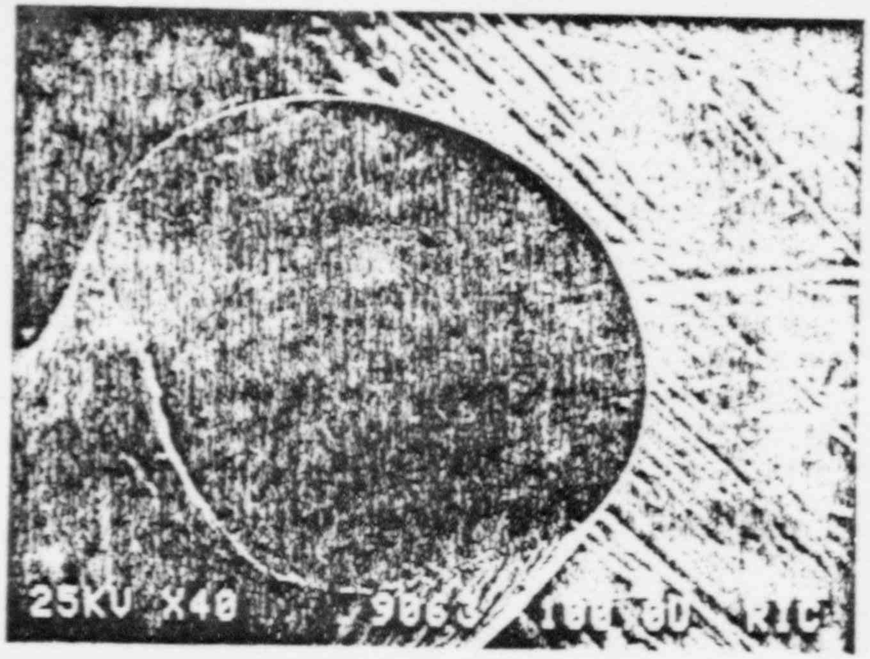
a. Area A



b. Area B



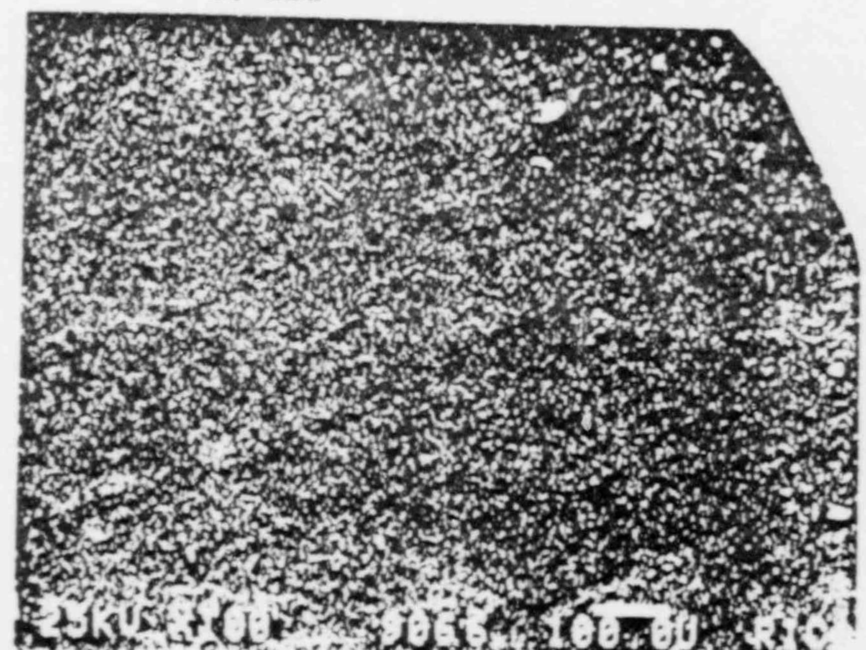
c. Area C



a. SEI

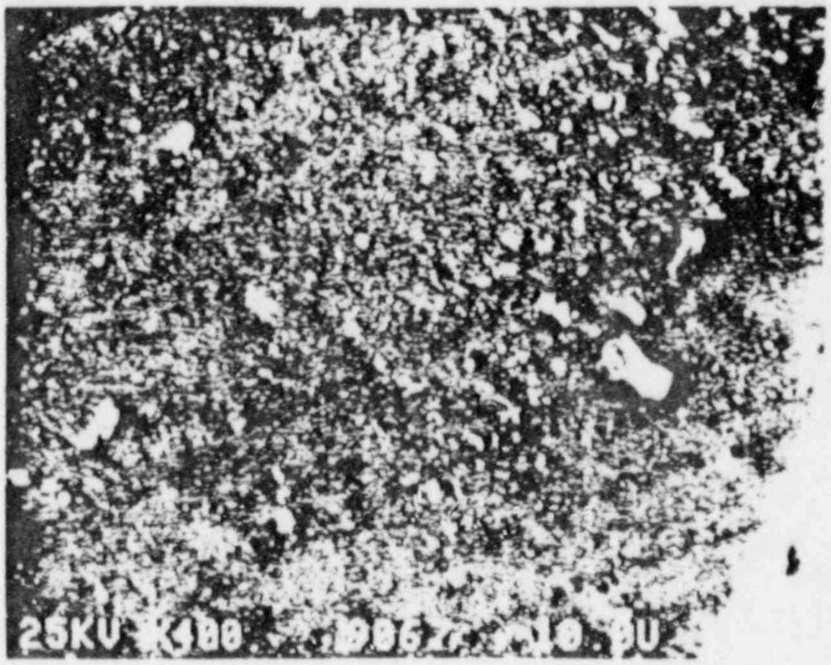
b. BEI

c. SEI See Plots A=18; B=19

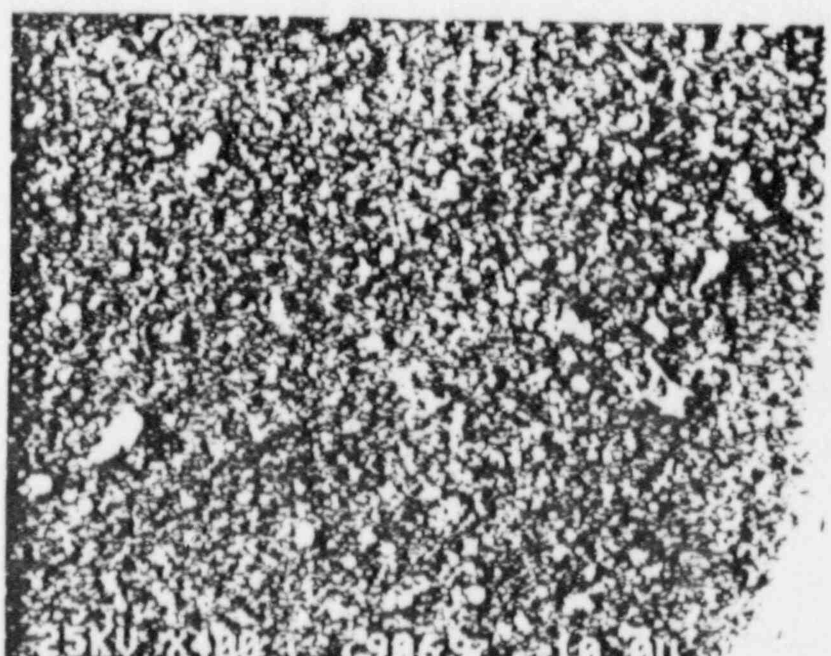


d. BEI

Figure 11. MSIV Control
O-ring Cross-section

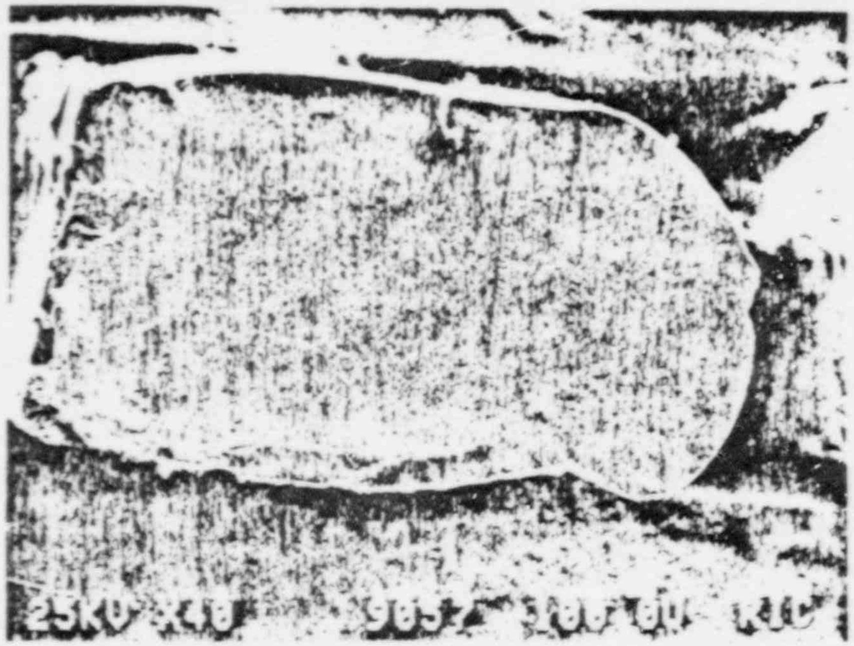


a. SEI

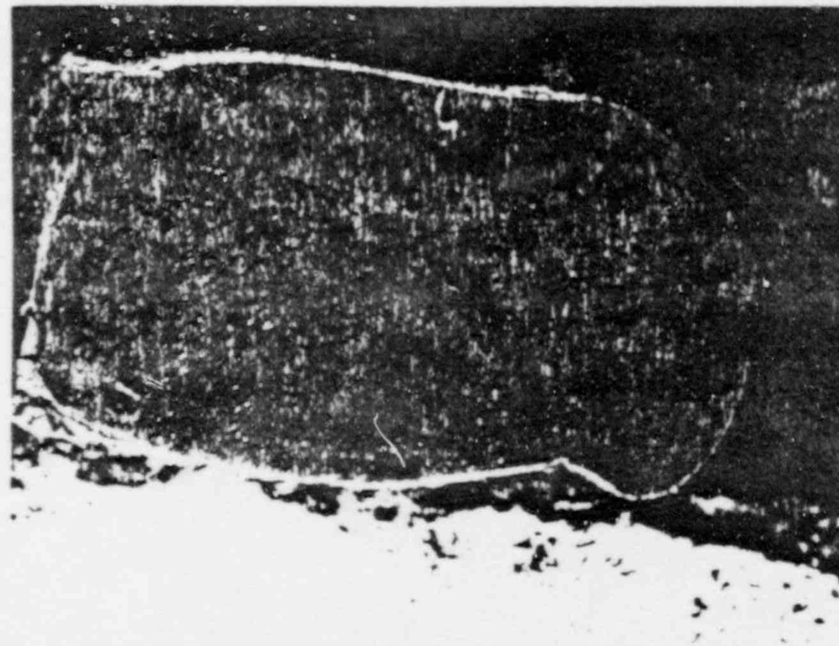


b. BEI

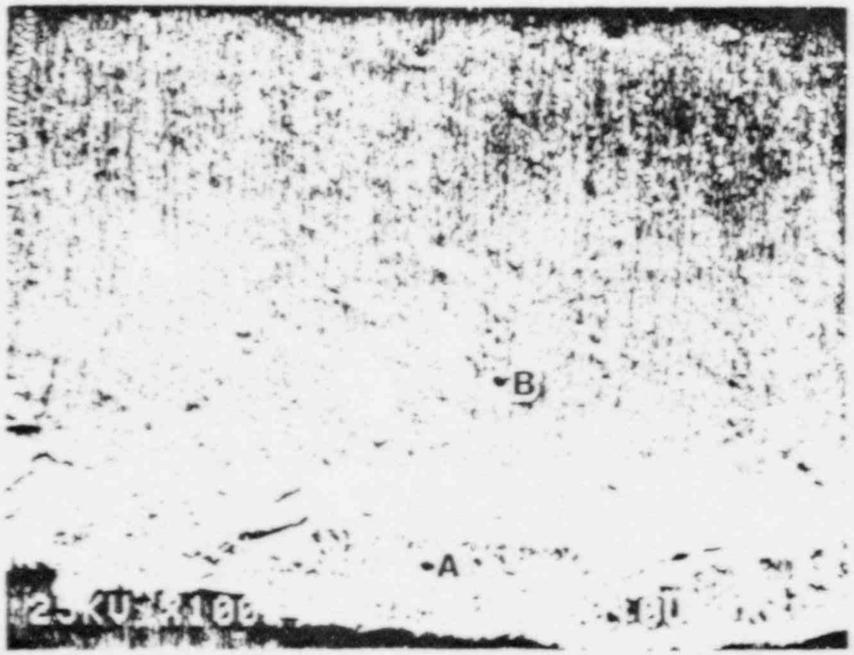
Figure 12. MSIV Control
O-ring Cross-section



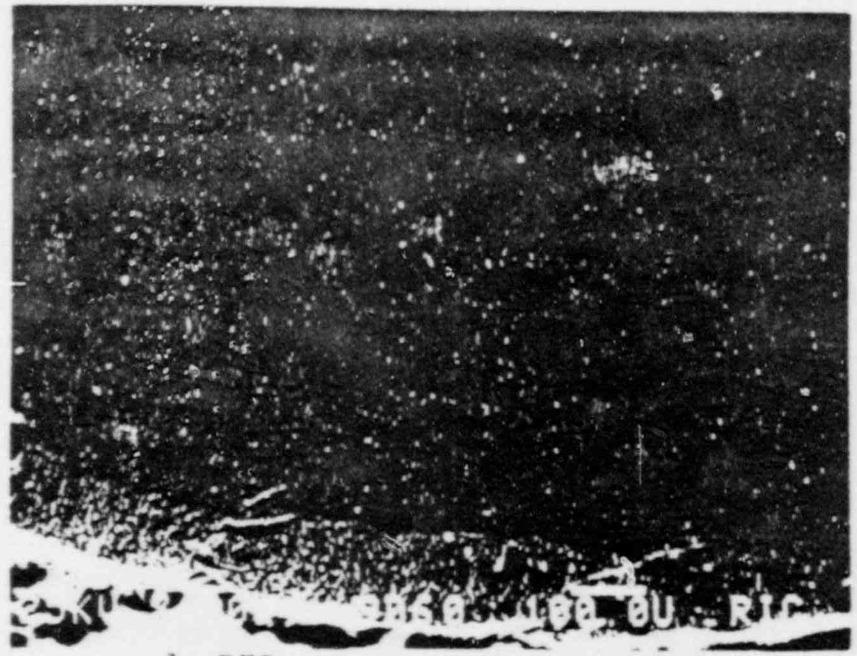
a. SEI



b. BEI

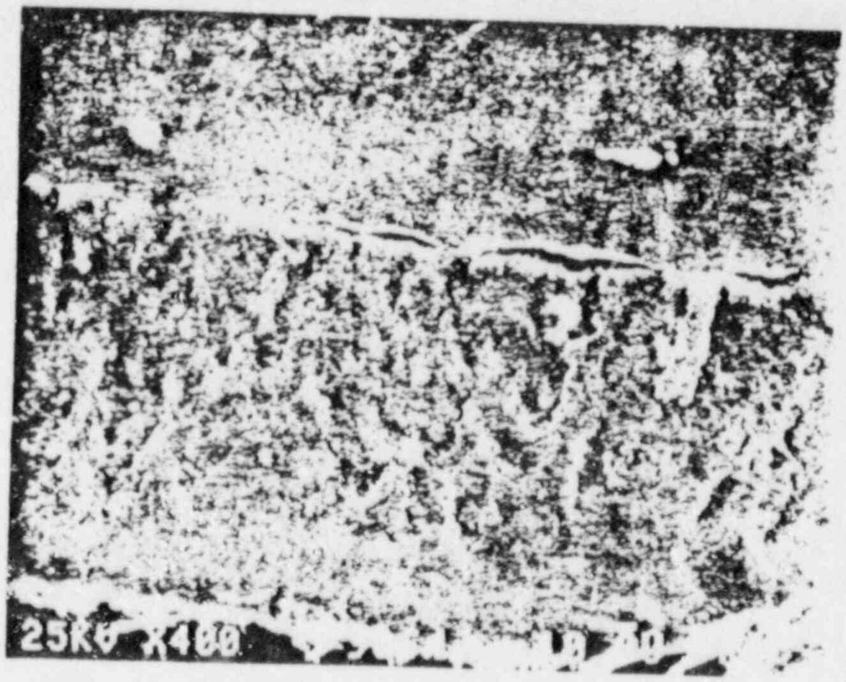


c. SEI See Plots A=20; B=21



d. BEI

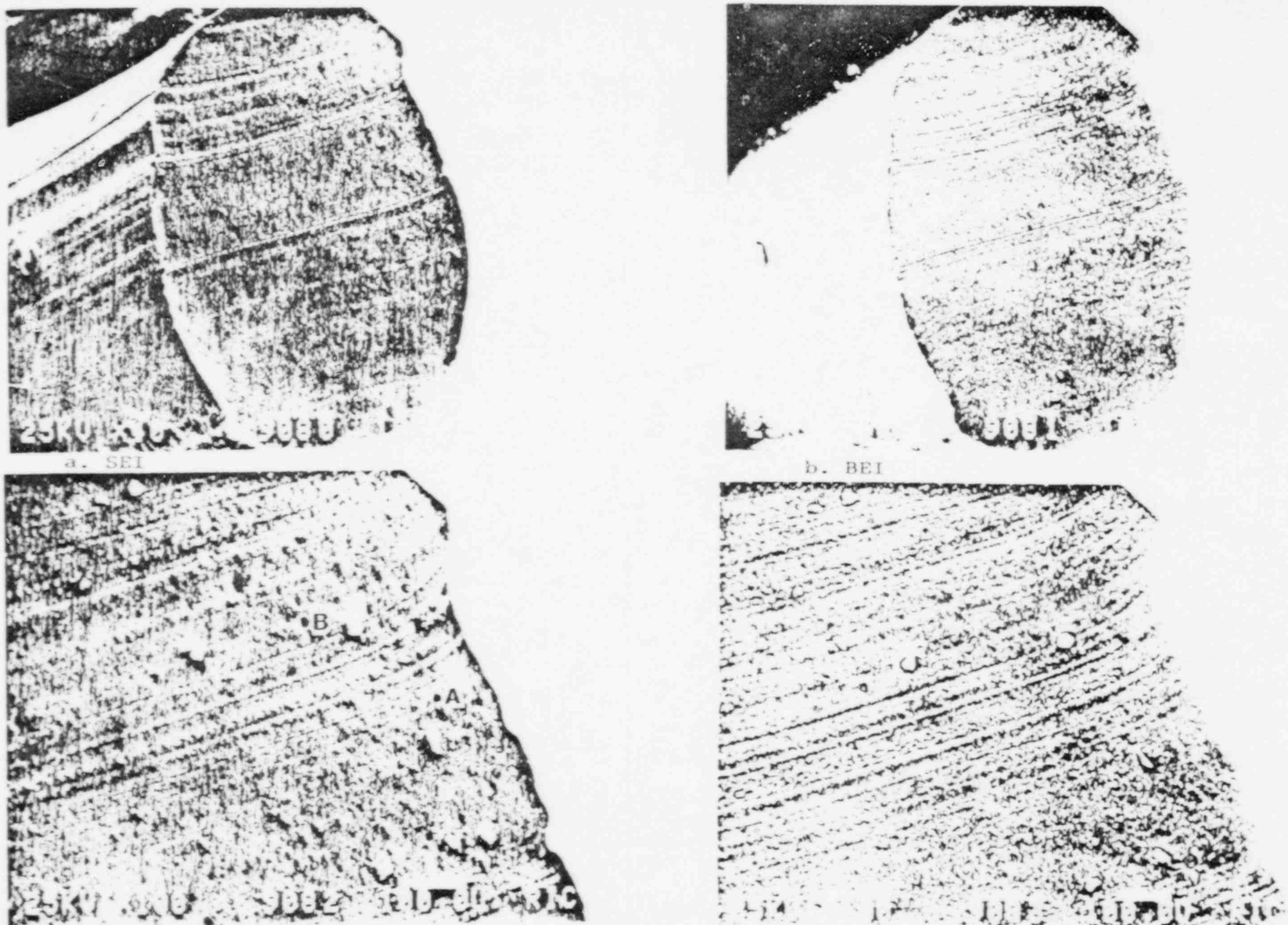
Figure 13. MSIV24
O-ring Cross-section Failed



a. SEI

b. BEI See Plots A=20; B=21

Figure 14. MSIV24
O-ring Cross-section; Failed



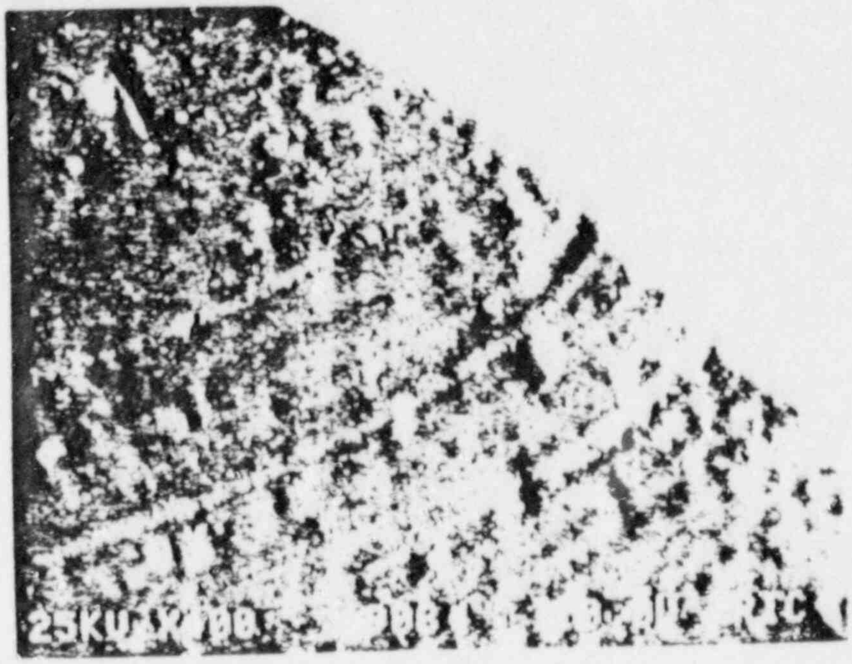
a. SEI

b. BEI

c. SEI See Plots A=22; B=23

d. BEI

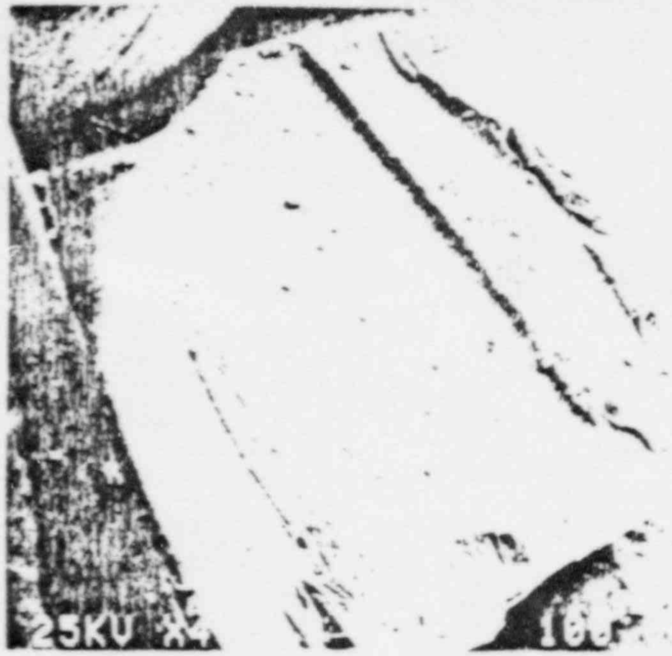
Figure 15. MSIV26
O-ring Cross-section; Not Failed



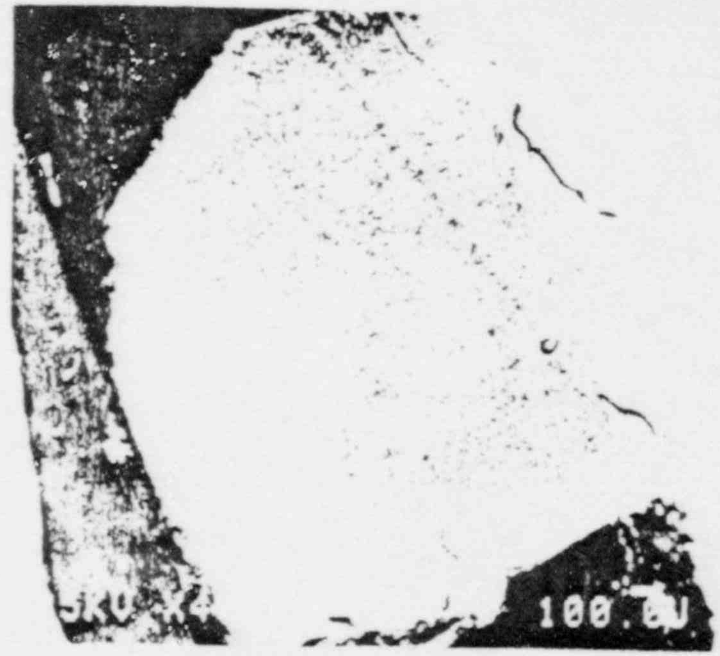
a. SEI

b. BEI

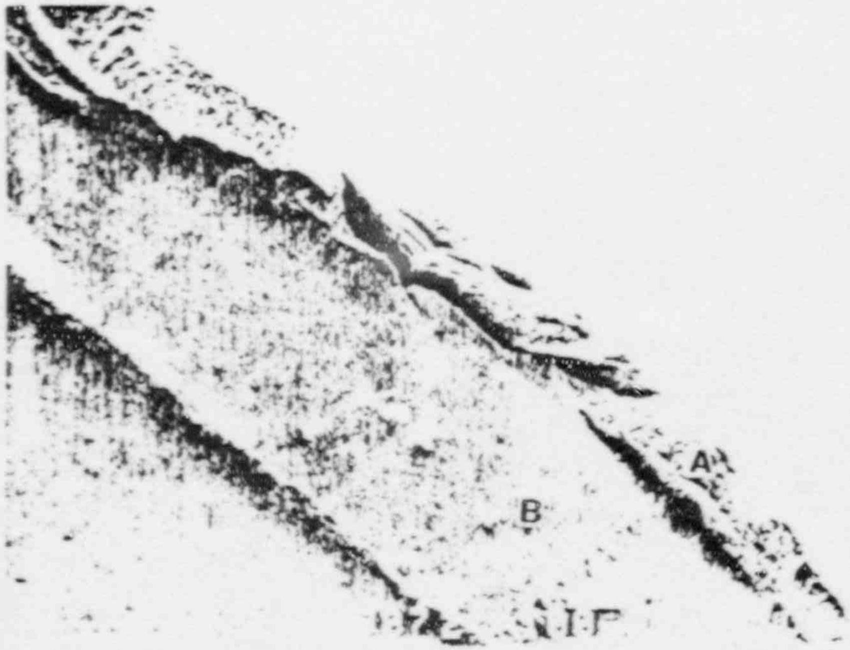
Figure 16. MSIV26
O-ring Cross-section; Not Failed



a. SEI



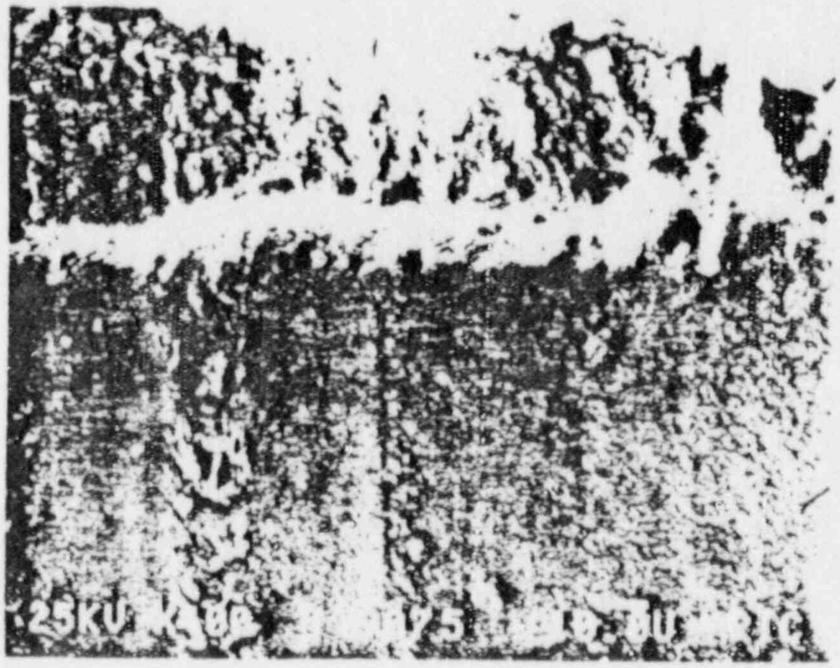
b. BEI



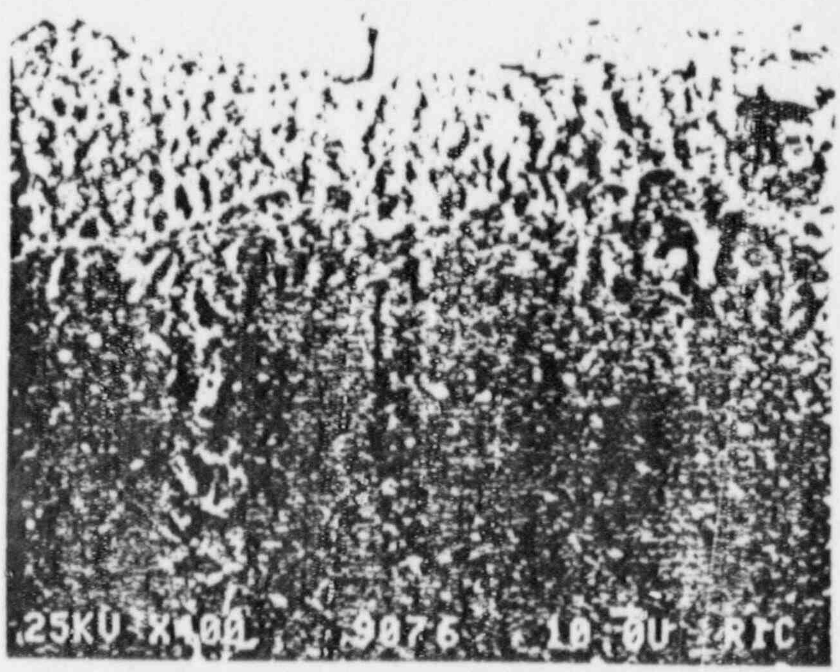
c. SEI See Plots A=24; B=25

d. BEI See Plots A=24; B=25

Figure 17. MSIV27
O-ring Cross-section; Failed



a. SEI

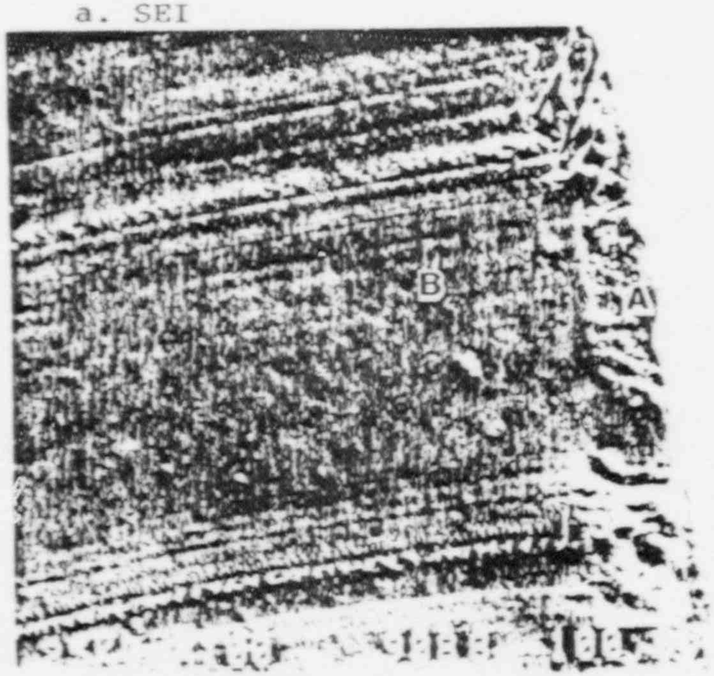


b. BEI

Figure 18. MSIV27
O-ring Cross-section; Failed

a. SEI

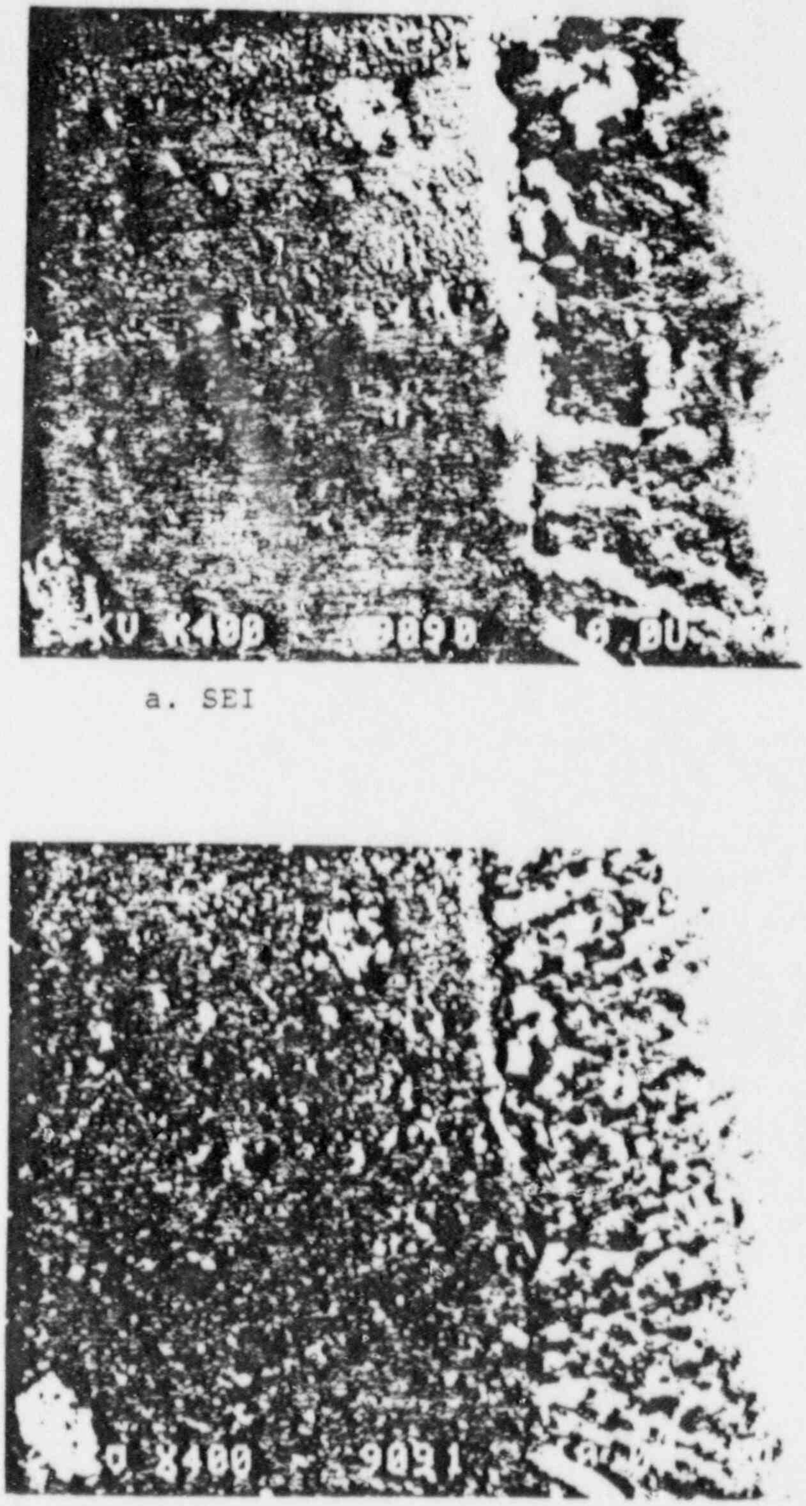
b. BEI



c. SEI See Plots A=26; B=27

d. BEI

Figure 19. MSIV28
O-ring Cross-section; Failed

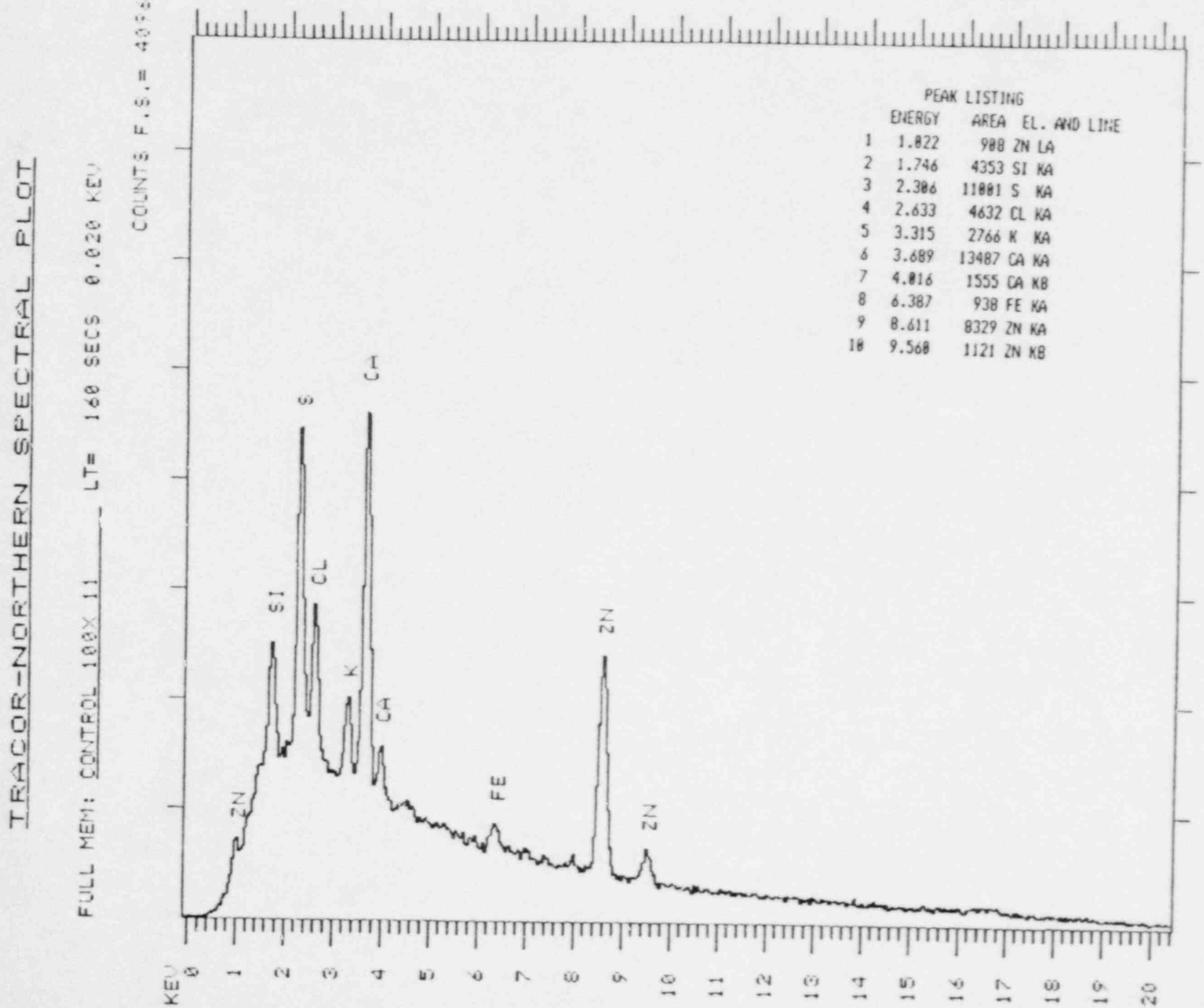


a. SEI

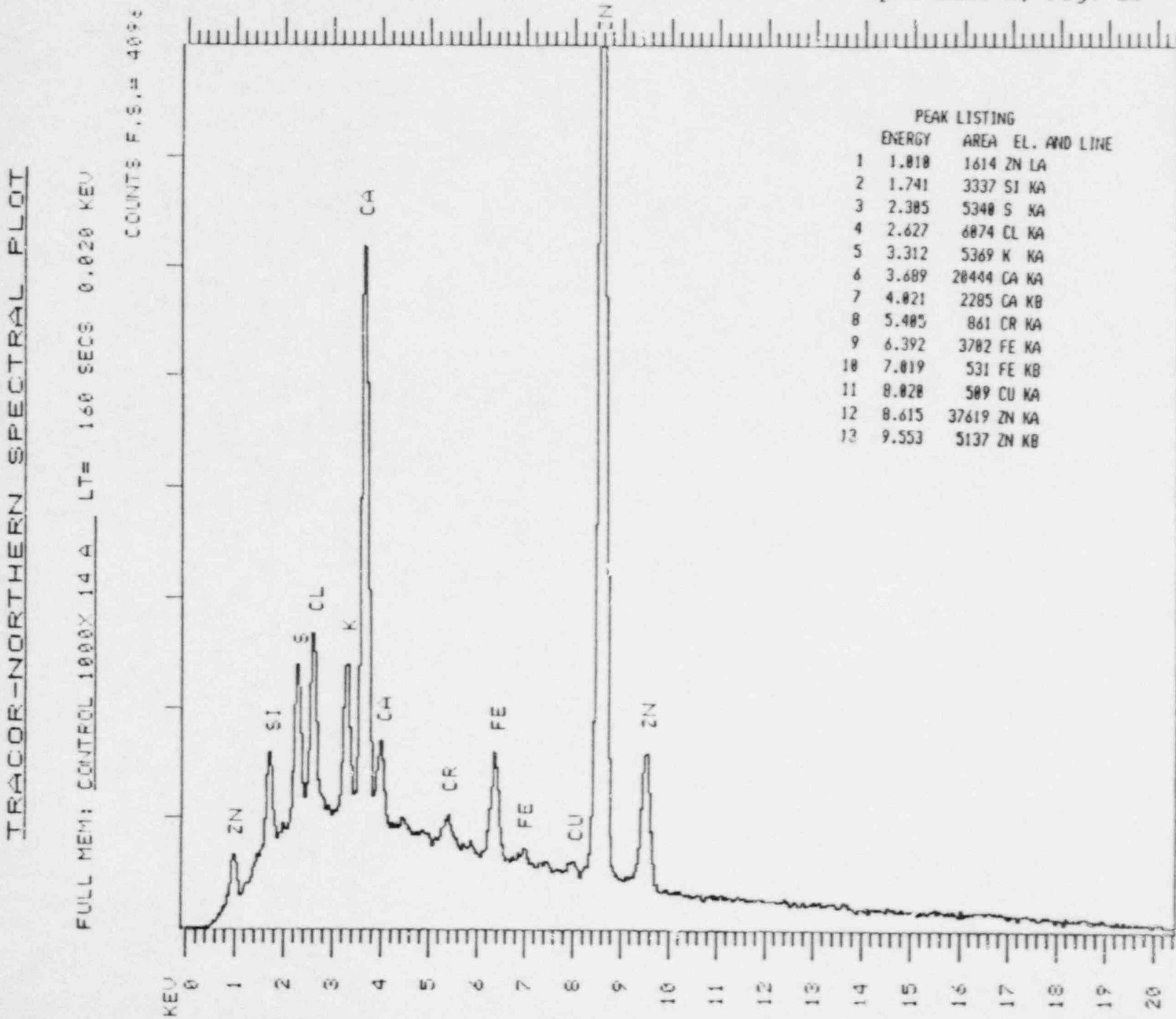
b. BEI

Figure 20. MSIV28
O-ring Cross-section; Failed

Plot 1
MSIV Control
O-ring Surface
100X Area



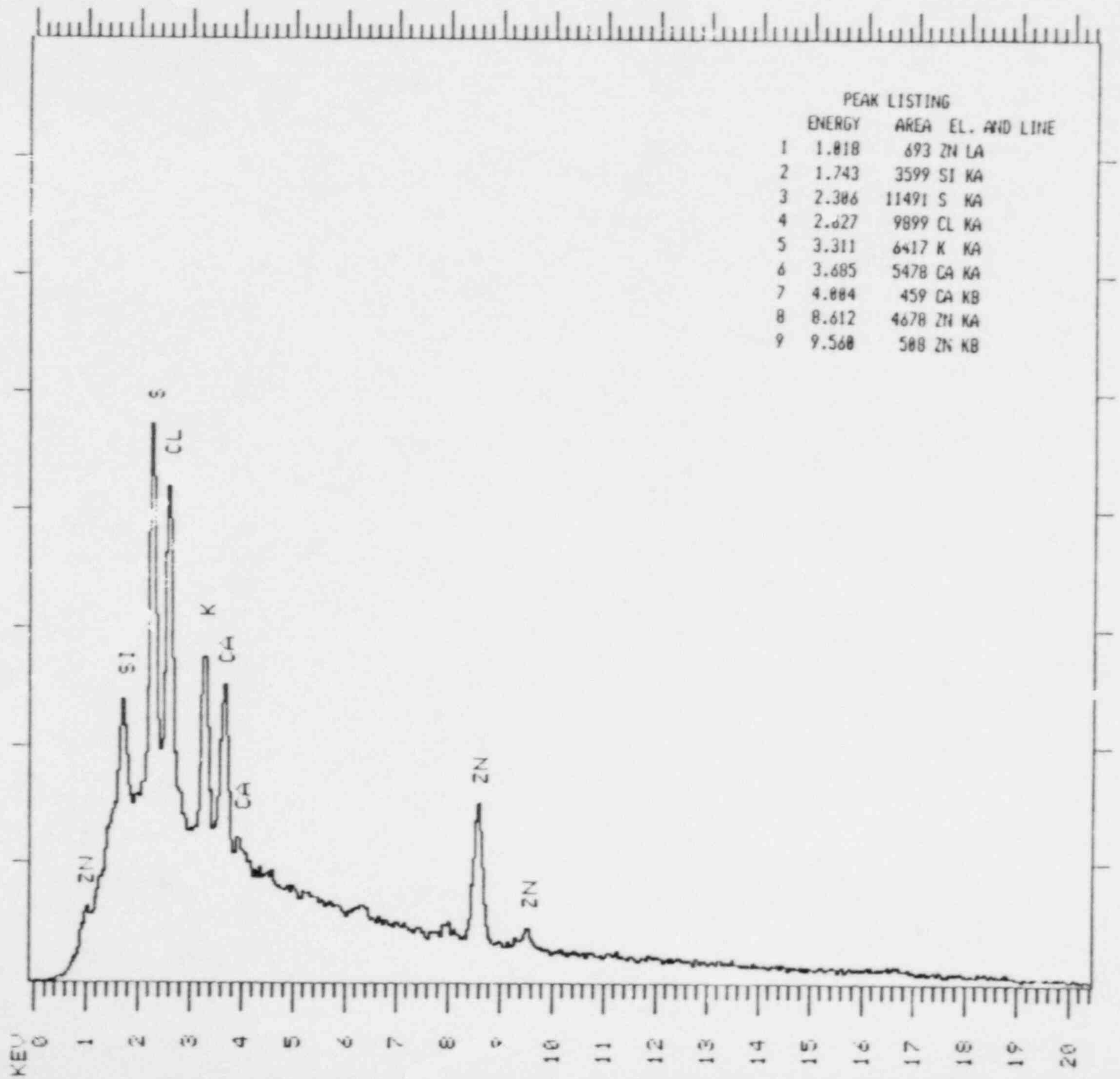
Plot 2
MSIV Control
O-ring Surface
Spot Mode A; Fig. 2b



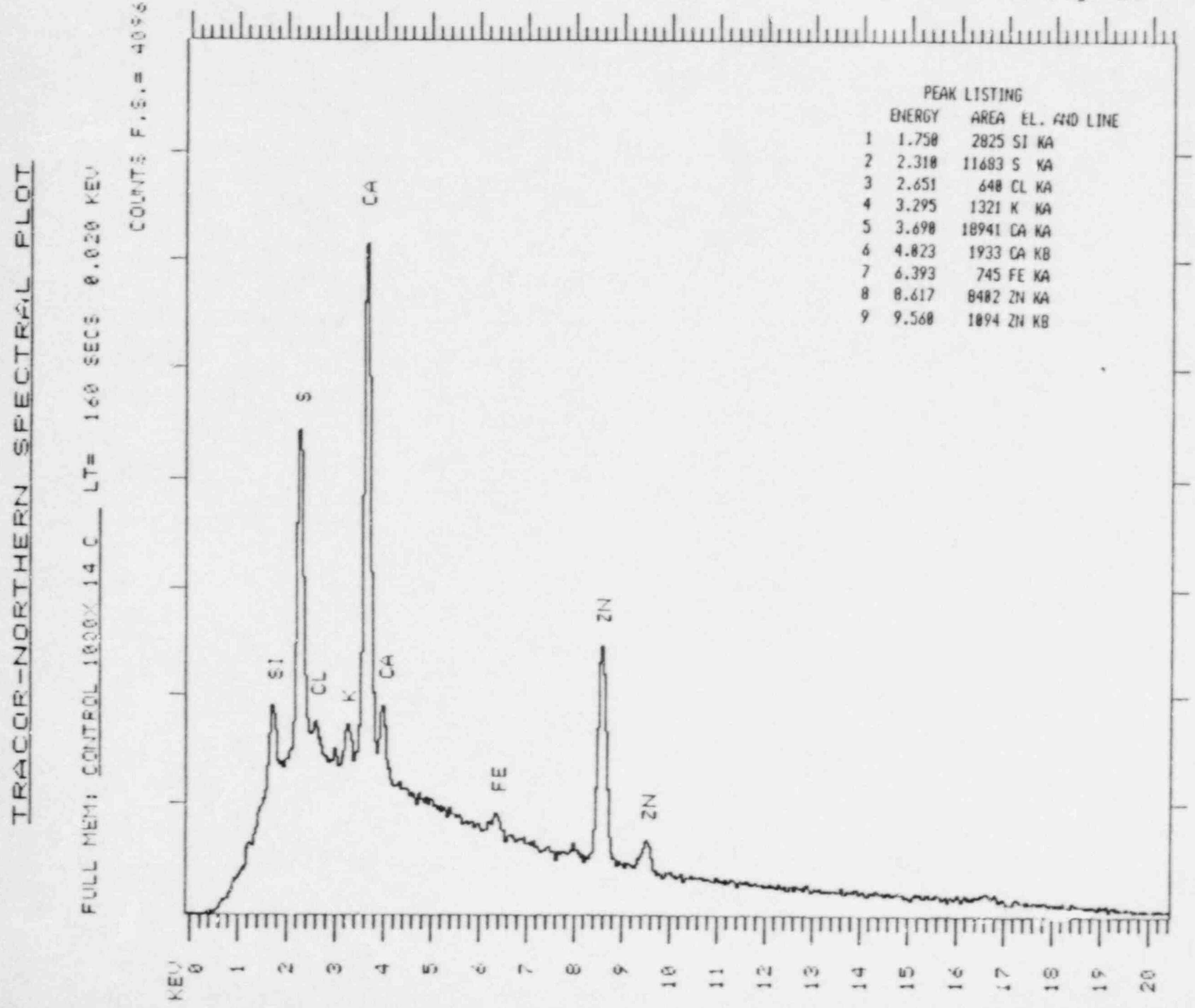
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.010	1614	ZN LA
2	1.741	3337	SI KA
3	2.305	5340	S KA
4	2.627	6074	CL KA
5	3.312	5369	K KA
6	3.689	20444	CA KA
7	4.021	2285	CA KB
8	5.405	861	CR KA
9	6.392	3702	FE KA
10	7.019	531	FE KB
11	8.020	509	CU KA
12	8.615	37619	ZN KA
13	9.553	5137	ZN KB

Plot 3
MSIV Control
O-ring Surface
Spot Mode B; Fig. 2b



Plot 4
MSIV Control
O-ring Surface
Spot Mode C; Fig. 2c

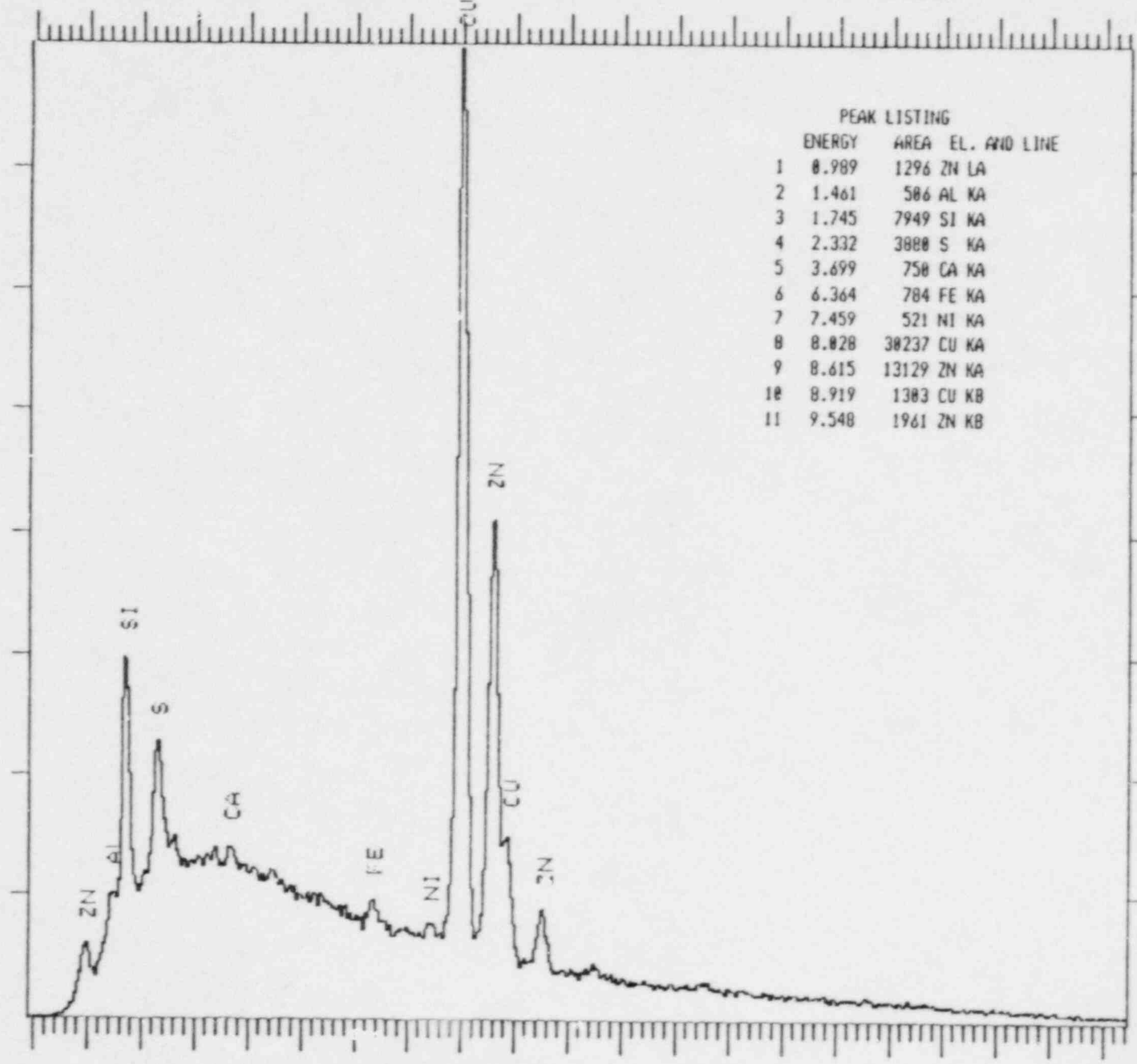


Plot 5
MSIV24
O-ring Surface
100X Area

TRACOR-NORTHERN SPECTRAL PLOT

FULL MEM: MSIV 24 100x 45 LT= 160 SECS 0.020 KEV

COUNTS F.S.= 4096



PEAK LISTING

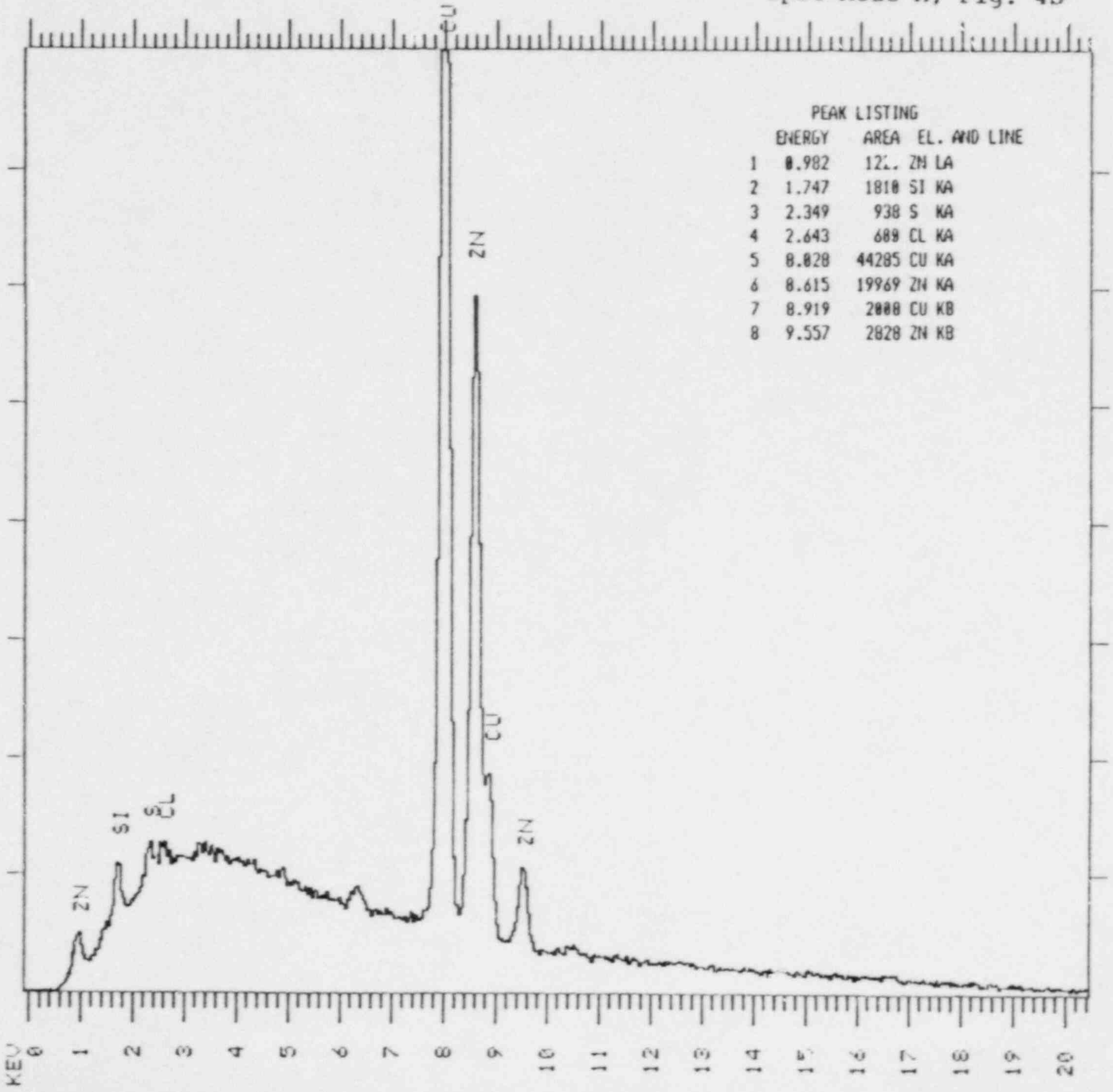
	ENERGY	AREA	EL. AND LINE
1	0.989	1296	ZN LA
2	1.461	586	AL KA
3	1.745	7949	SI KA
4	2.332	3880	S KA
5	3.699	750	CA KA
6	6.364	784	FE KA
7	7.459	521	NI KA
8	8.028	30237	CU KA
9	8.615	13129	ZN KA
10	8.919	1303	CU KB
11	9.548	1961	ZN KB

Plot 6
MSIV24
O-ring Surface
Spot Mode A; Fig. 4b

TRACOR-NORTHERN SPECTRAL PLOT

FULL MEM: MSIV 24 600 a 45 LT= 160 SECS 0.020 KEV

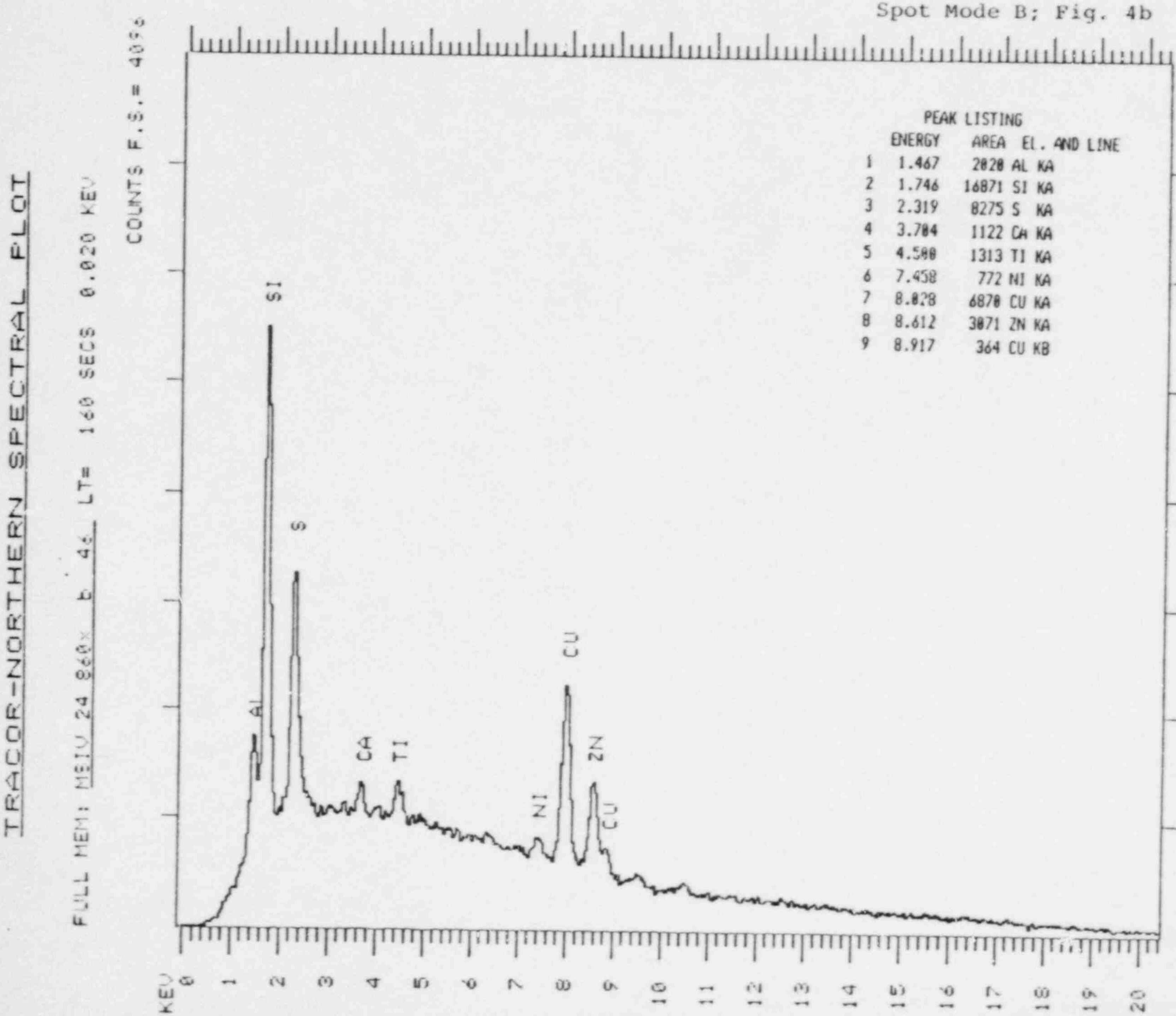
COUNTS F.S.= 4096



PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	0.982	12[illegible]	ZN LA
2	1.747	1810	SI KA
3	2.349	938	S KA
4	2.643	689	CL KA
5	8.028	44285	CU KA
6	8.615	19969	ZN KA
7	8.919	2008	CU KB
8	9.557	2828	ZN KB

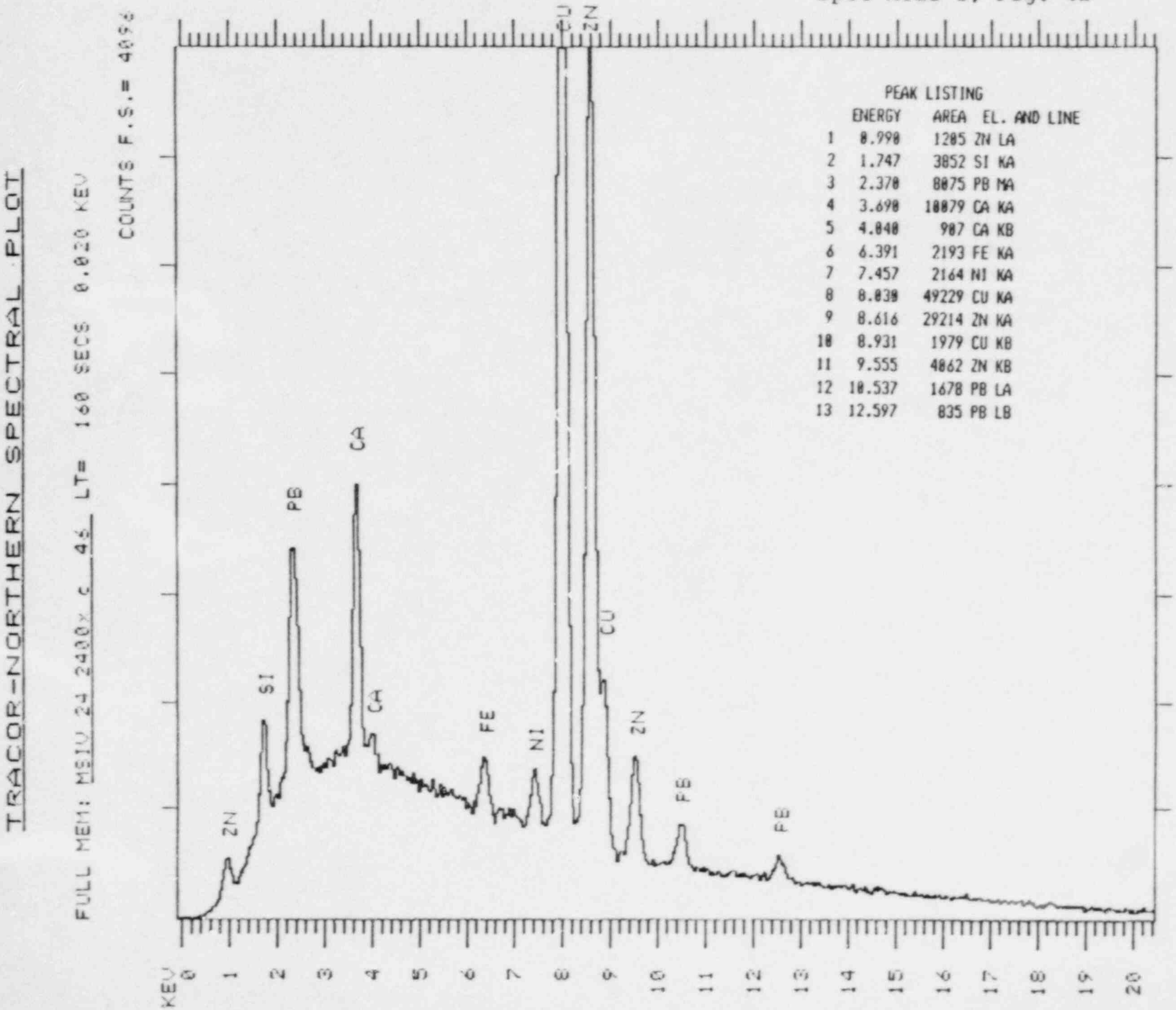
Plot 7
MSIV24
O-ring Surface
Spot Mode B; Fig. 4b



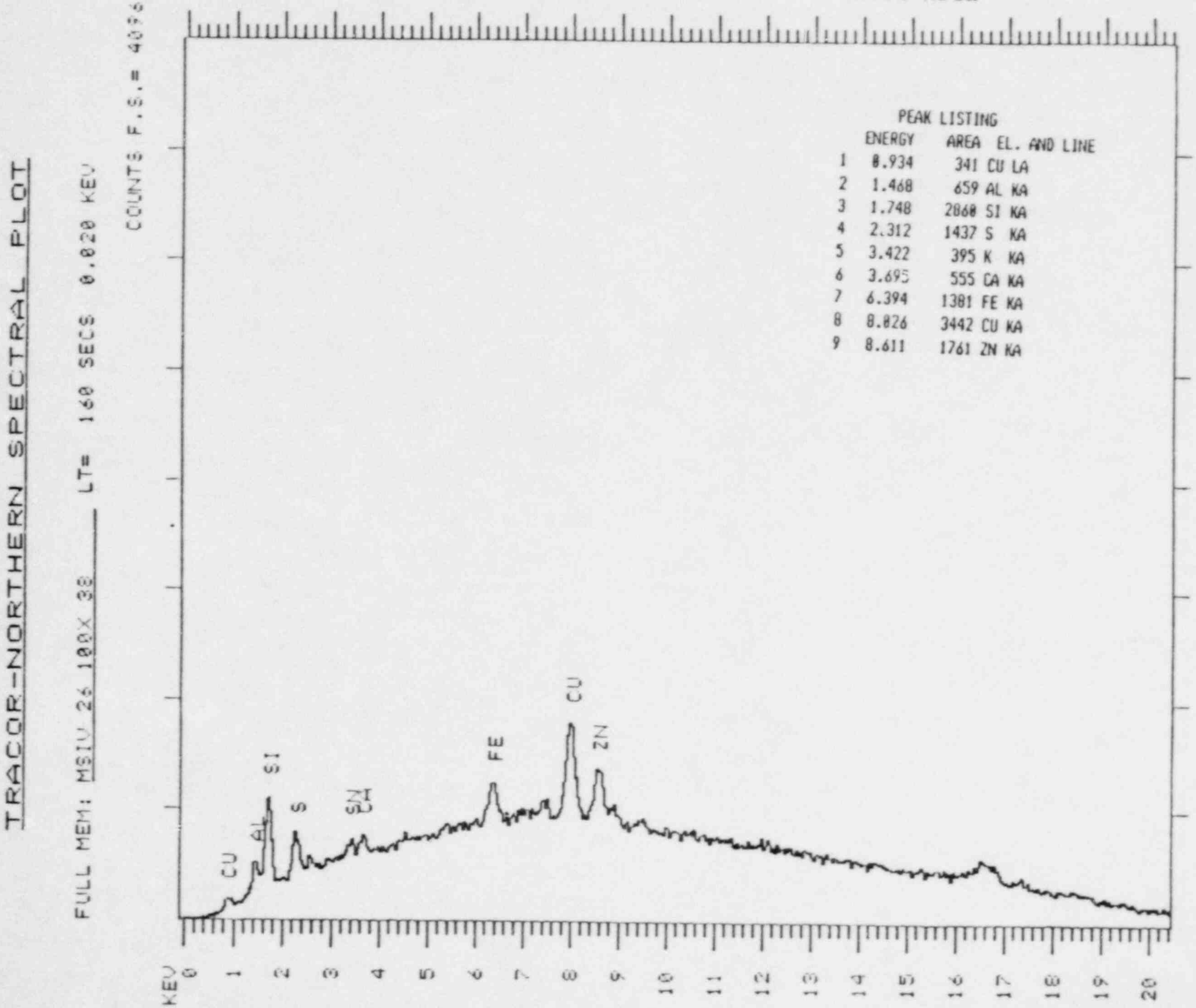
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.467	2020	AL KA
2	1.746	16871	SI KA
3	2.319	8275	S KA
4	3.704	1122	CA KA
5	4.500	1313	TI KA
6	7.458	772	NI KA
7	8.028	6870	CU KA
8	8.612	3071	ZN KA
9	8.917	364	CU KB

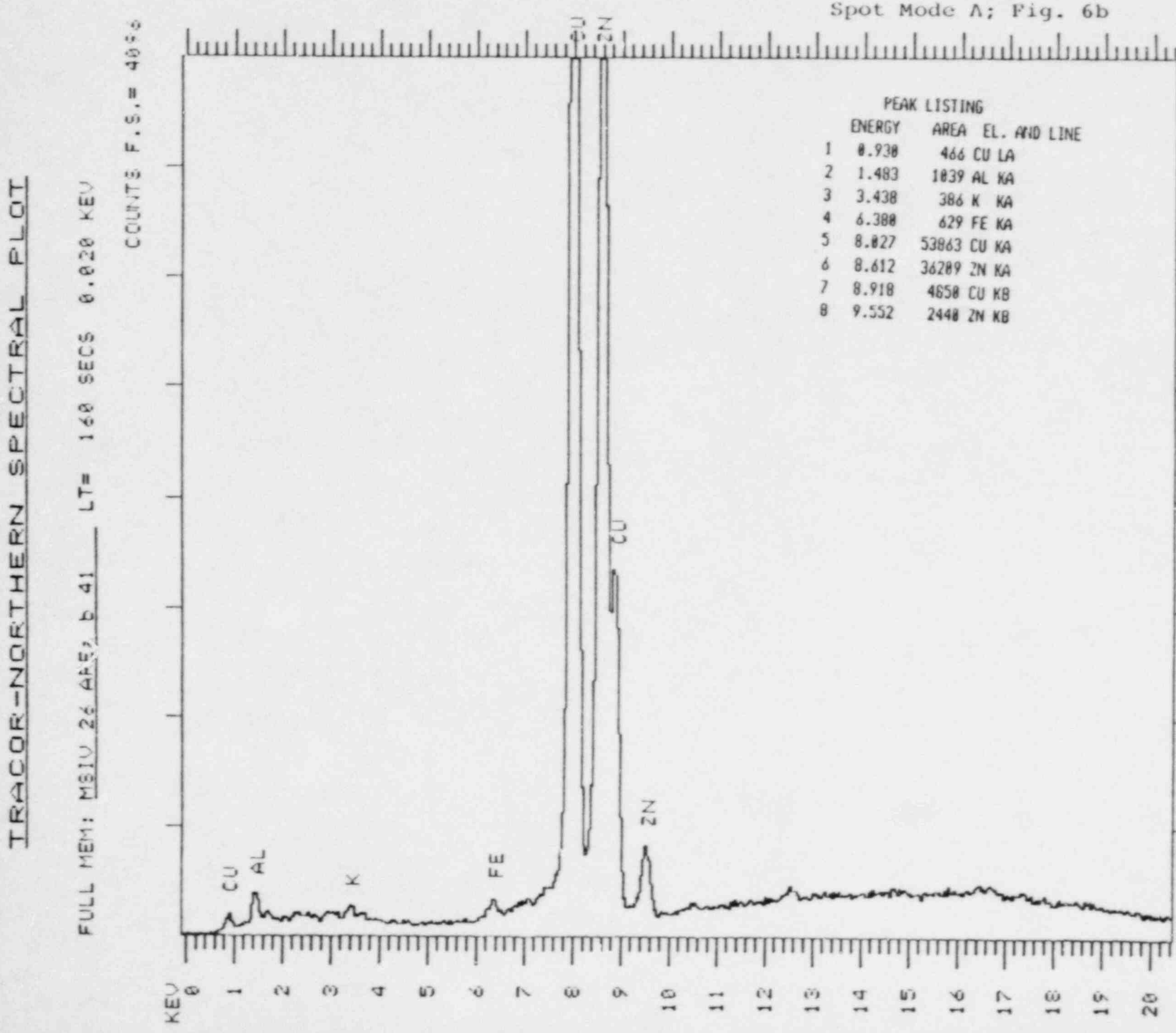
Plot 8
MSIV24
O-ring Surface
Spot Mode C; Fig. 4b



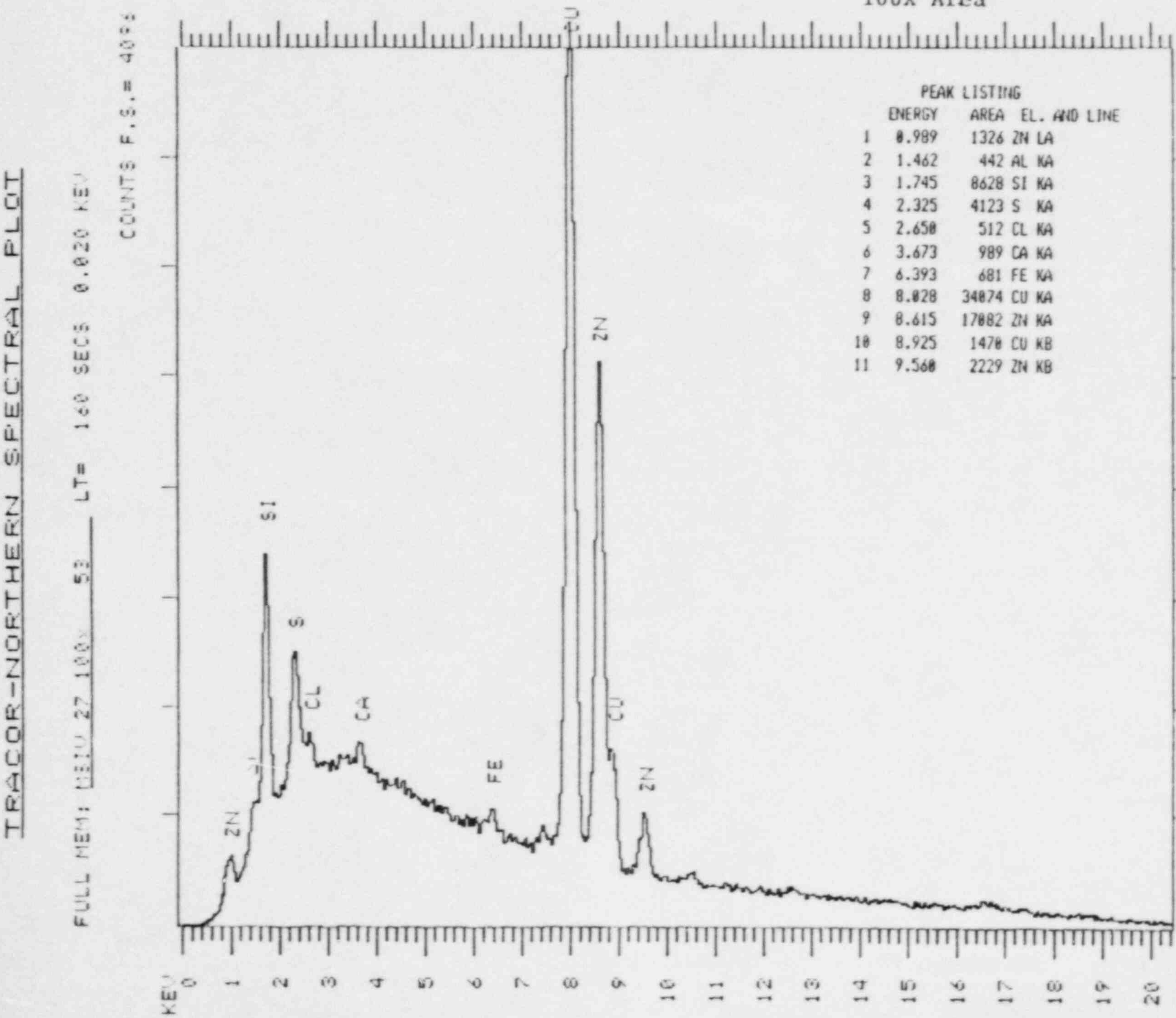
Plot 9
MSIV26
O-ring Surface
100X Area



Plot 10
MSIV26
O-ring Surface
Spot Mode A; Fig. 6b



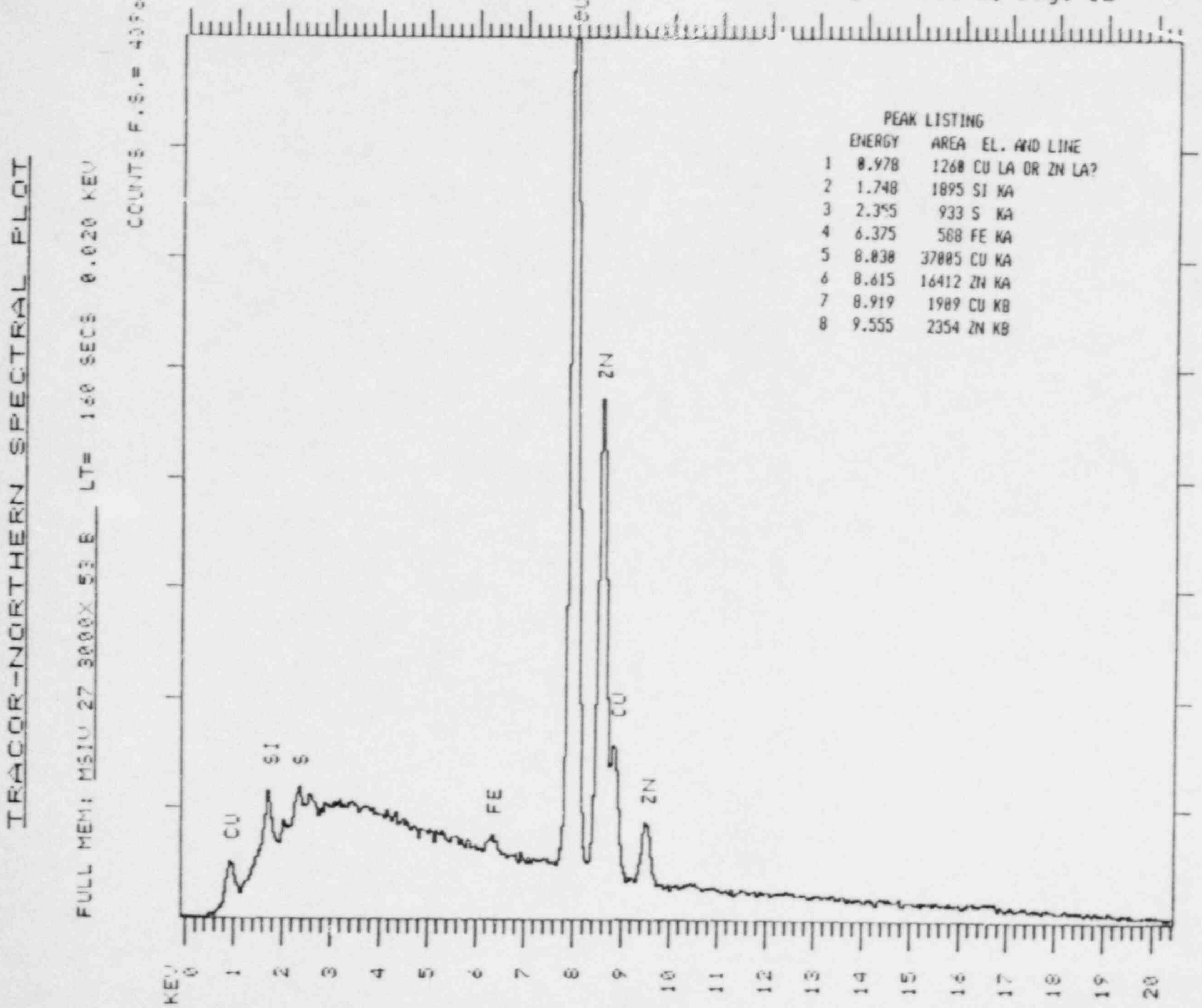
Plot 11
MSIV27
O-ring Surface
100X Area



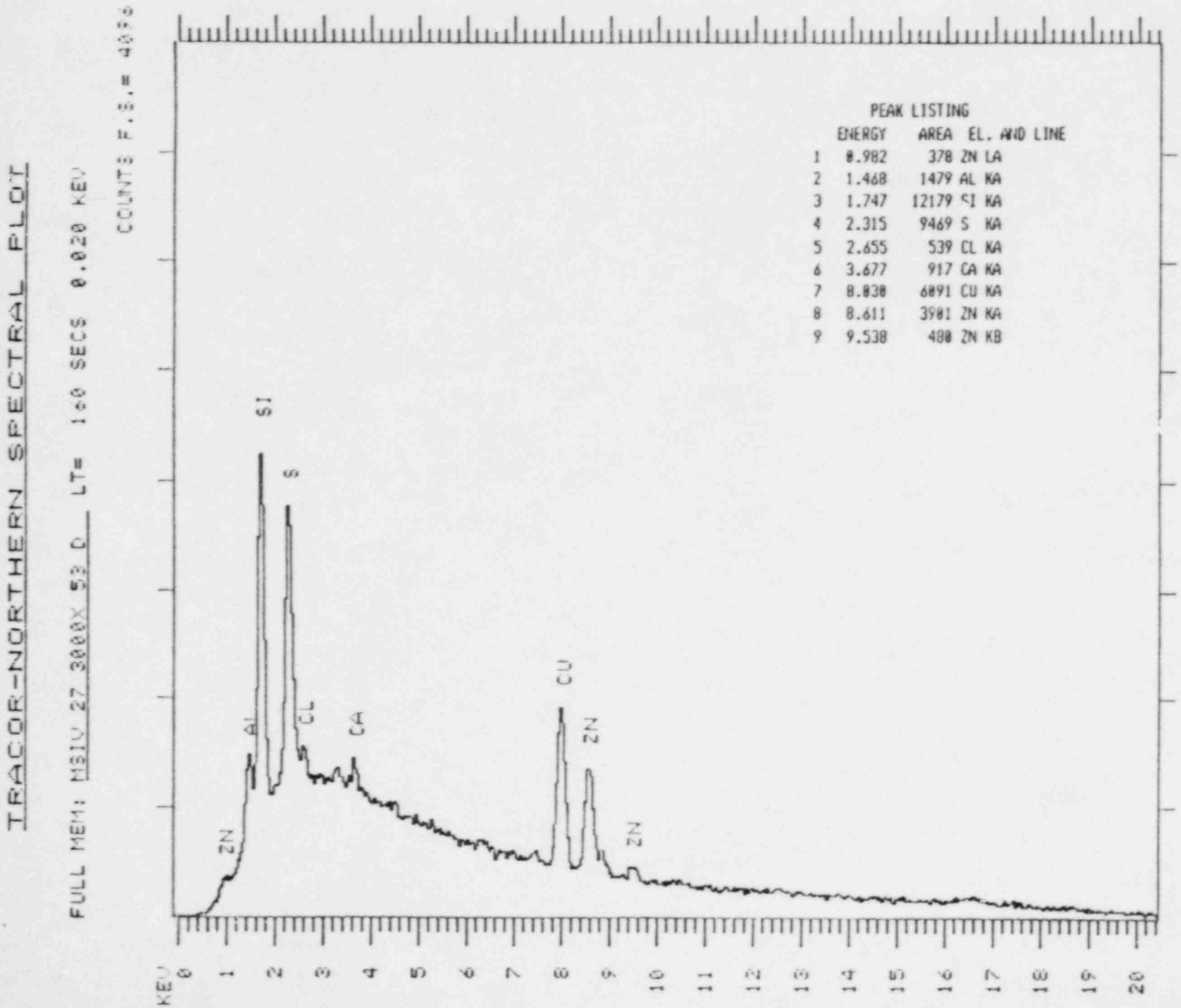
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	0.989	1326	ZN LA
2	1.462	442	AL KA
3	1.745	8628	SI KA
4	2.325	4123	S KA
5	2.650	512	CL KA
6	3.673	989	CA KA
7	6.393	681	FE KA
8	8.028	34074	CU KA
9	8.615	17082	ZN KA
10	8.925	1470	CU KB
11	9.560	2229	ZN KB

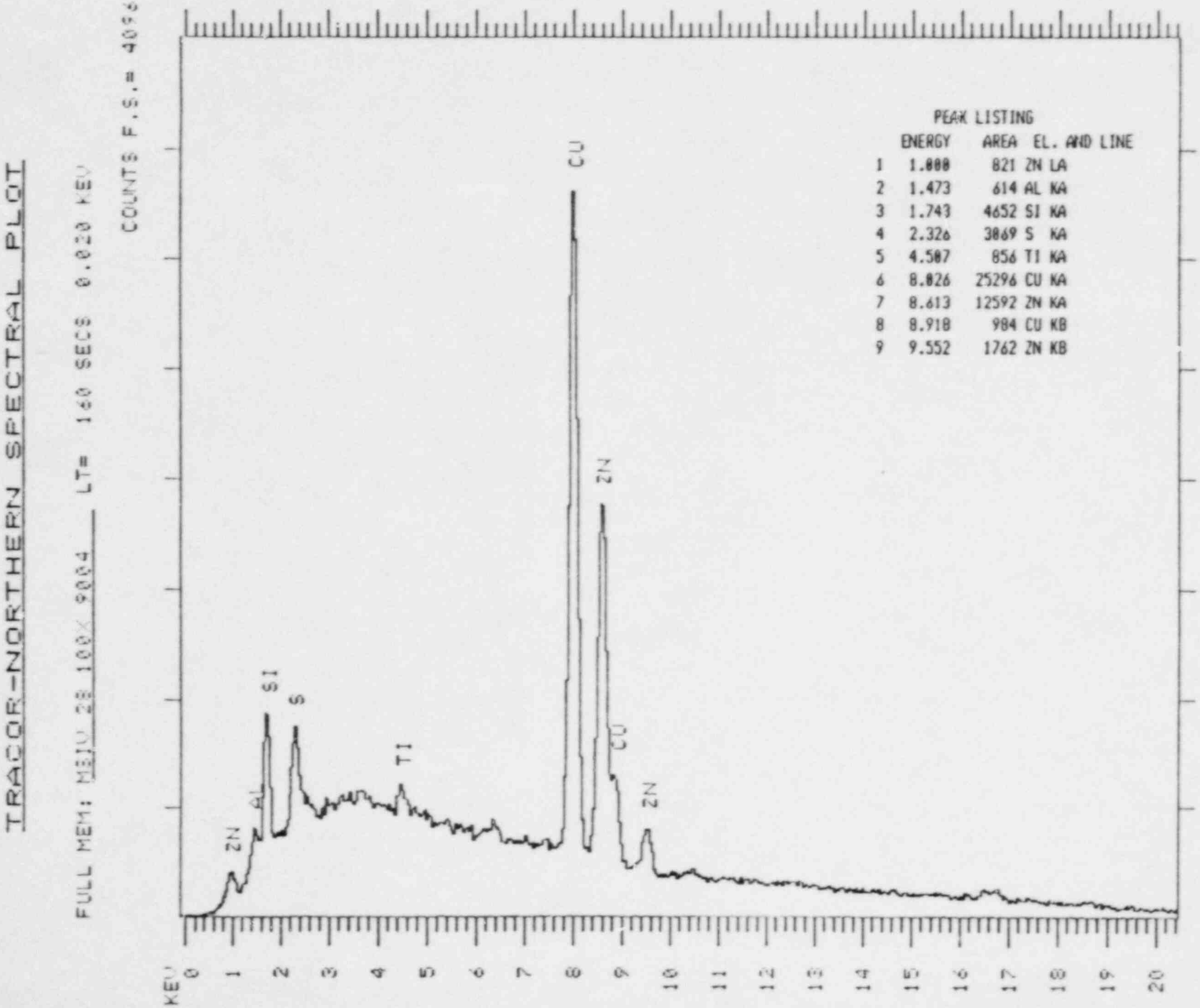
Plot 12
MSIV27
O-ring Surface
Spot Mode B; Fig. 3b



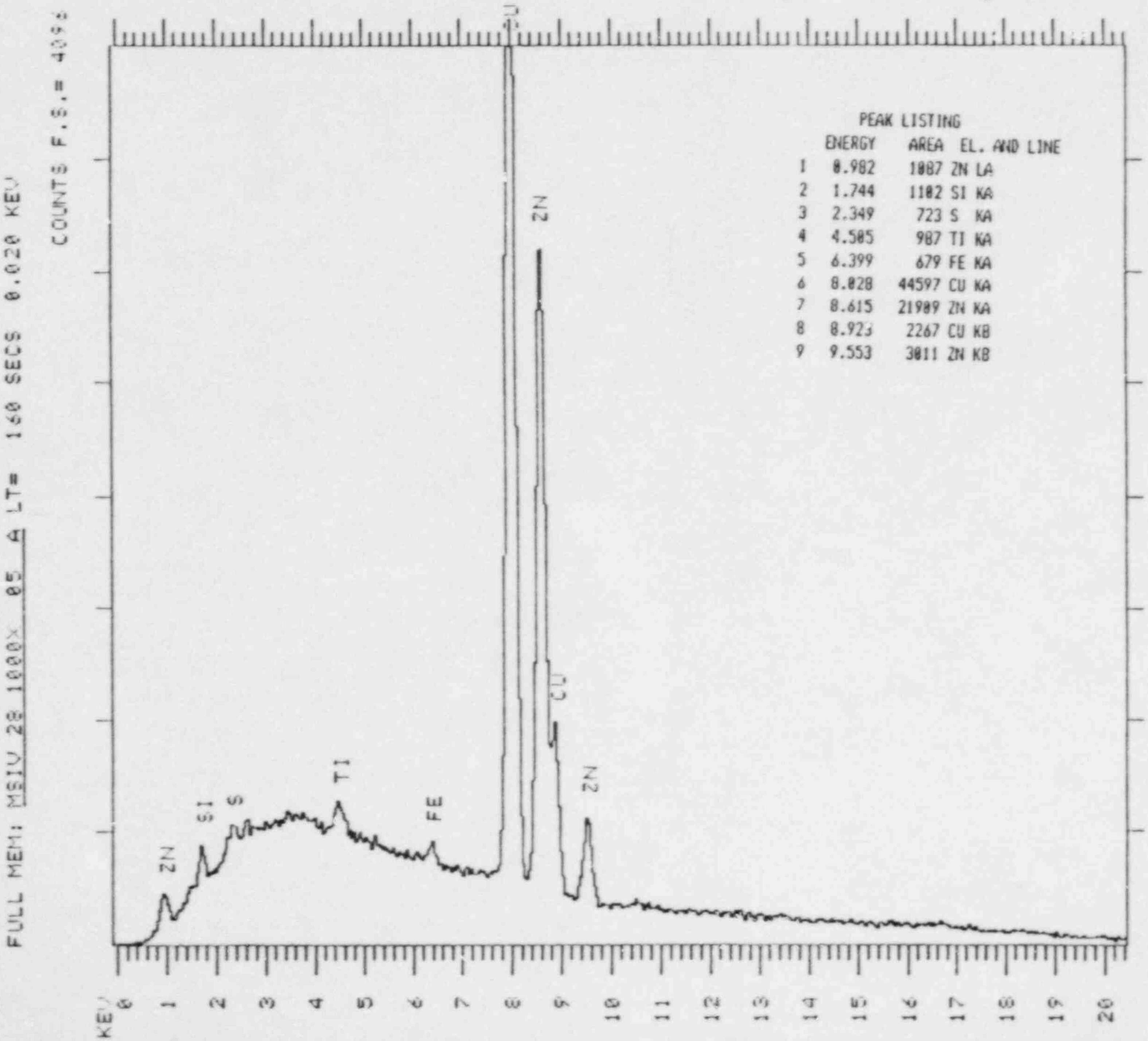
MSIV27
O-ring Surface
Spot Mode D; Fig. 8b



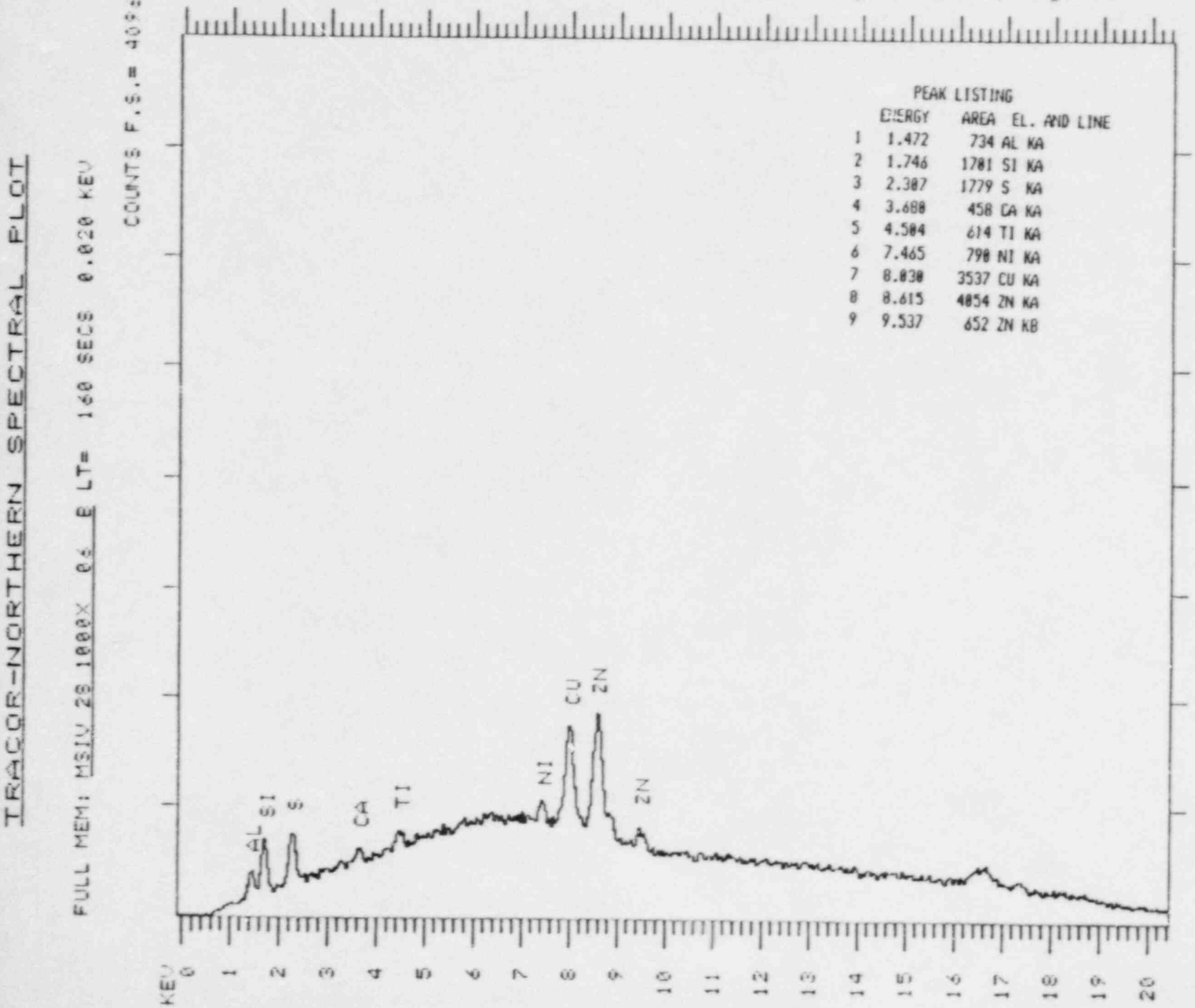
Plot 14
MSIV28
O-ring Surface
100X Area



Plot 15
MSIV28
O-ring Surface
Spot Mode A; Fig. 9a



Plot 16
MSIV28
O-ring Surface
Spot Mode B; Fig. 9a

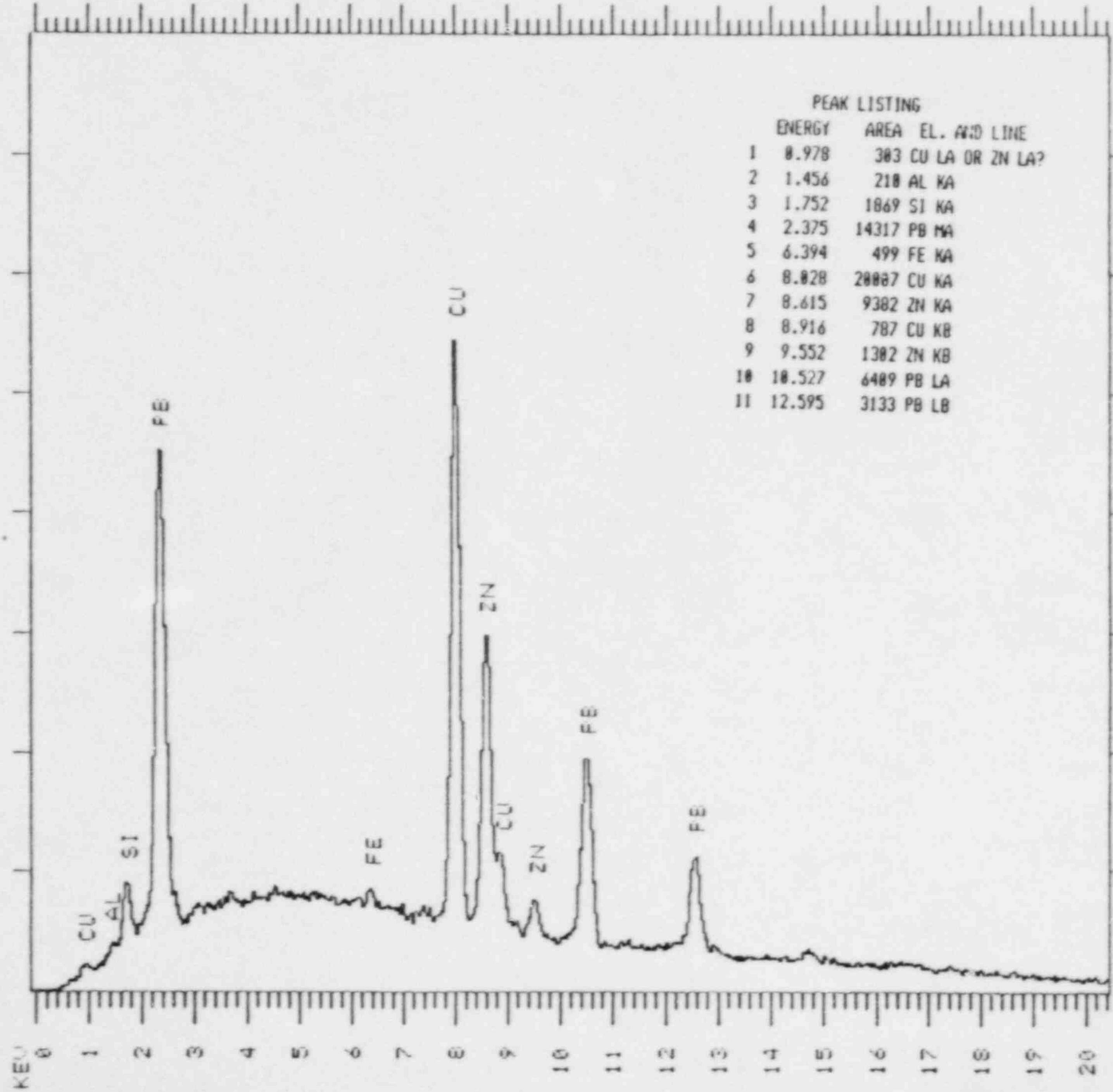


Plot 17
MSIV28
O-ring Surface
Spot Mode C; Fig. 9a

TRACOR-NORTHERN SPECTRAL PLOT

FULL MEM: MSIV 28 1000X 07 C LT= 160 SECS 0.020 KEV

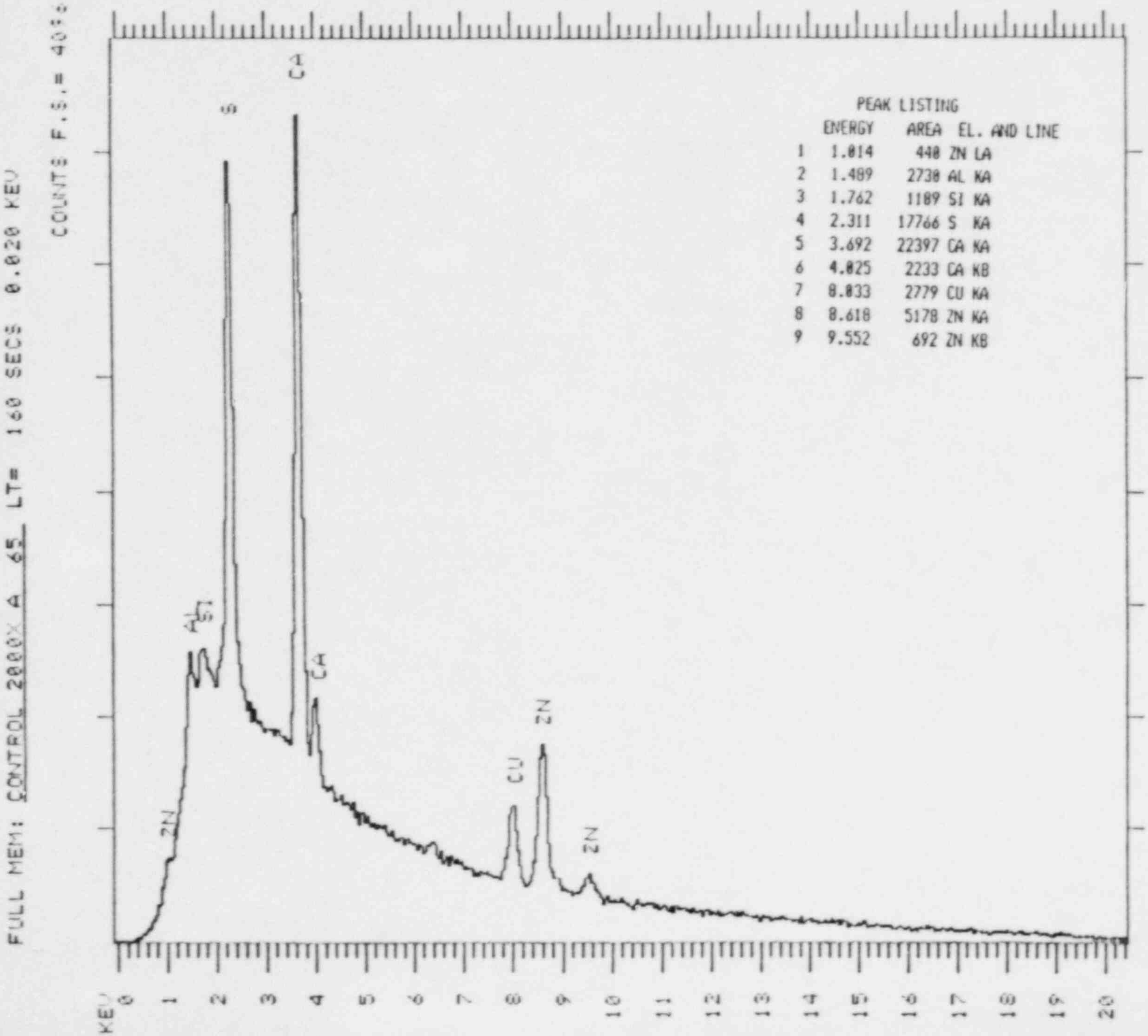
COUNTS F.S.= 40[illegible]



PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	0.978	303	CU LA OR ZN LA?
2	1.456	210	AL KA
3	1.752	1869	SI KA
4	2.375	14317	PB MA
5	6.394	499	FE KA
6	8.028	20007	CU KA
7	8.615	9382	ZN KA
8	8.916	787	CU KB
9	9.552	1302	ZN KB
10	10.527	6409	PB LA
11	12.595	3133	PB LB

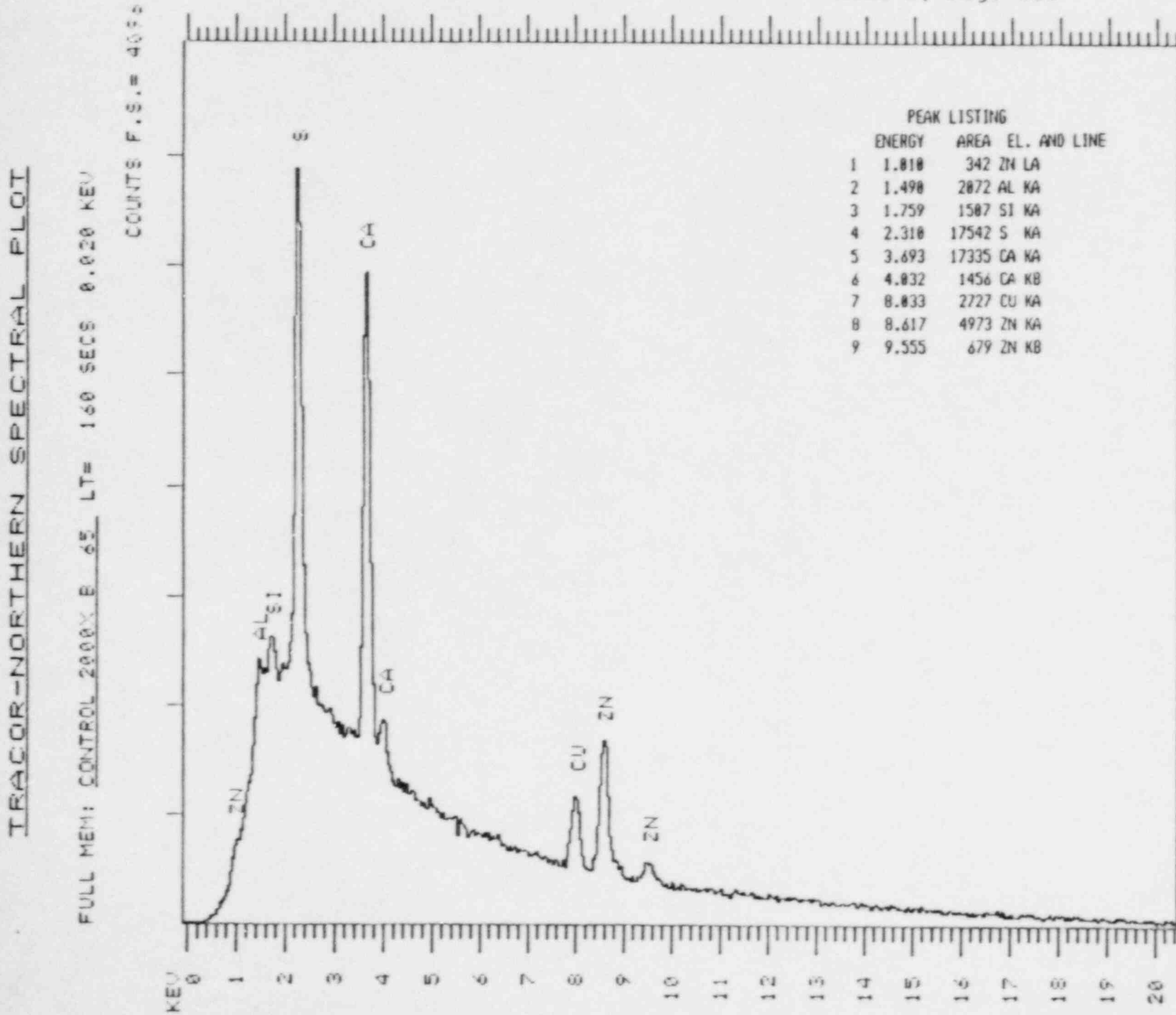
Plot 18
MSIV Control
O-ring Cross-section
Area A; Fig. 11c



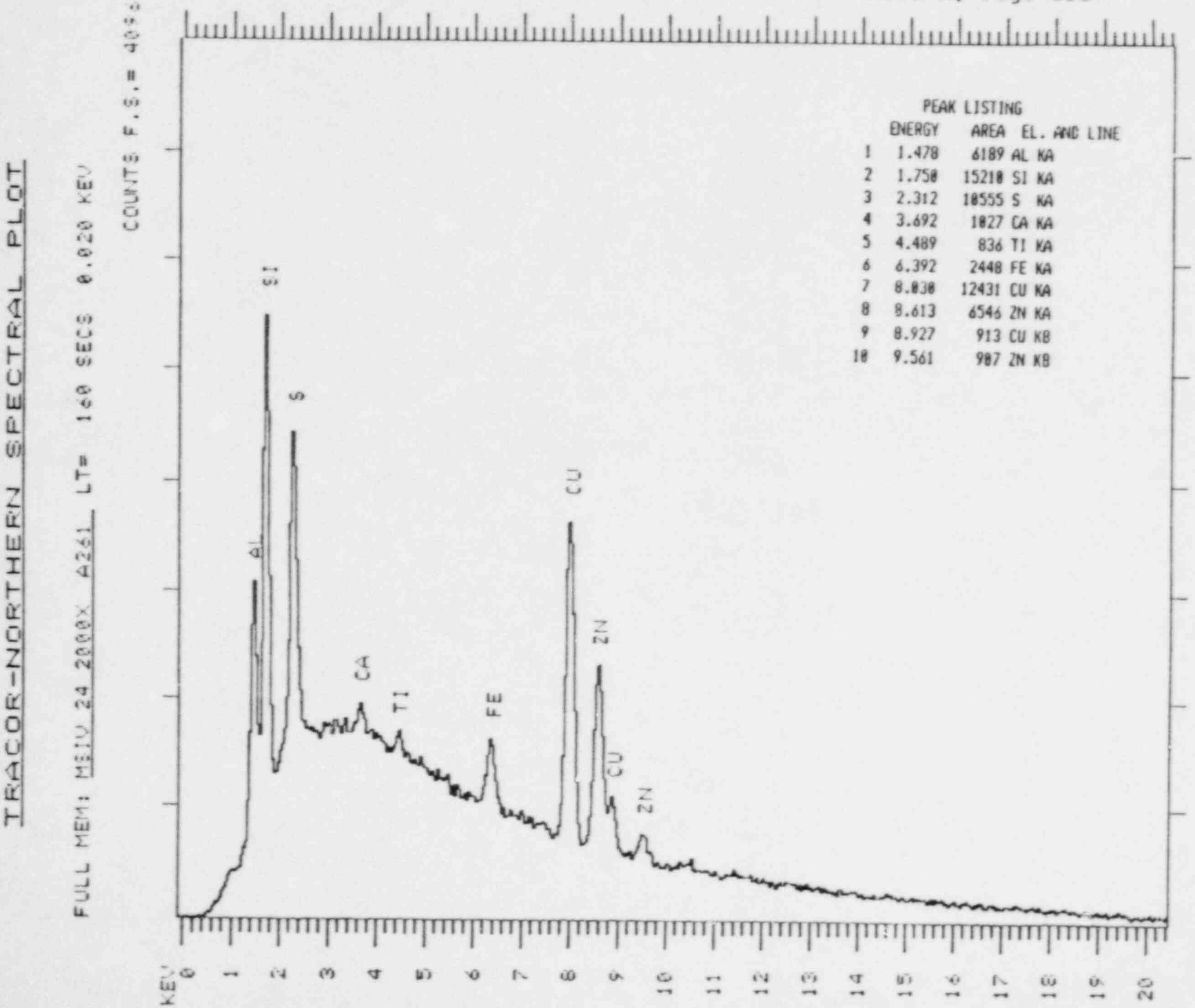
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.014	440	ZN LA
2	1.489	2730	AL KA
3	1.762	1189	SI KA
4	2.311	17766	S KA
5	3.692	22397	CA KA
6	4.025	2233	CA KB
7	8.033	2779	CU KA
8	8.618	5178	ZN KA
9	9.552	692	ZN KB

Plot 19
MSIV Control
O-ring Cross-section
Area B; Fig. 11c



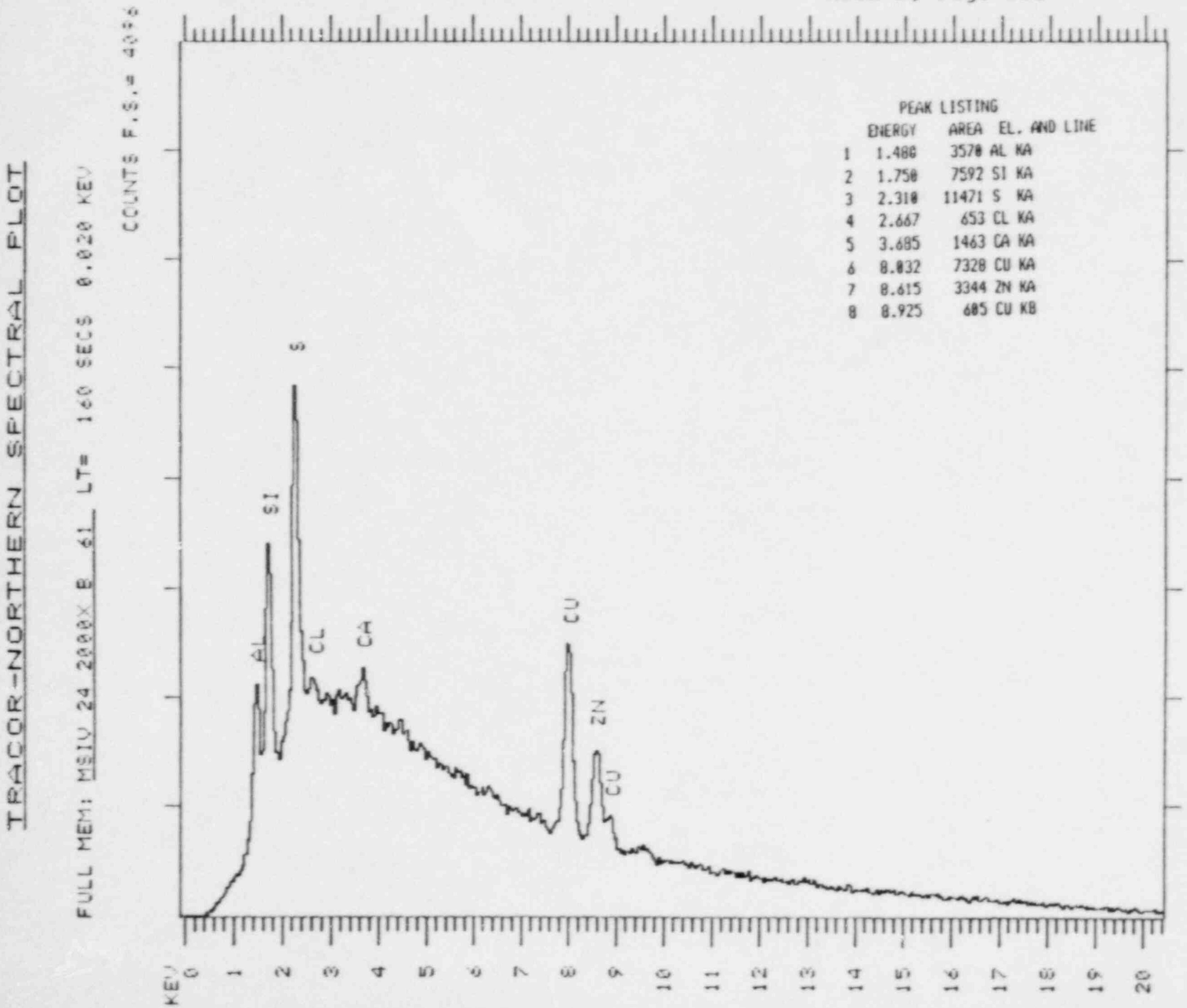
Plot 20
MSIV24
O-ring Cross-section
Area A; Fig. 13c



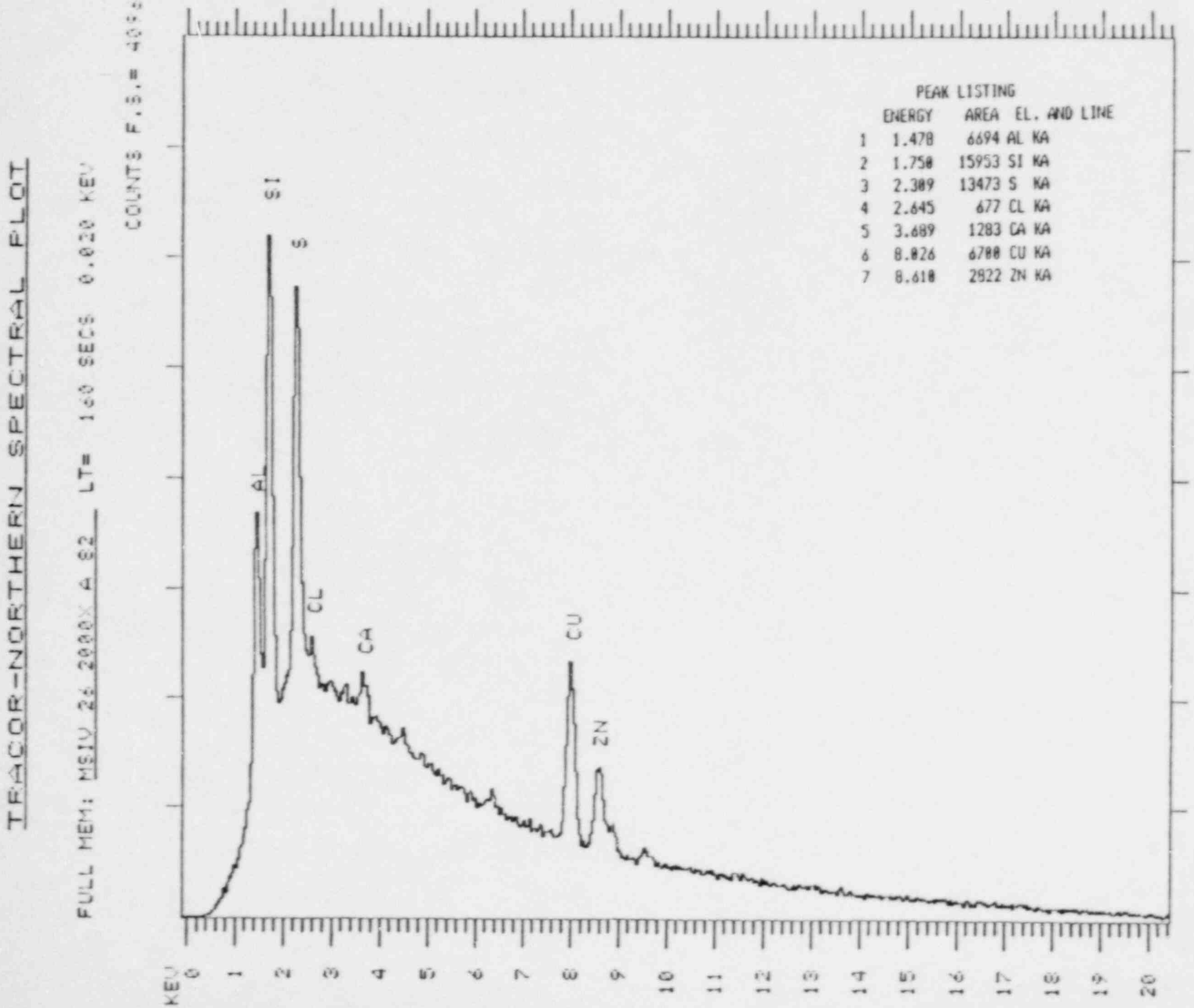
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.478	6189	AL KA
2	1.750	15210	SI KA
3	2.312	10555	S KA
4	3.692	1027	CA KA
5	4.489	836	TI KA
6	6.392	2448	FE KA
7	8.030	12431	CU KA
8	8.613	6546	ZN KA
9	8.927	913	CU KB
10	9.561	907	ZN KB

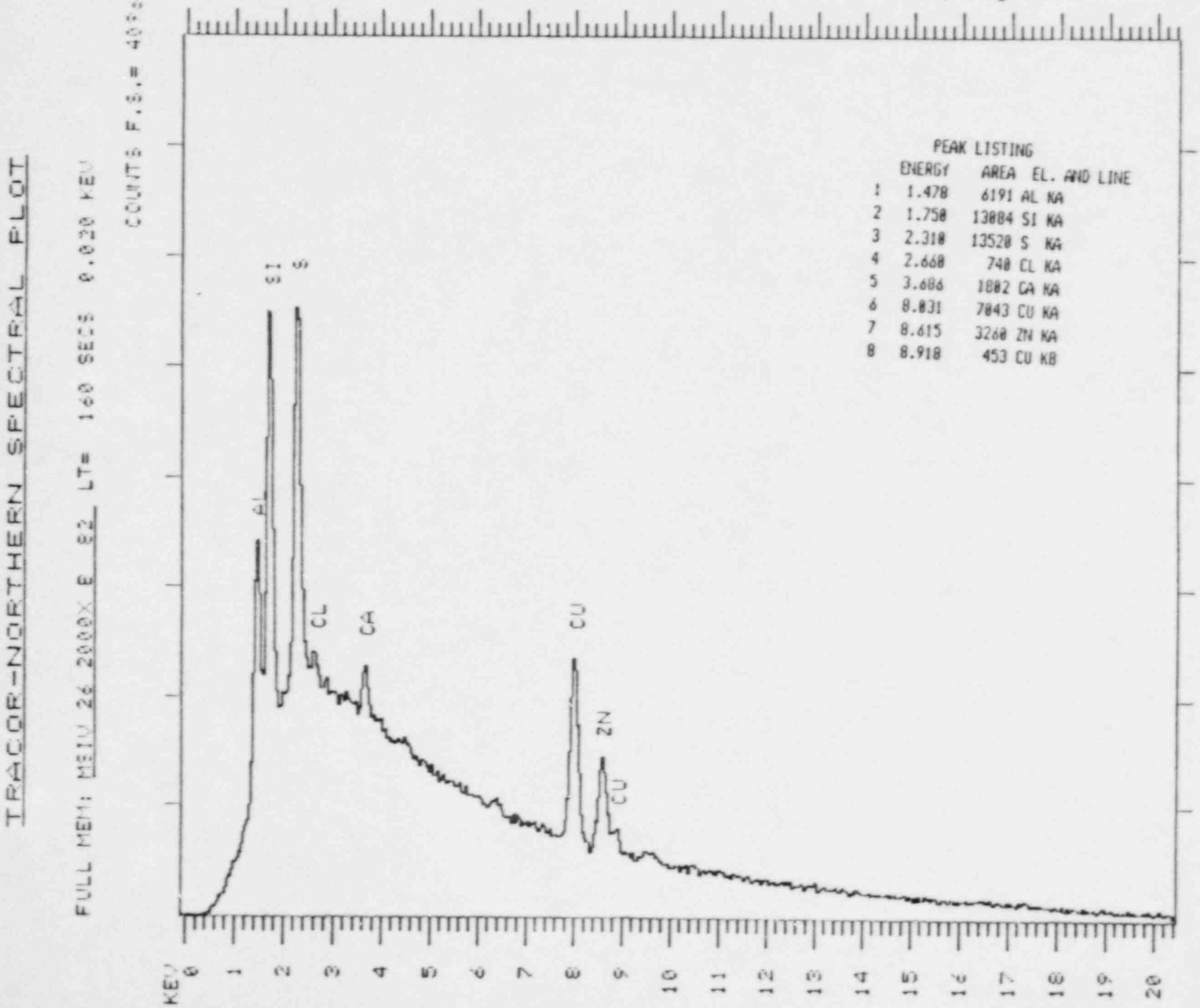
Plot 21
MSIV 24
O-ring Cross-section
Area B; Fig. 13c



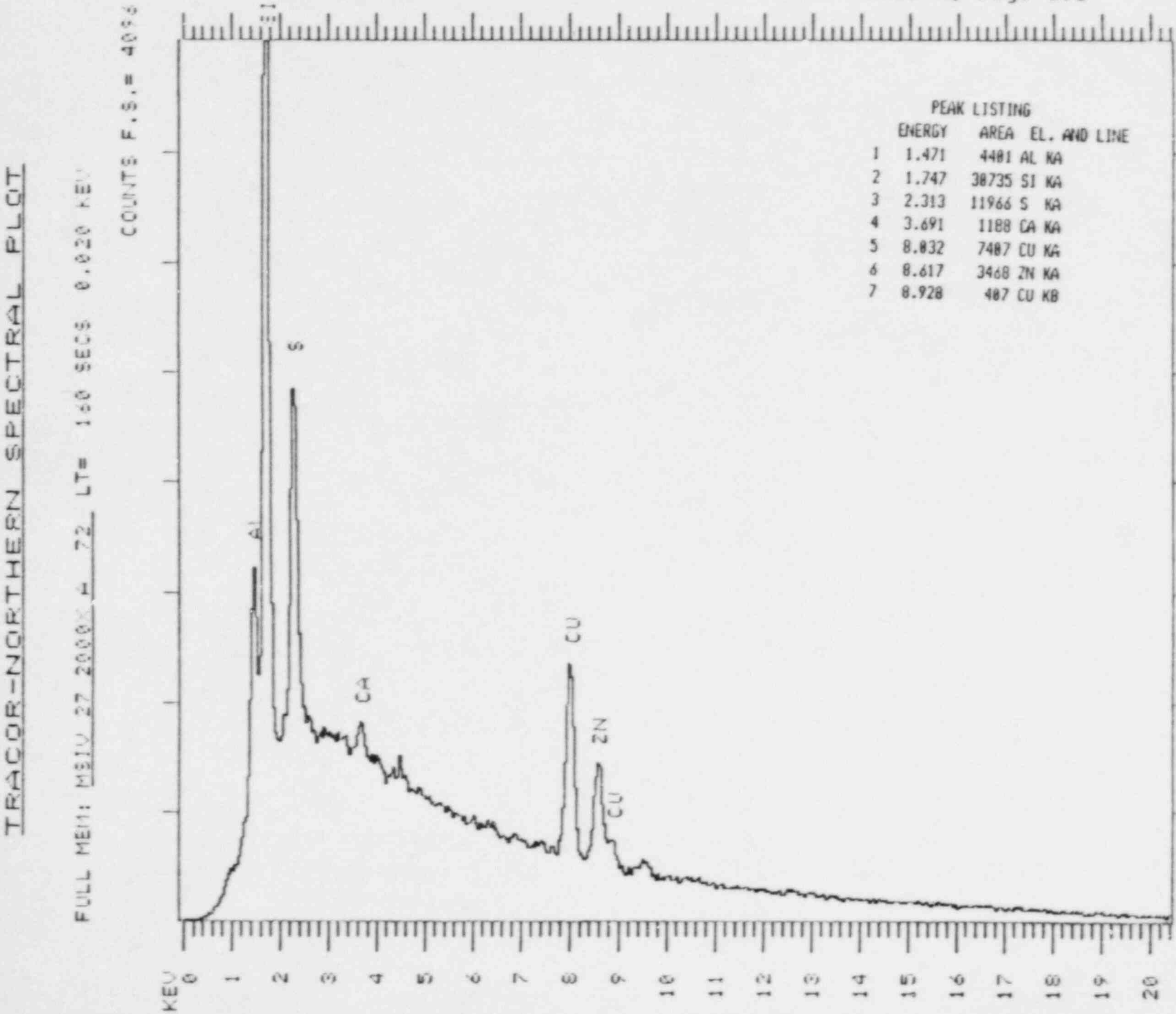
Plot 22
MSIV26
O-ring Cross-section
Area A; Fig. 15c



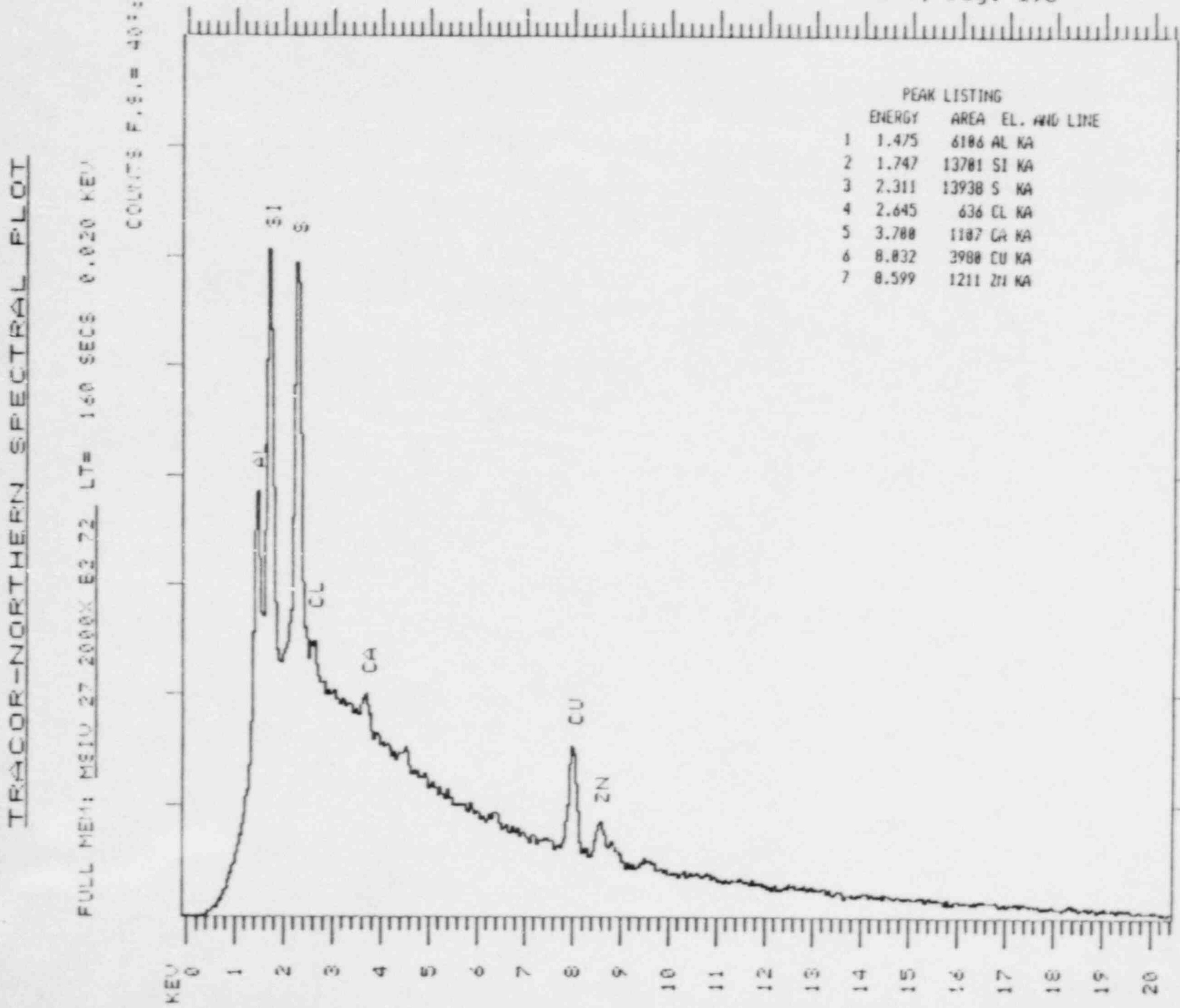
Plot 23
MSIV26
O-ring Cross-section
Area B; Fig. 15c



Plot 24
MSIV27
O-ring Cross-section
Area A; Fig. 17c

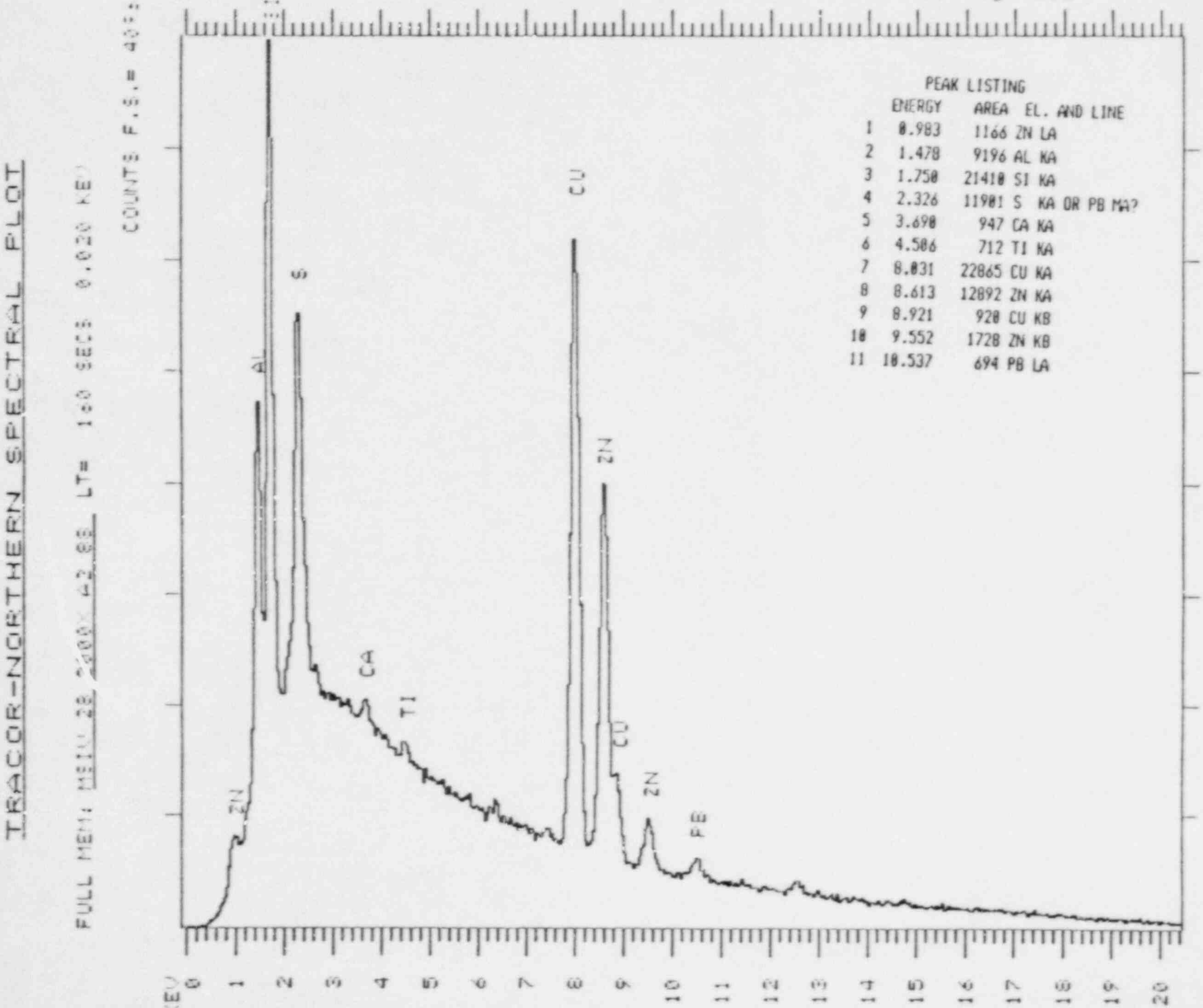


Plot 25
MSIV27
O-ring Cross-section
Area B; Fig. 17c

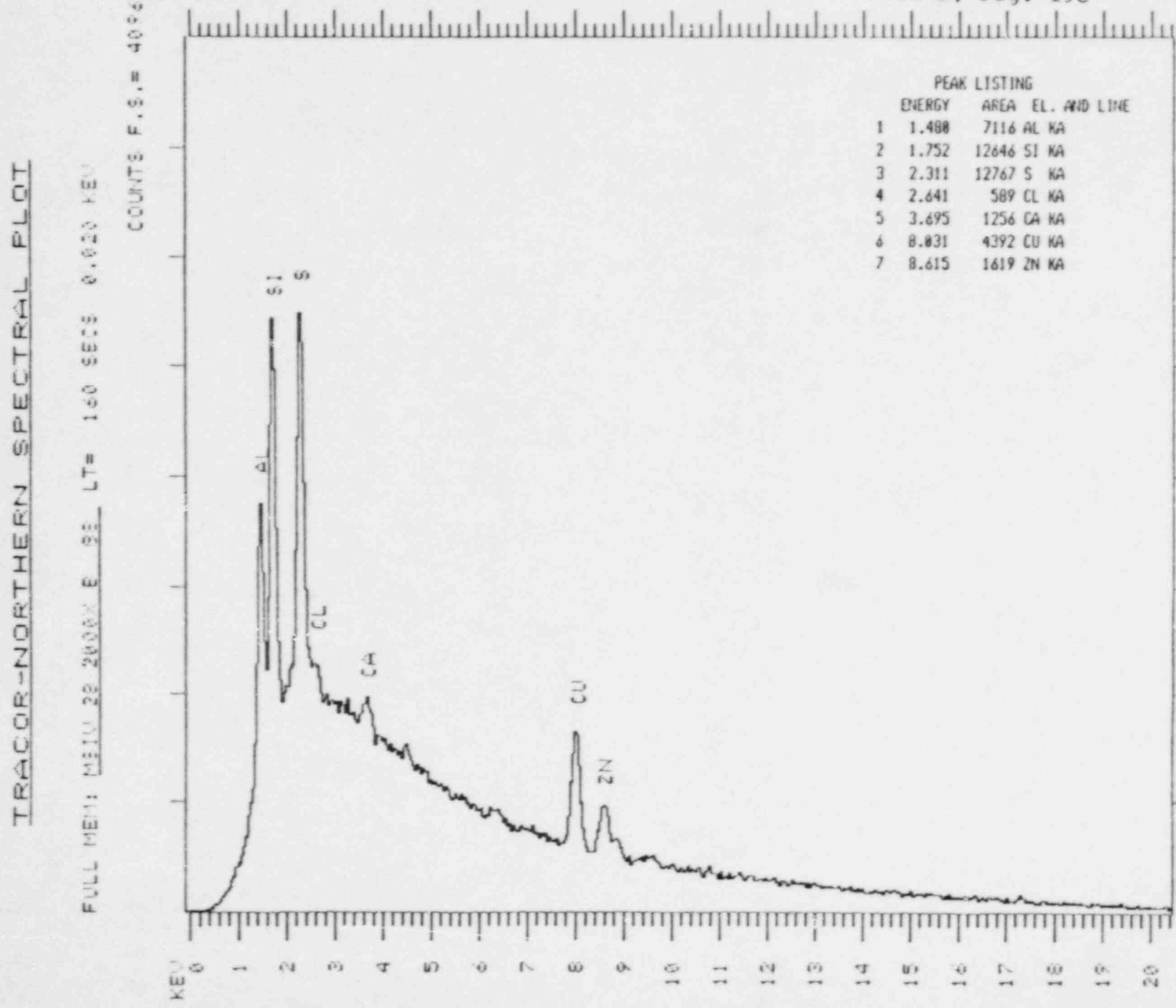


	ENERGY	AREA	EL. AND LINE
1	1.475	6106	AL KA
2	1.747	13701	SI KA
3	2.311	13938	S KA
4	2.645	636	CL KA
5	3.700	1107	CA KA
6	8.032	3980	CU KA
7	8.599	1211	ZN KA

Plot 26
MSIV28
O-ring Cross-section
Area A; Fig. 19c



Plot 27
MSIV28
O-ring Cross-section
Area B; Fig. 19c



APPENDIX H

Main Steam Isolation Valves - Energized Elastomer Seats - Destructive Evaluation by Scanning Electron Microscopy

TO: J. J. Grimm - CEI
FROM: K. A. Krutyholowa
DATE: January 11, 1988

SUBJECT: **MAIN STEAM ISOLATION VALVES - ENERGIZED ELASTOMER SEATS - DESTRUCTIVE EVALUATION BY SCANNING ELECTRON MICROSCOPY**

SAMPLE NO.

The surfaces & cross-sections of energized elastomer seats from samples MSIV Control, MSIV24, MSIV26 and MSIV27 were evaluated by scanning electron microscopy (SEM) and energy dispersive x-ray (EDS) microanalysis. The cross-sections were also examined by optical microscopy (OM).

The center cones of the flow control valves (MSIV20 & MSIV21) were evaluated by optical microscopy.

CLIENT REQUEST

1. To determine the depth of the indentation present in the failed and not failed energized elastomer seats.

2. To document any morphological or elemental changes in the energized elastomer seats.

3. To record any morphological or elemental changes in the cross-section of the energized elastomer seats.

METHODS

Optical microscopy was done under the Zeiss stereo widefield optical microscope (SV-8) equipped with indirect reflected light.

Scanning electron micrographs were taken on the JEOL 35C SEM, equipped with a Tracor Northern Energy Dispersive X-ray Spectroscopy (EDS) detector.

Before examination, the surfaces were mounted on carbon stubs and carbon coated. After the surfaces were examined by SEM/EDS, the cross-sections of the seats were prepared. The cross-sections were cut with a razor blade exposing the indented area of the seats. They were mounted onto carbon stubs and carbon coated.

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Elements from Na (Z=11) thru U (Z=92) can be detected by EDS. Backscatter electron imaging (BEI) was used on both the surface and cross-sections of the energized elastomer seats (EES). In this technique, the contrast is dependent upon the average atomic number. The brighter areas reflect the presence of relatively heavier elements. For example, Zn will have a brighter image than Cu which will have a brighter image than Si.

CONCLUSIONS

1. The failed energized elastomer seats have an indentation which is deeper than the "not failed" seat.

2. No morphological changes have occurred to the rubber beneath the indented areas.

3. More particles have deposited within the indentations of the failed seats versus the "not failed" seats.

4. More copper is present at the surface of the indentation of the failed seats than in the not failed and control seats.

RESULTS

I. Energized Elastomer Seats - Surface

A. Morphology & EDS - MSIV Control

1. Morphology (Figure 1)

The MSIV Control energized elastomer seat is level with no indentation. Particles of material are visible making the surface relatively rough.

2. EDS (Plot 1)

All EDS data is summarized in Table I. Major quantities of S & Zn and minor quantities of Si, Cl, Ca, K, Fe and Cu are present in the rubber.

B. Morphology & EDS - MSIV26 - Not Failed

1. Morphology (Figures 4 & 5)

The MSIV26 energized elastomer seat has an indentation ring at the center. Within this indented area, there are small quantities of particles (Figures 4b, 5a).

2. EDS (Plots 5, 6 & 7)

All EDS data is summarized in Table I. In the indented area A, major quantities of Si & Zn and minor quantities of Fe, Cu, S, Cl and Ca are present.

Area B in Figure 4a has less Cu present than in area A. Area C in Figure 4a has less Cu and significantly more Fe than in area A.

C. Morphology & EDS - MSIV24 & 27 - Failed

1. Morphology (Figures 2, 3, 6, 7)

The MSIV24 and 27 energized elastomer seats have an indentation ring at the center. Within these indented areas are large quantities of particles (3a & b, 7a & b).

2. EDS (Plots 2-4, 8-10)

All EDS data is summarized in Table I.

In the indented area A (Figures 2a & 6c), major quantities of Si, Zn & Cu, moderate quantities of S & Fe, and minor quantities of Cl, Ca & K are present. Examination of the seats by backscatter electron imaging (Figures 2b & 6d) reveals numerous bright particles in the indented area A. This indicates the presence of heavier elements such as Cu & Zn.

Area B in Figures 2a & 6c have less Cu than in area A. Area C in Figures 2a & 6c have less Cu and significantly more Fe than in area A.

II. Energized Elastomer Seats - Cross-sections

A. Optical Micrographs - Cross-sections (Figure 8)

The cross-sections of the energized elastomer seats revealed the depth of the indentations for the four samples (MSIV Control, -24, -26 & -27). They were as follows:

MSIV Control -	0 µm
MSIV24	350 µm
MSIV26	230 µm
MSIV27	350 µm

The two failed energized elastomer seats had a deeper indentation than the "not failed" energized elastomer seat MSIV26.

B. Morphology & EDS - MSIV Control (Figure 9)

The cross-section of the control seat reveals a uniform morphology. The backscatter electron image reveals a uniform distribution of brighter particles. EDS data is located in Table II. Major quantities of Zn & S and minor quantities of Si, Cl, K, Ca, Fe & Cu were present in areas A & B (Figure 9a) of the cross-section (Plots 11 & 12).

C. Morphology & EDS - MSIV26 - Not Failed

1. Morphology (Figures 12 & 13)

When examining the area directly beneath the indented area A (Figures 12a & c), no changes have occured to the rubber.

2. EDS (Plots 15 & 16)

EDS data is located in Table II. Major quantities of Si, Zn & S and minor quantities of Cl, Ca, Fe & Cu were found in area A, Figure 12a. Backscatter electron imaging of the cross-section of seat MSIV26 identified very few particles within the indentation (Figures 12b, d & 13b).

D. Morphology & EDS - MSIV24 & 27 - Failed

1. Morphology (Figures 10 & 11, 14)

When examining the area directly beneath the indentation, no morphological changes have occured (Figures 10 & 14). Numerous particles and debris can be found in the indentation.

2. EDS (Plots 13, 14, 17 & 18)

EDS data is located in Table II. Major quantities of Si, Zn & S, moderate quantities of Cu and minor quantities of Cl, Ca & Fe were found in area A.

Backscatter electron imaging of the cross-section of seats MSIV24 & 27 identified numerous particles within the indentation (Figures 10b & d, 14b & d). These particles have large amounts of Cu, Zn & Fe.

E. Optical micrographs - cones from flow control valves

Figures 15a & b, and 16a & b have areas (arrows) where pieces of material appear to have adhered to the lip of the cone.

Kathy Krutyholowa

Kathy A. Krutyholowa

jsb
Atts.

File No's. 8702091, 8702086, 8702093, 8702094
Notebook Reference: 20294-93

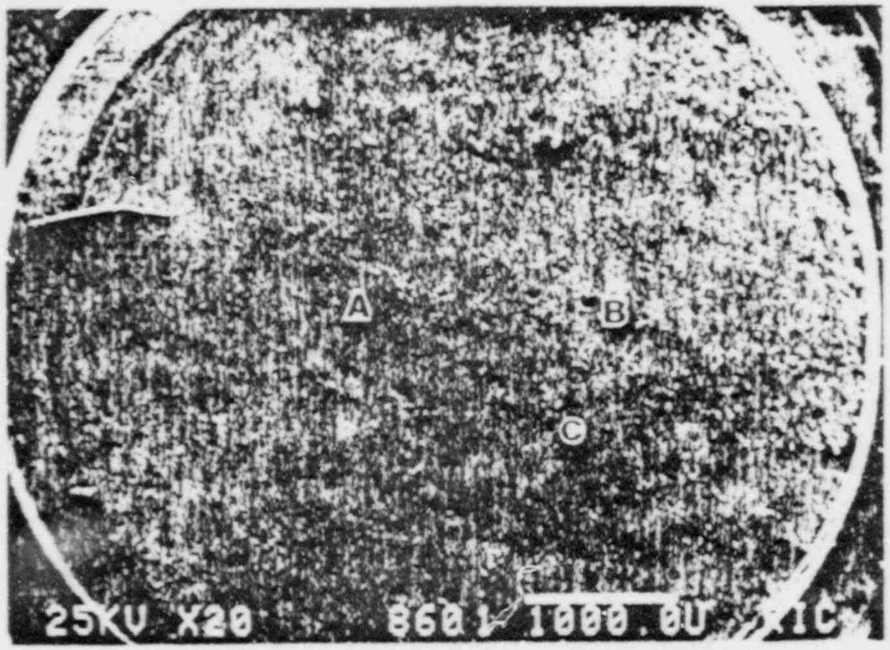
Reviewed By: W R Brunstedt

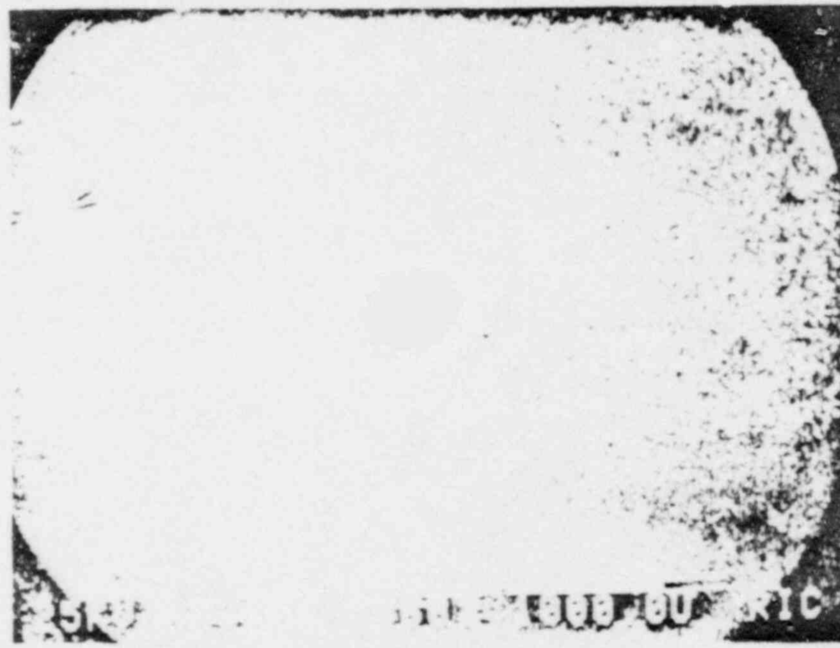
Table I
Energized Elastomer Seats - Surfaces
Energy Dispersive X-ray (EDS) Microanalysis
Net Counts per Second
400X Area

	Si	S	Cl	Ca	Cr	Fe	Cu	Zn	Pb
MSIV-Control (Figure 1a)	28	59	16	11	0	7	10	199	0
MSIV24 (Fig. 2a)									
Area A	255	44	5	6	2	57	87	166	2
Area B	123	56	15	6	1	56	13	180	0
Area C	163	54	13	4	0	85	11	172	0
MSIV26 (Fig. 4a)									
Area A	210	40	11	4	1	41	40	163	1
Area B	190	48	19	4	2	42	12	142	1
Area C	130	51	12	7	2	73	7	133	0
MSIV27 (Fig. 6c)									
Area A	172	35	12	5	4	82	55	218	1
Area B	175	48	13	5	1	63	13	137	0
Area C	181	51	19	9	1	85	9	146	1

Table II
Energized Elastomer Seals - Cross-sections
Energy Dispersive X-ray (EDS) Microanalysis
Net Counts per Second
3000X Area

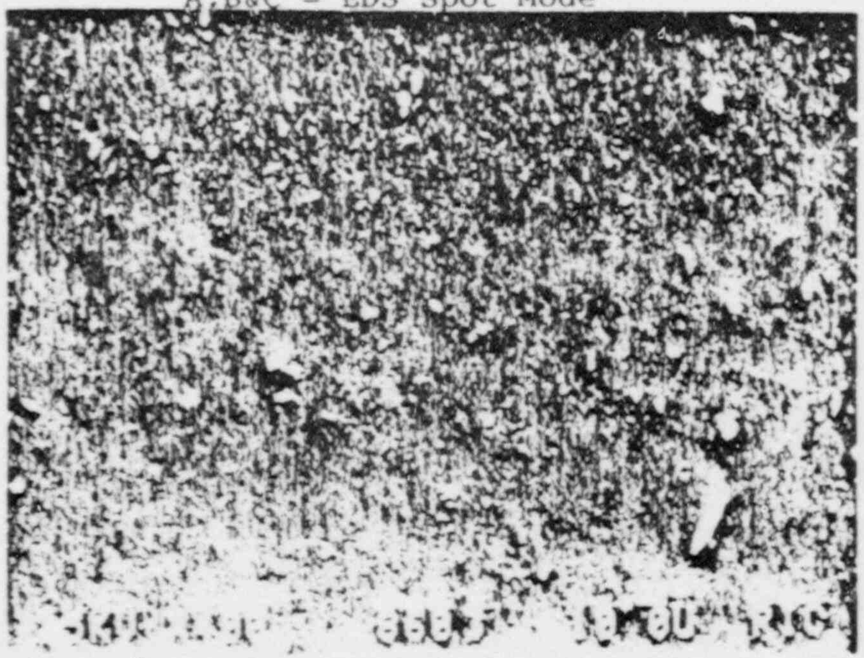
	Si	S	Cl	Ca	Fe	Cu	Zn
MSIV-Control (Figures 9a)							
A	34	91	6	9	6	8	162
B	17	86	2	5	3	4	155
MSIV24 (Fig. 10a)							
A	111	97	3	5	11	14	120
B	1	14	1	15	4	6	197
MSIV26 (Fig. 12a)							
A	80	83	2	4	6	9	113
B	1	14	1	5	1	6	173
MSIV27 (Fig. 14a)							
A	212	70	6	11	53	32	100
B	3	22	0	6	6	10	171





a. See Table I
A,B&C = EDS Spot Mode

b. BEI of Figure 1a



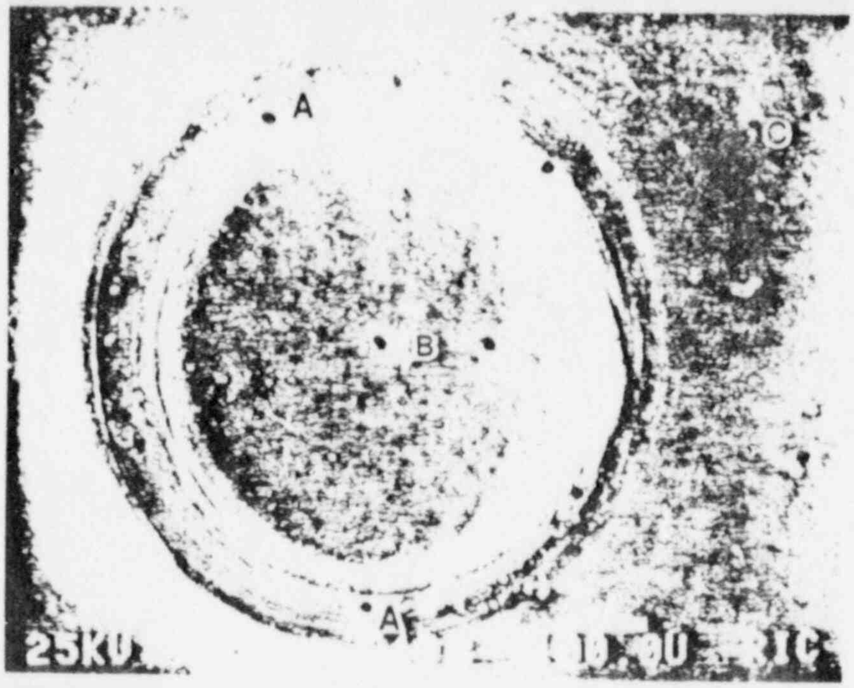
c.

d.

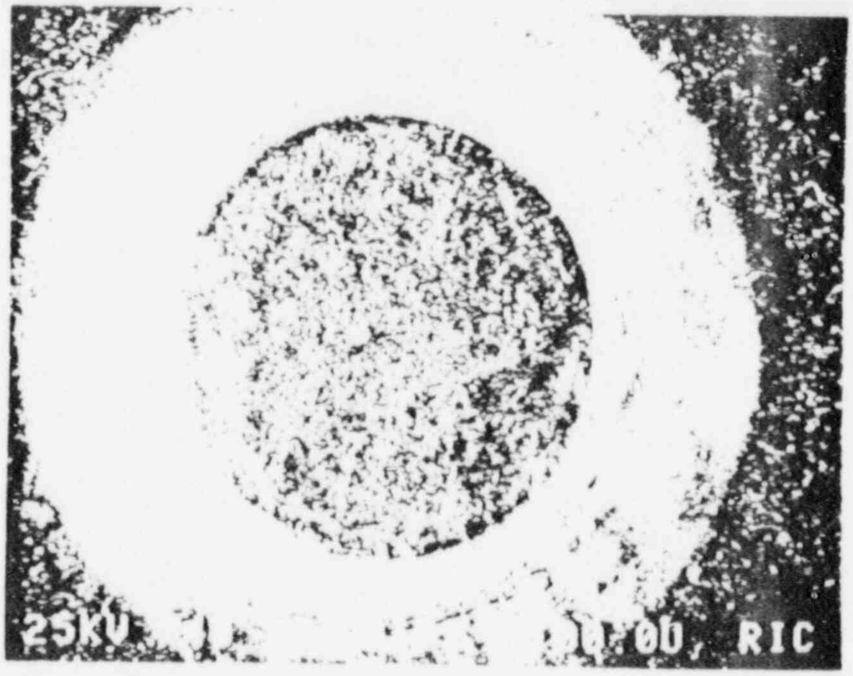
Figure 1. MSIV Control; Energized Elastomer Seats; Surface

Figure 2.

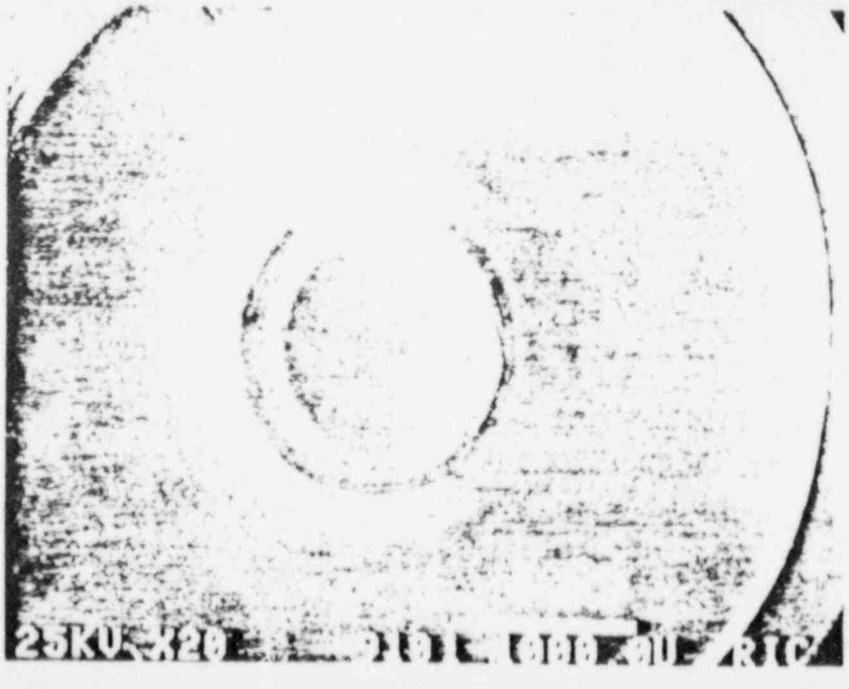
MSIV24
Energized Elastomer Seats
Failed
Surface



a. See Table I
Spot Mode
A=Indent
B=Center
C=Outside



b. BEI of Figure 2a



c.

Figure 3.

MSIV24
Energized Elastomer Seats
Failed
Surface

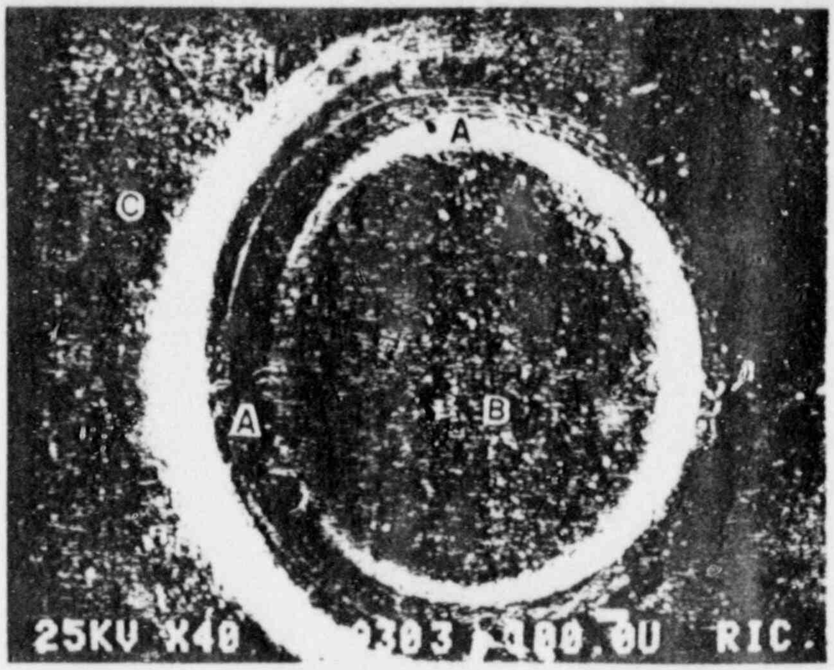
a. Area A = Indent

b. Area A = Indent

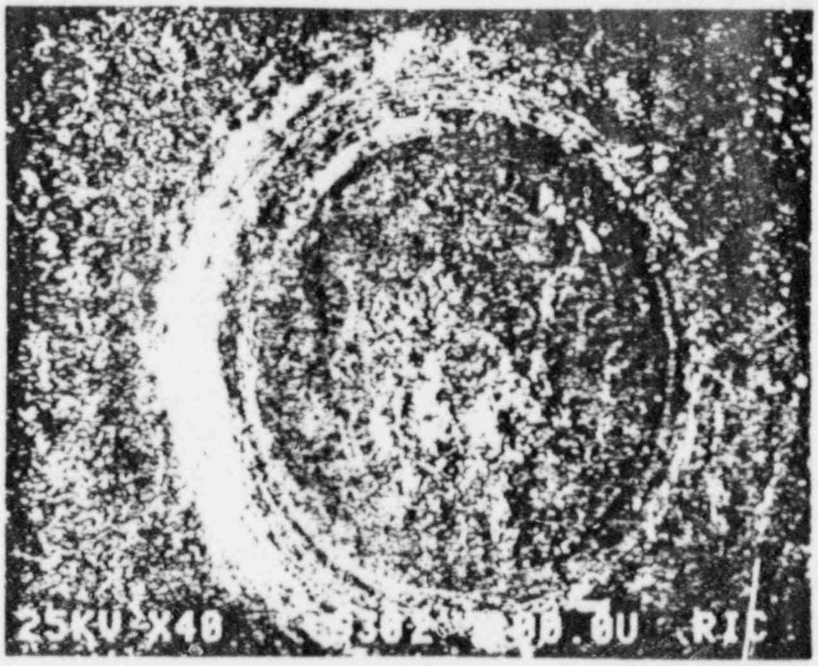
c. Area B = Center

Figure 4.

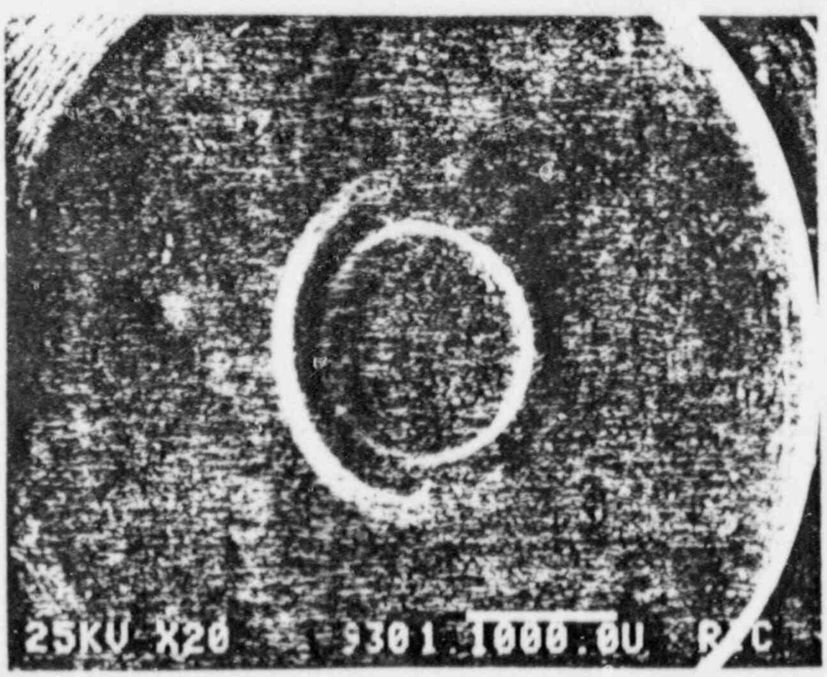
MSIV26
Energized Elastomer Seats
Not Failed
Surface



a. See Table I
Spot Mode
A=Indent
B=Center
C=Outside



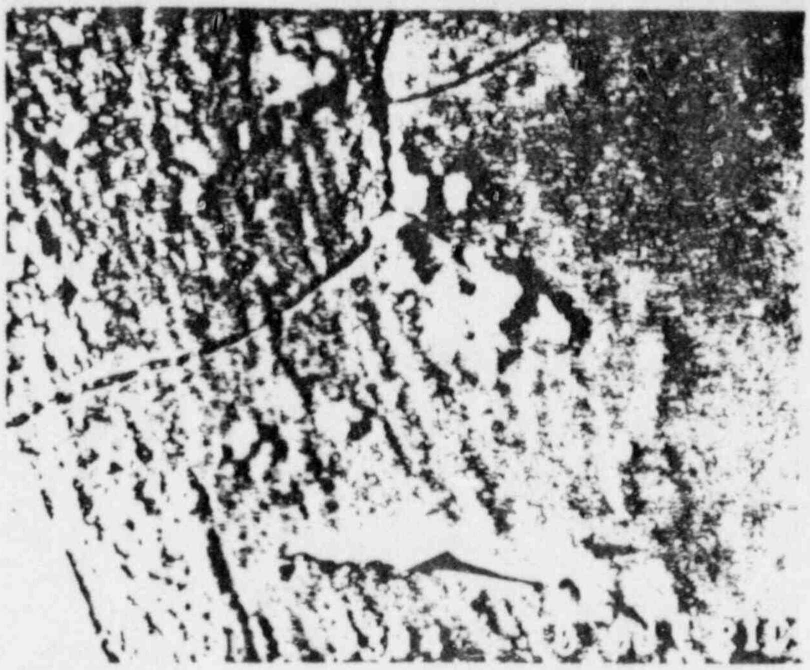
b. BEI of Figure 4a



c.

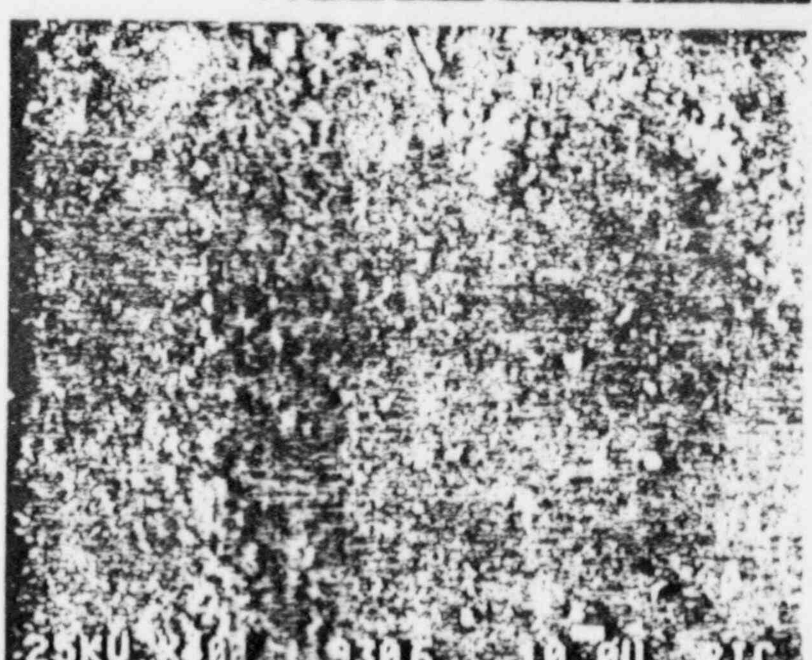
Figure 5.

MSIV26
Energized Elastomer Seat
Not Failed
Surface

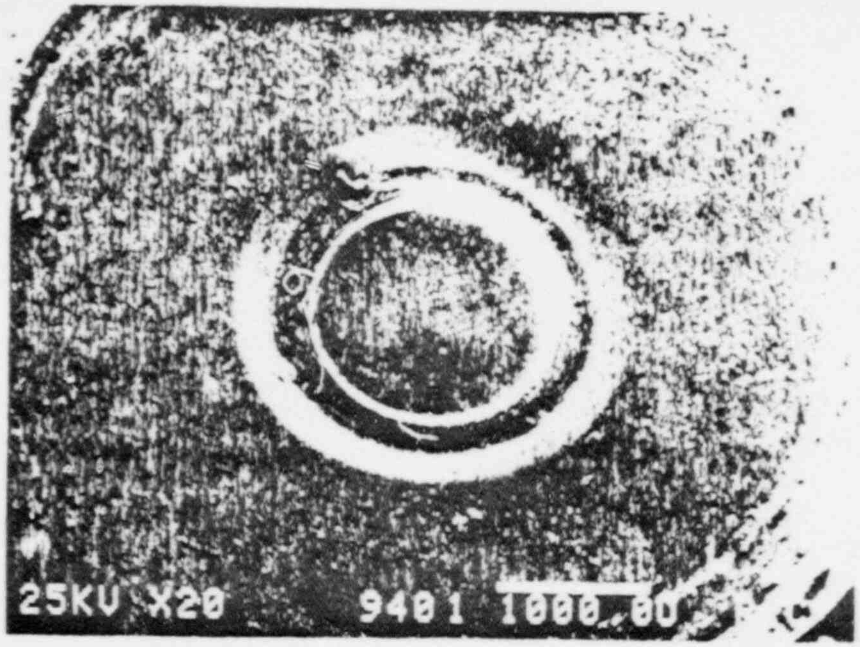


a. Area A = Indent

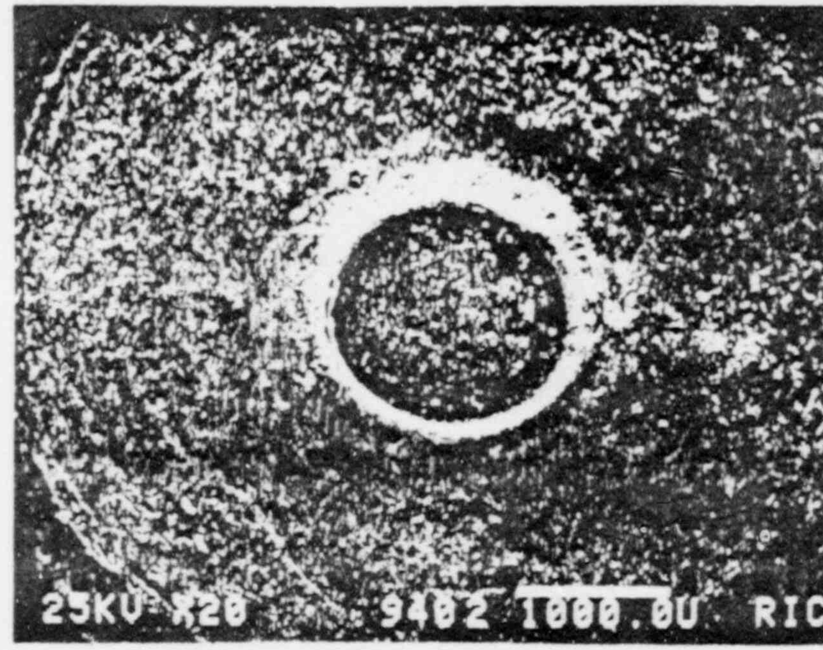
b. Area A = Indent



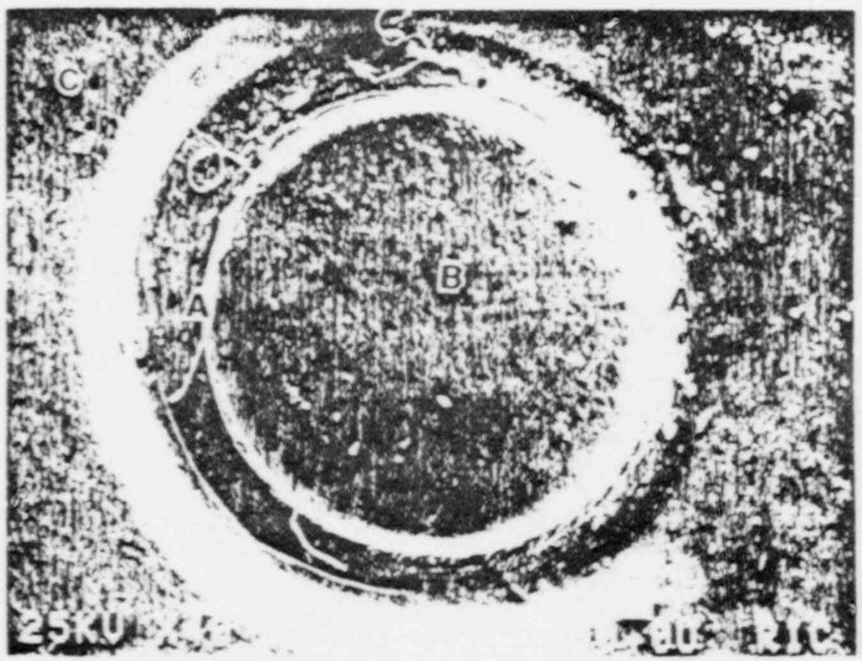
c. Area B = Center



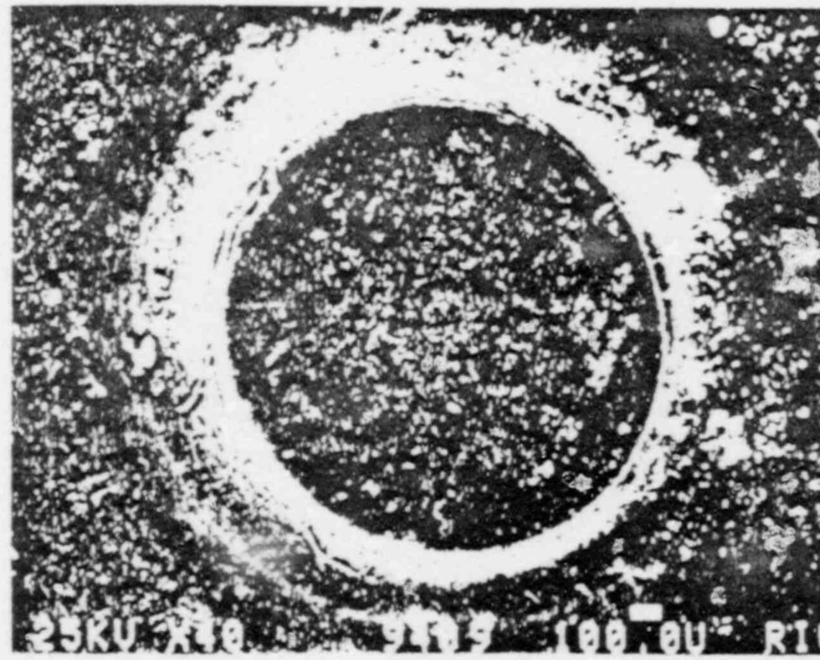
a.



b. BEI of Figure 6a



c. See Table I
Spot Mode A=Indent; B=Center;
C=Outside

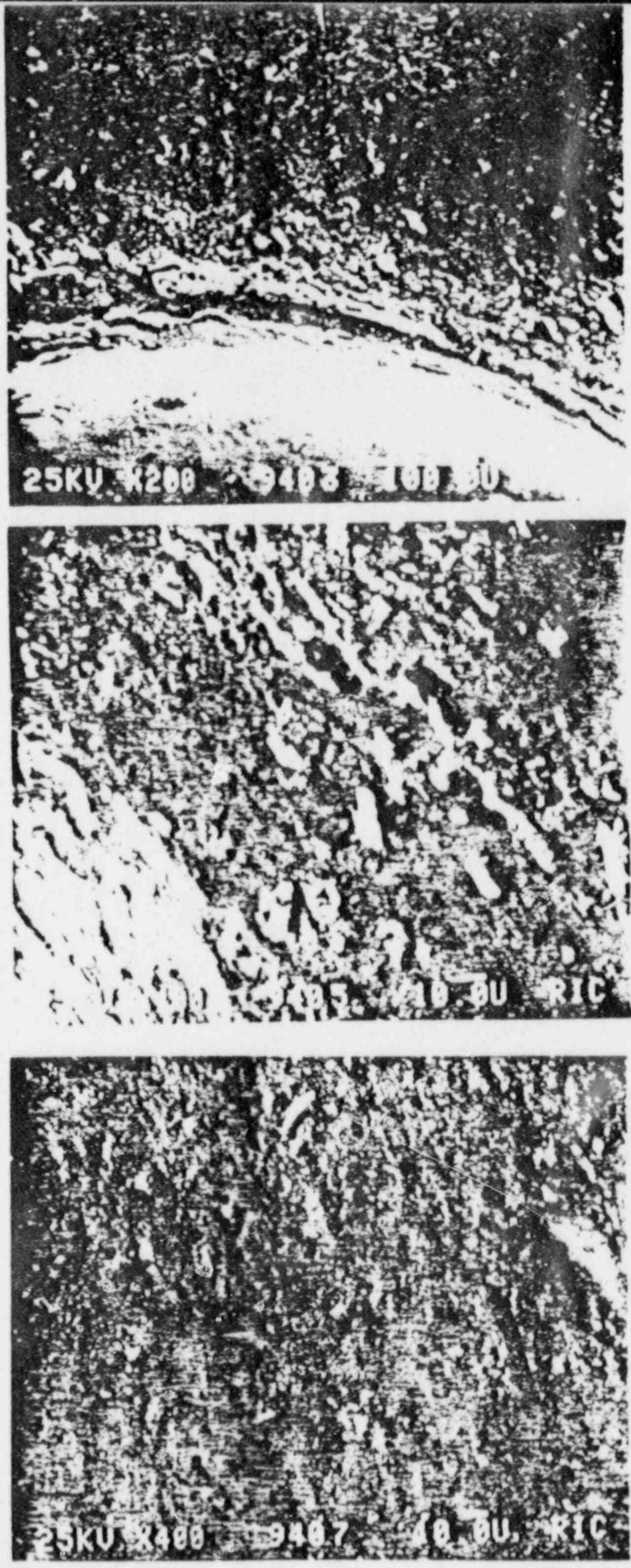


d. BEI of Figure 6c

Figure 6. MSIV27; Energized Elastomer Seat; Failed; Surface

Figure 7.

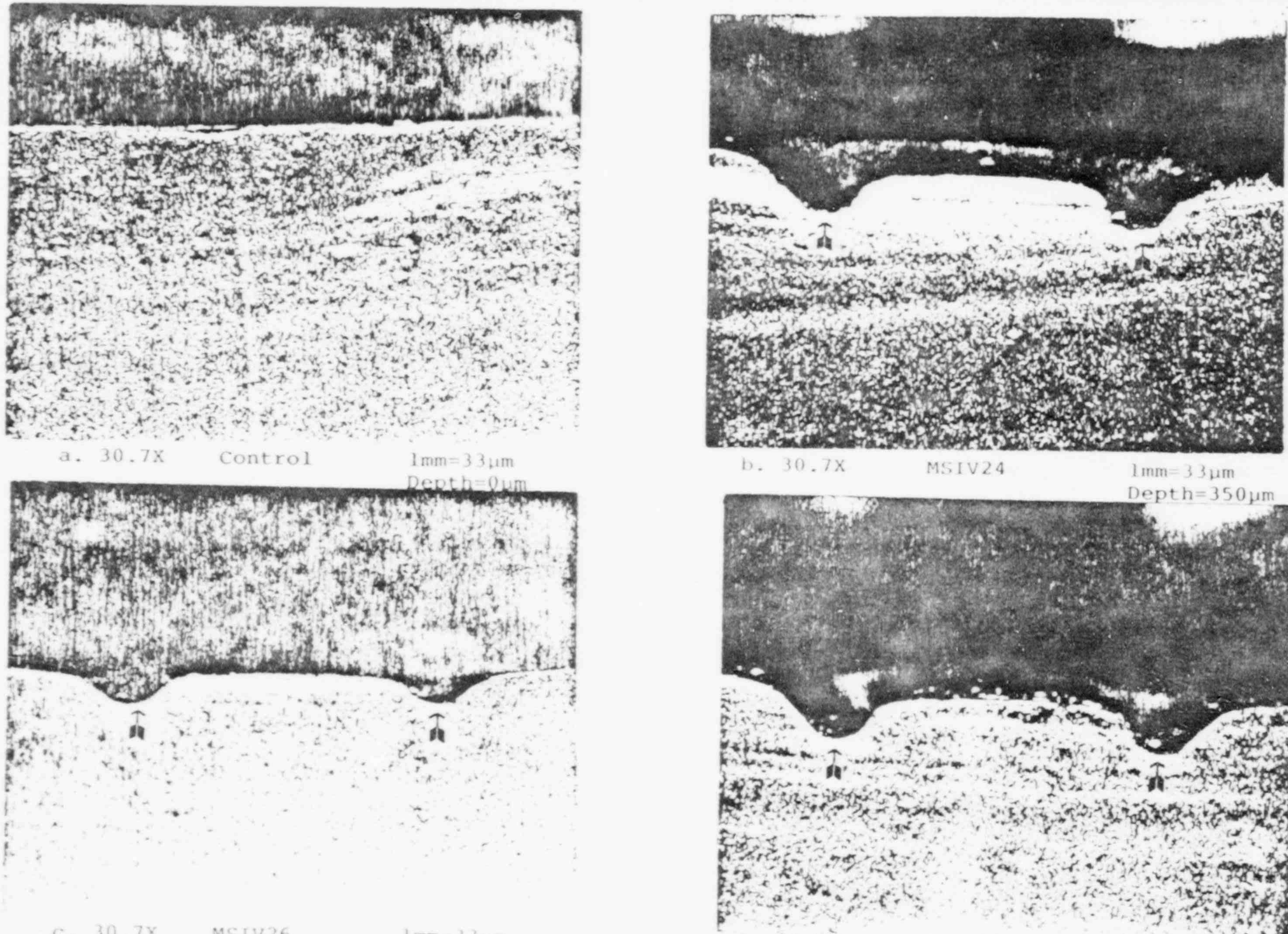
MSIV27
Energized Elastomer Seat
Failed
Surface



a. Area A = Inden

b. Area A = Indent

c. Area B = Center



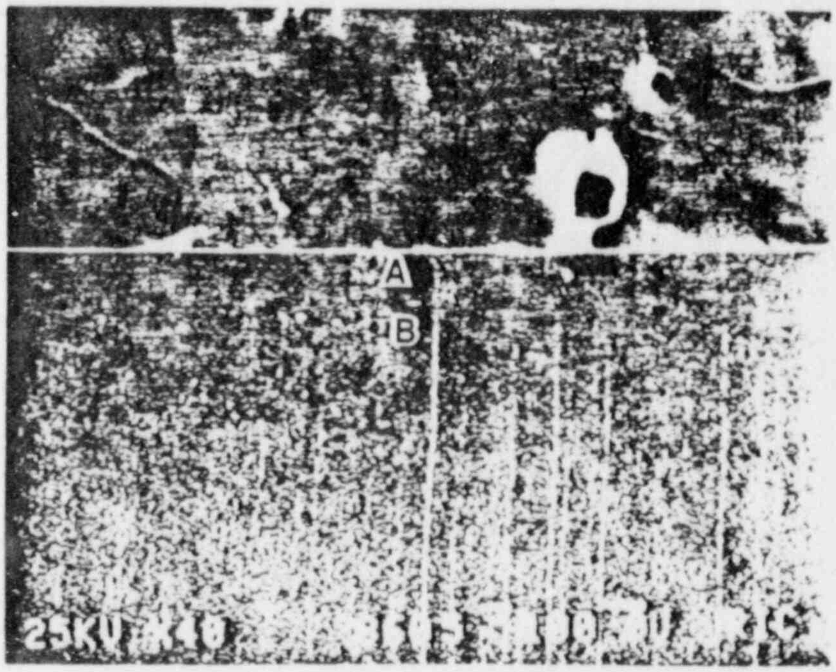
a. 30.7X Control 1mm=33μm Depth=0μm

b. 30.7X MSIV24 1mm=33μm Depth=350μm

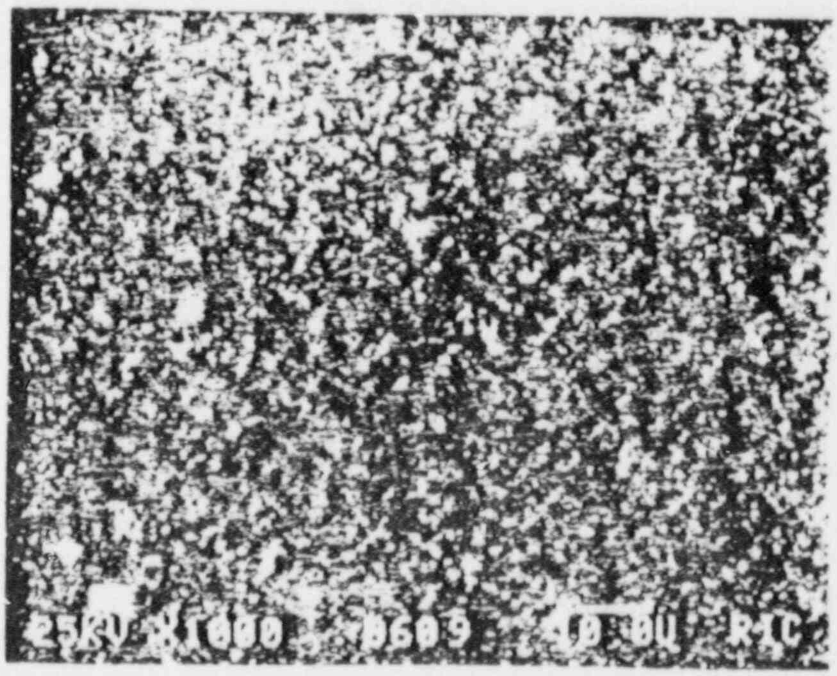
c. 30.7X MSIV26 1mm=33μm Depth=230μm

d. 30.7X MSIV27 1mm=33μm Depth=350μm

Figure 8. Optical Microscopy; Energized Elastomer Seats; Cross-section

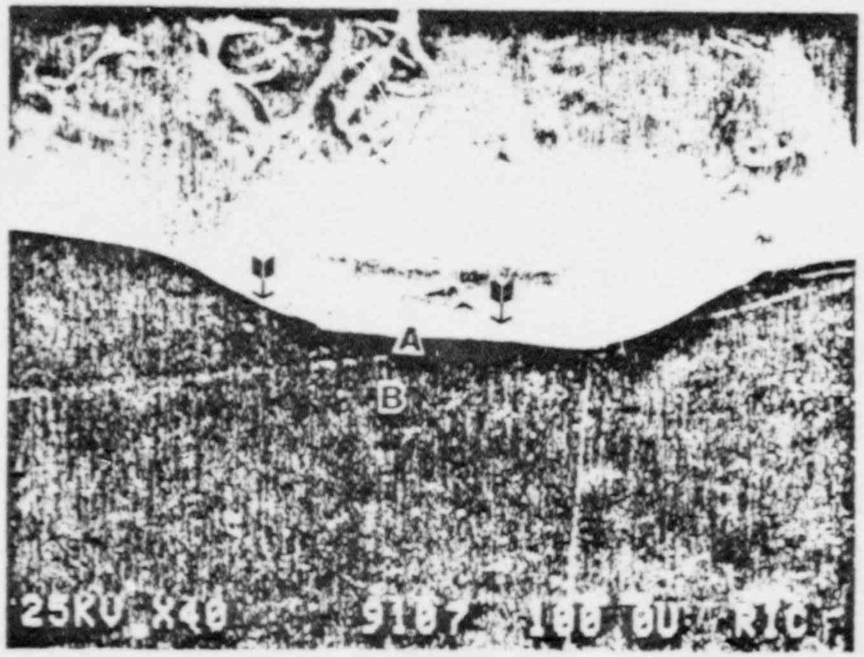


a. See Table II Spot Mode A&B

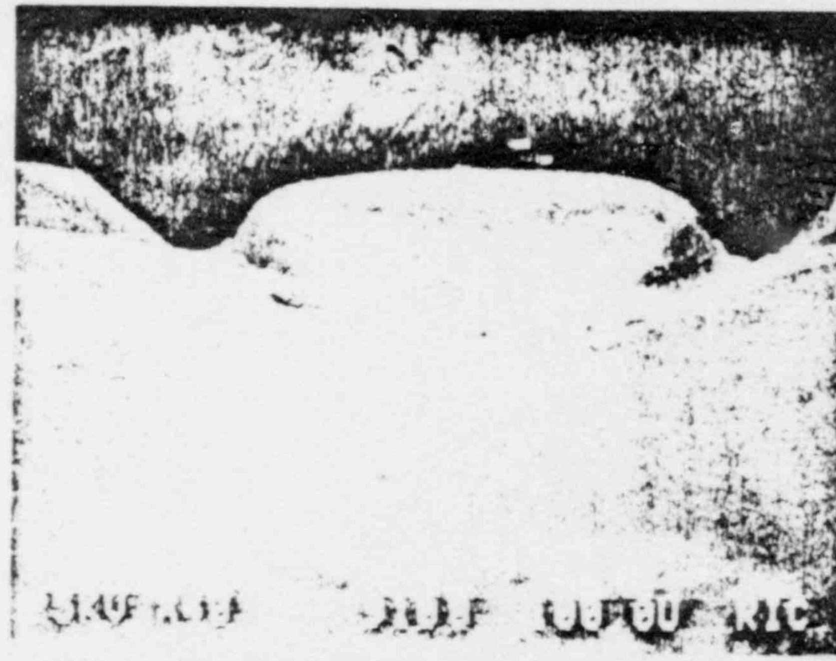


b. BEI of Edge of Seat

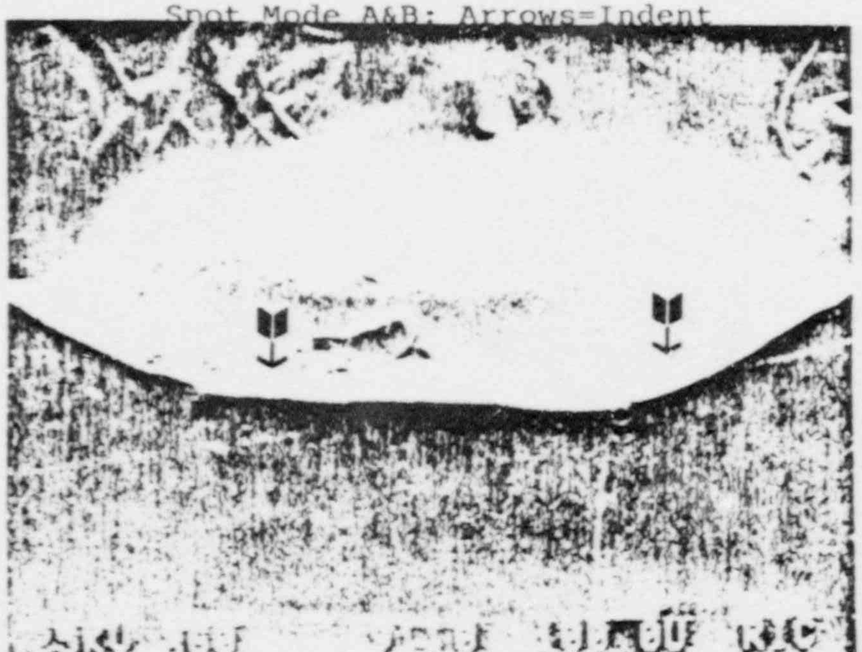
Figure 9. MSIV-Control; Energized Elastomer Seat Cross-section



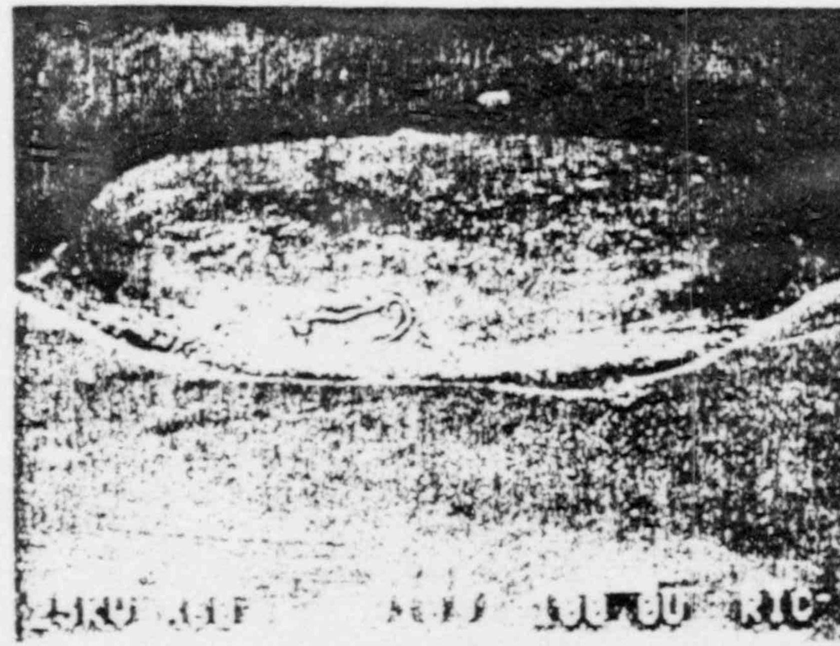
a. See Table II
Spot Mode A&B; Arrows=Indent



b. BEI of Figure 10a



c. Arrows = Indent



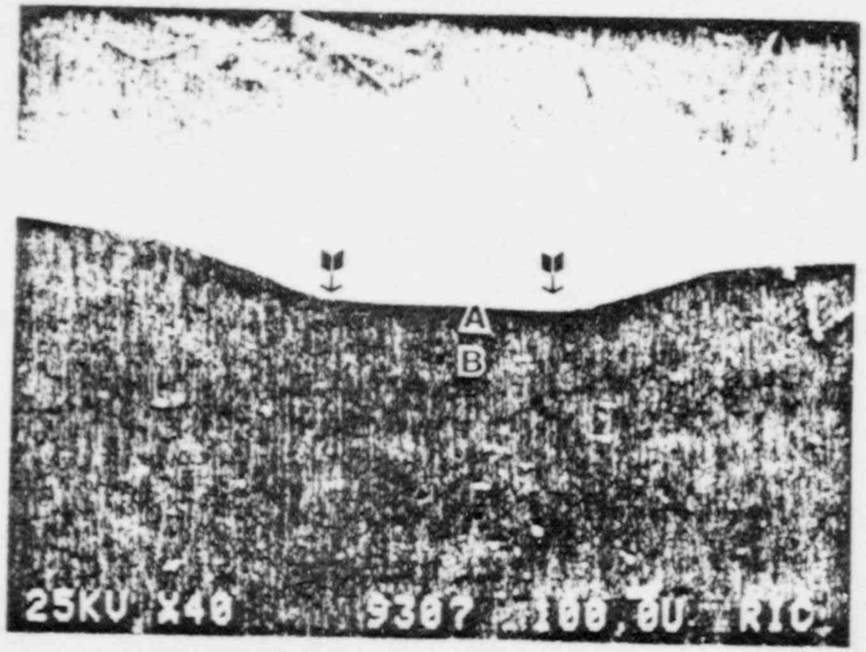
d. BEI of Figure 10c

Figure 10. MSIV24; Energized Elastomer Seat; Cross-section

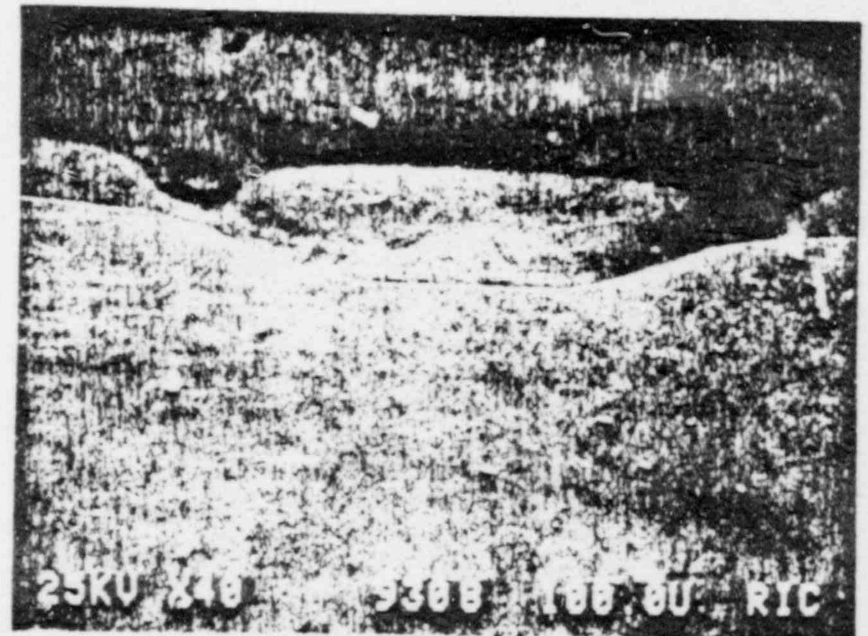
a. Arrow = Indent

b. BEI of Figure 11a

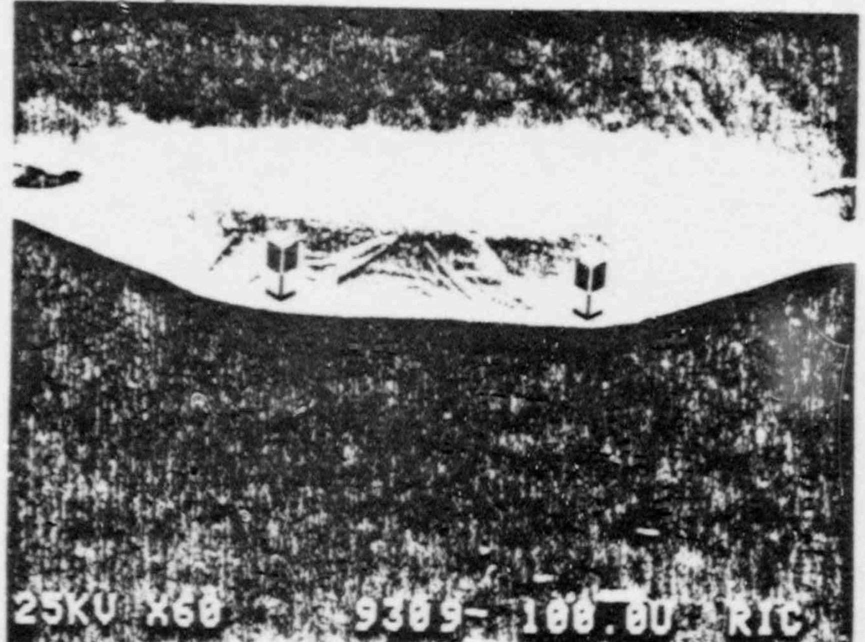
Figure 11. MSIV24; Energized Elastomer Seat Cross-section; Failed



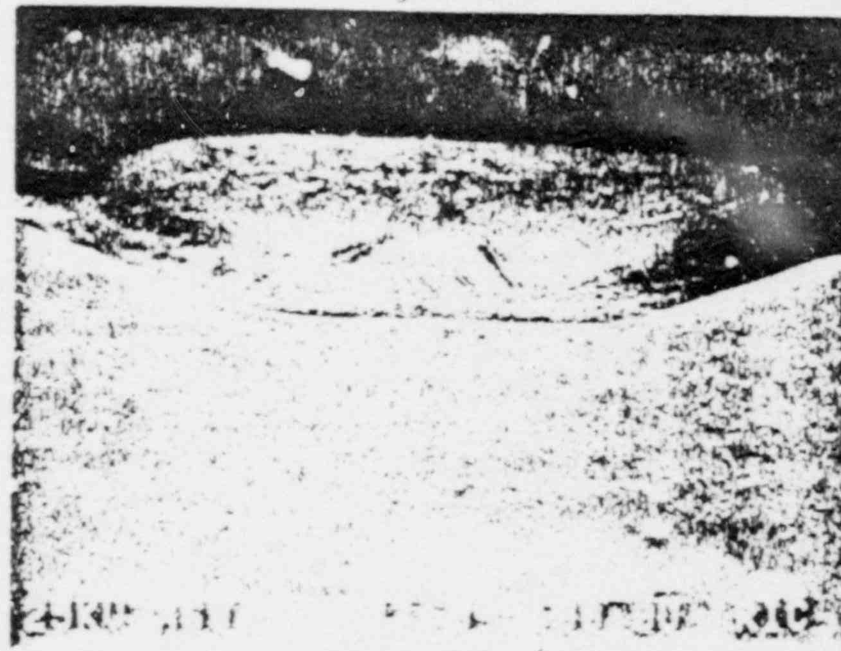
a. See Table II
Spot Mode A&B; Arrows=Indent



b. BEI of Figure 12a

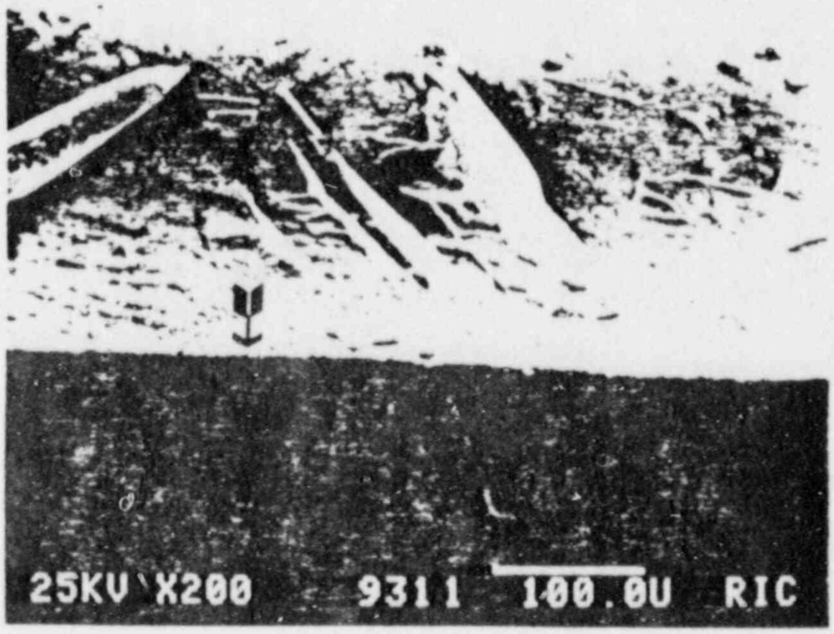


c. Arrows = Indent

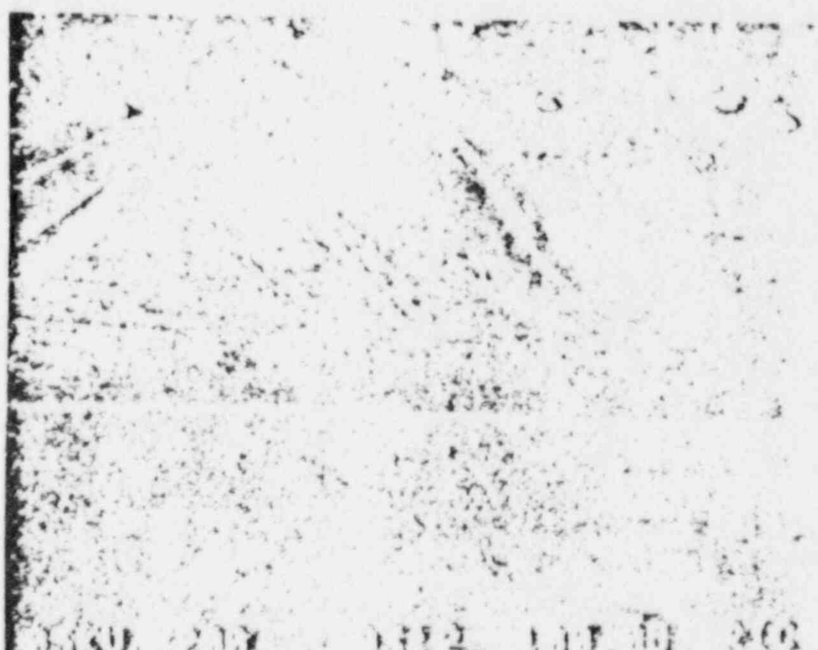


d. BEI of Figure 12c

Figure 12. MSIV26; Energized Elastomer Seat; Not Failed; Cross-section

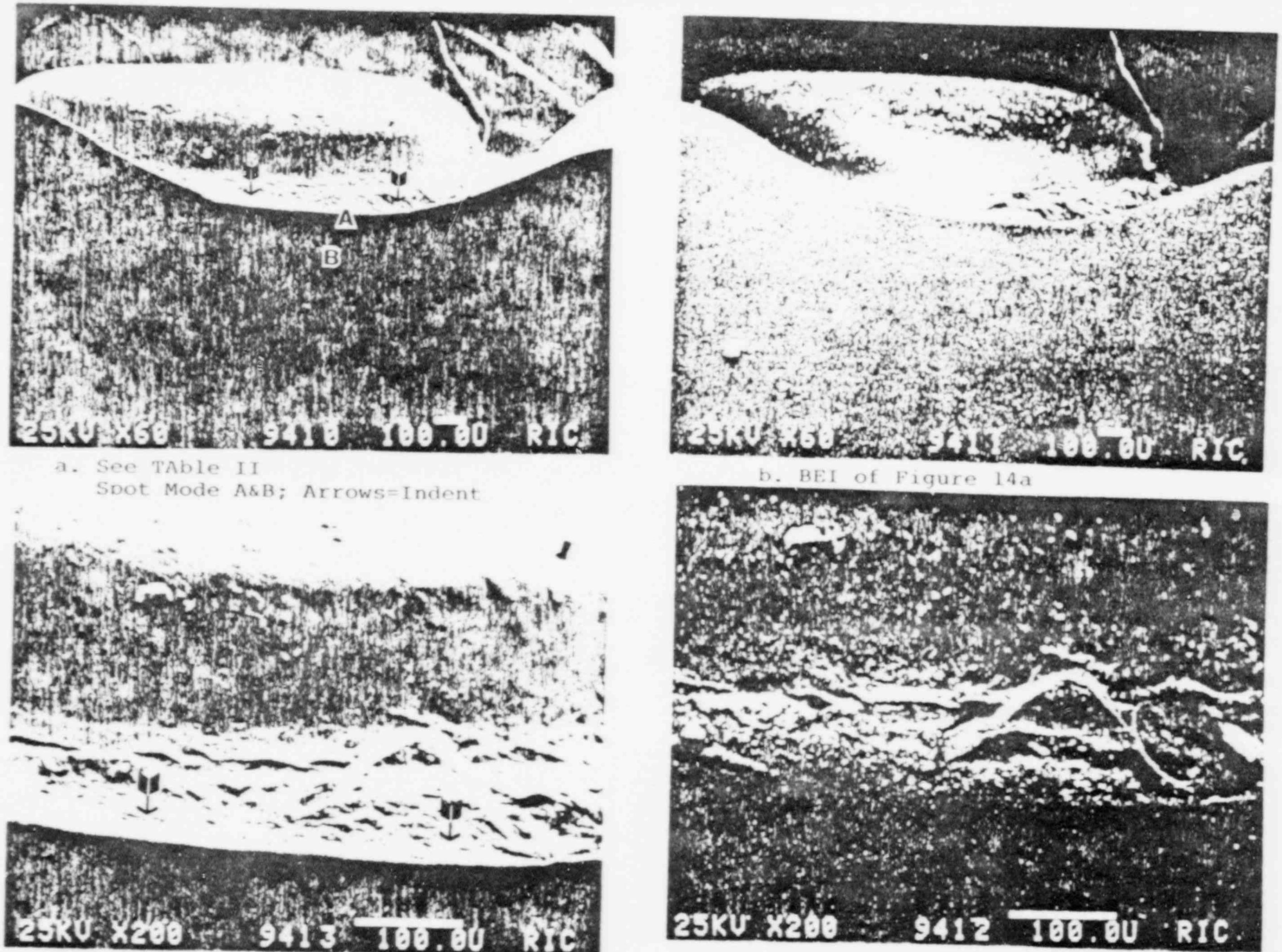


a. Arrows = Indent



b. BEI of Figure 13a

Figure 13. MSIV26; Energized Elastomer Seat Not Failed; Cross-section



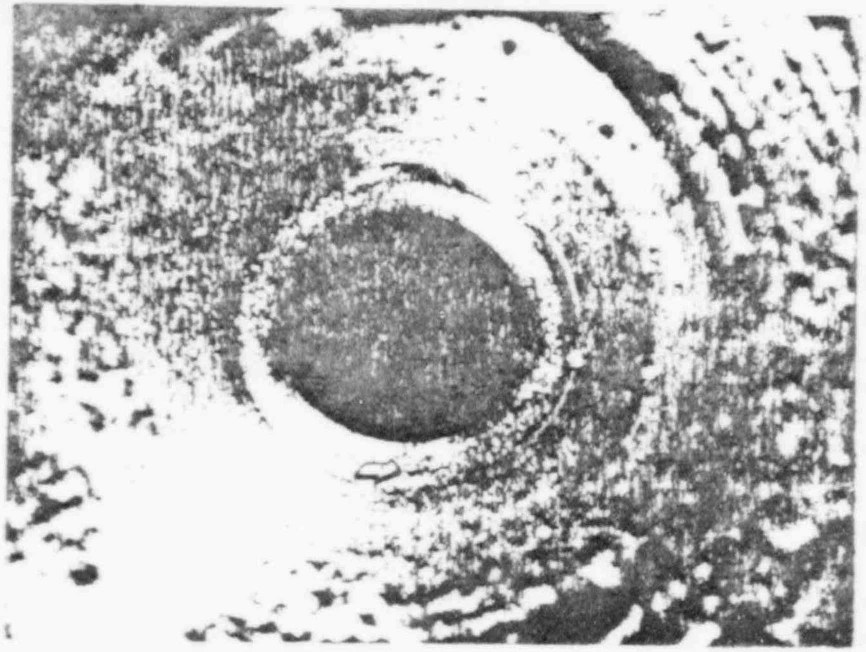
a. See TAble II
Spot Mode A&B; Arrows=Indent

b. BEI of Figure 14a

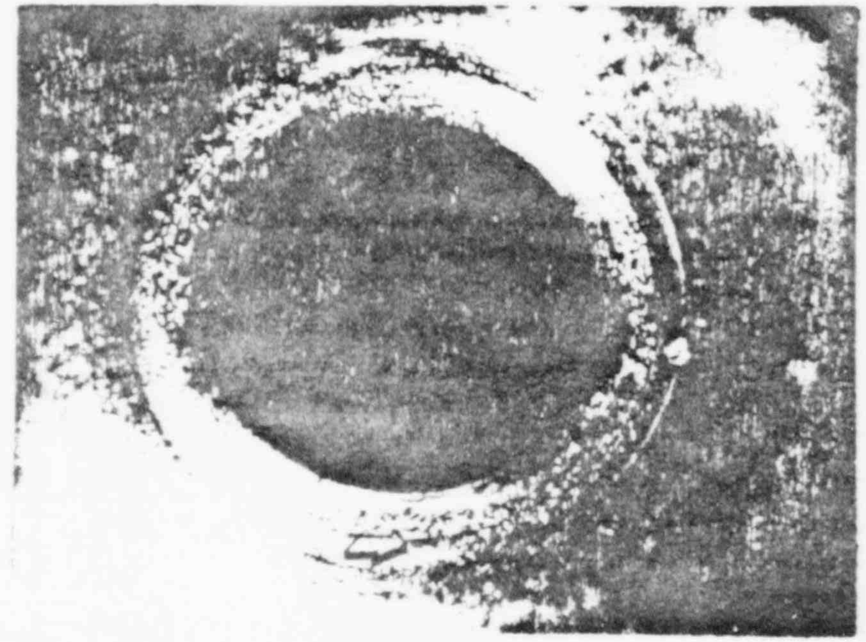
c.

d.

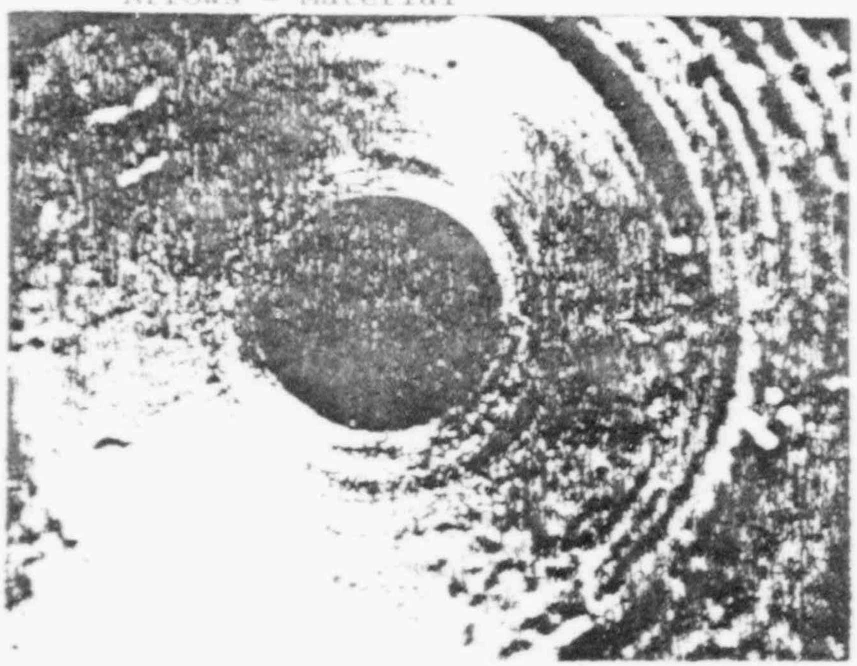
Figure 14. MSIV27; Energized Elastomer Seat; Failed; Cross-section



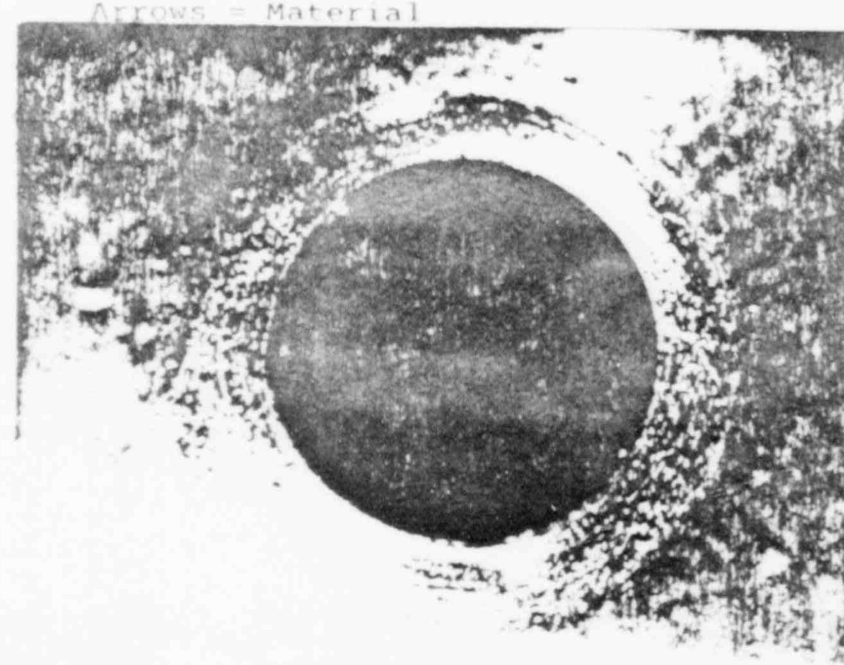
a. 18.8X Side 1 1mm=53μm
Arrows = Material



b. 30.7X Side 1 1mm=33μm
Arrows = Material

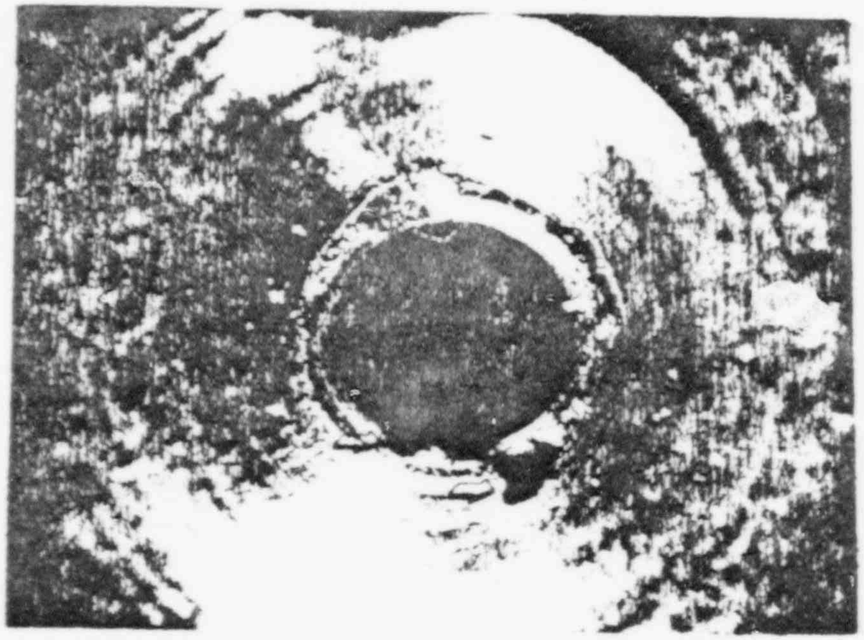


c. 18.8X Side 2 1mm=53μm

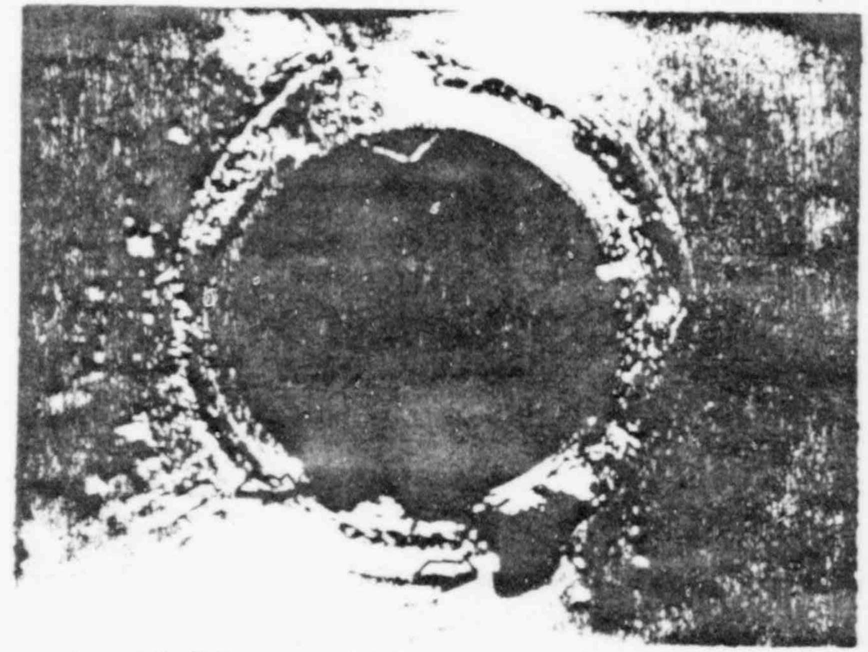


d. 30.7X Side 2 1mm=33μm

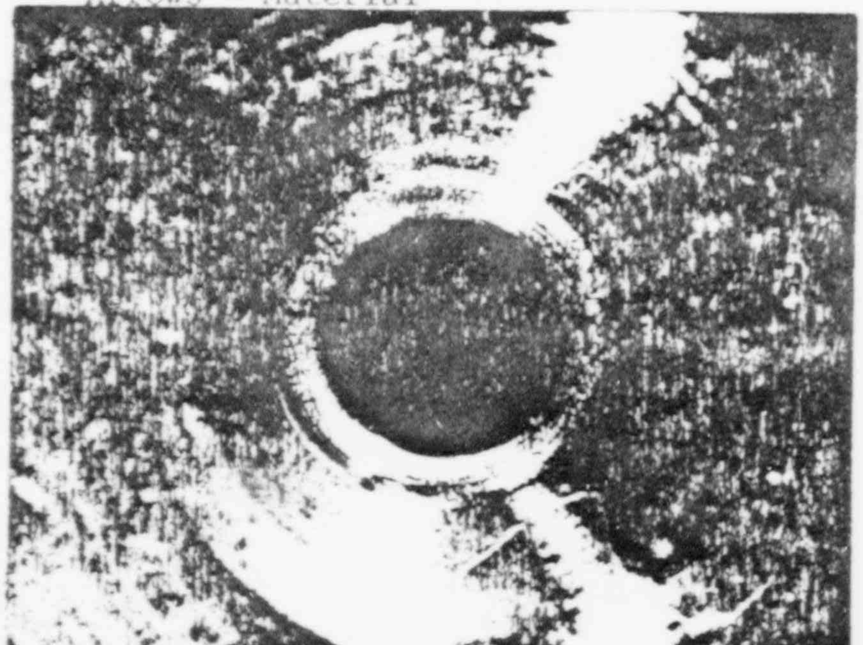
Figure 15. Optical Microscopy; Flow Control Valve; MSIV20; Center Cone



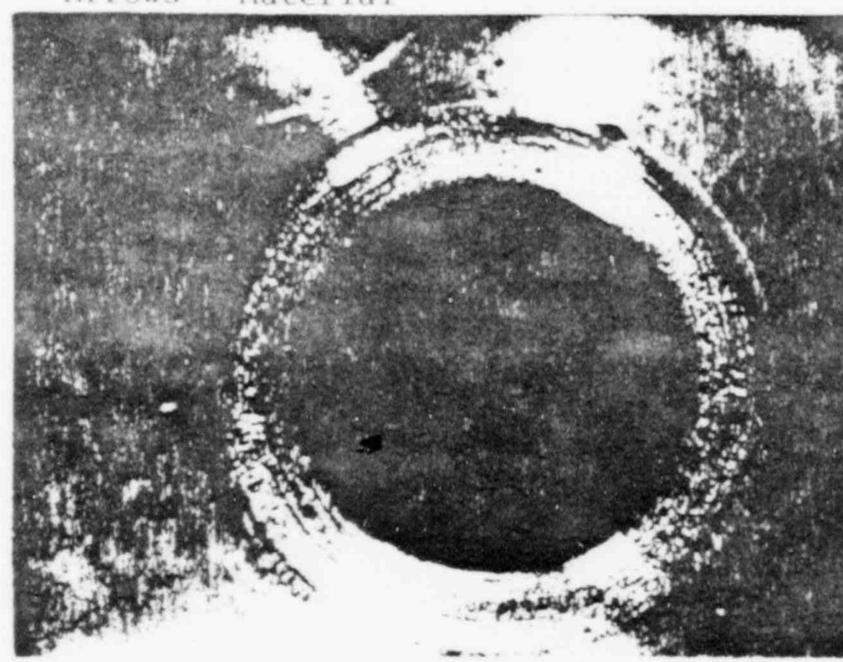
a. 18.8X Side 1 1mm=53μm
Arrows = Material



b. 30.7X Side 1 1mm=33μm
Arrows = Material



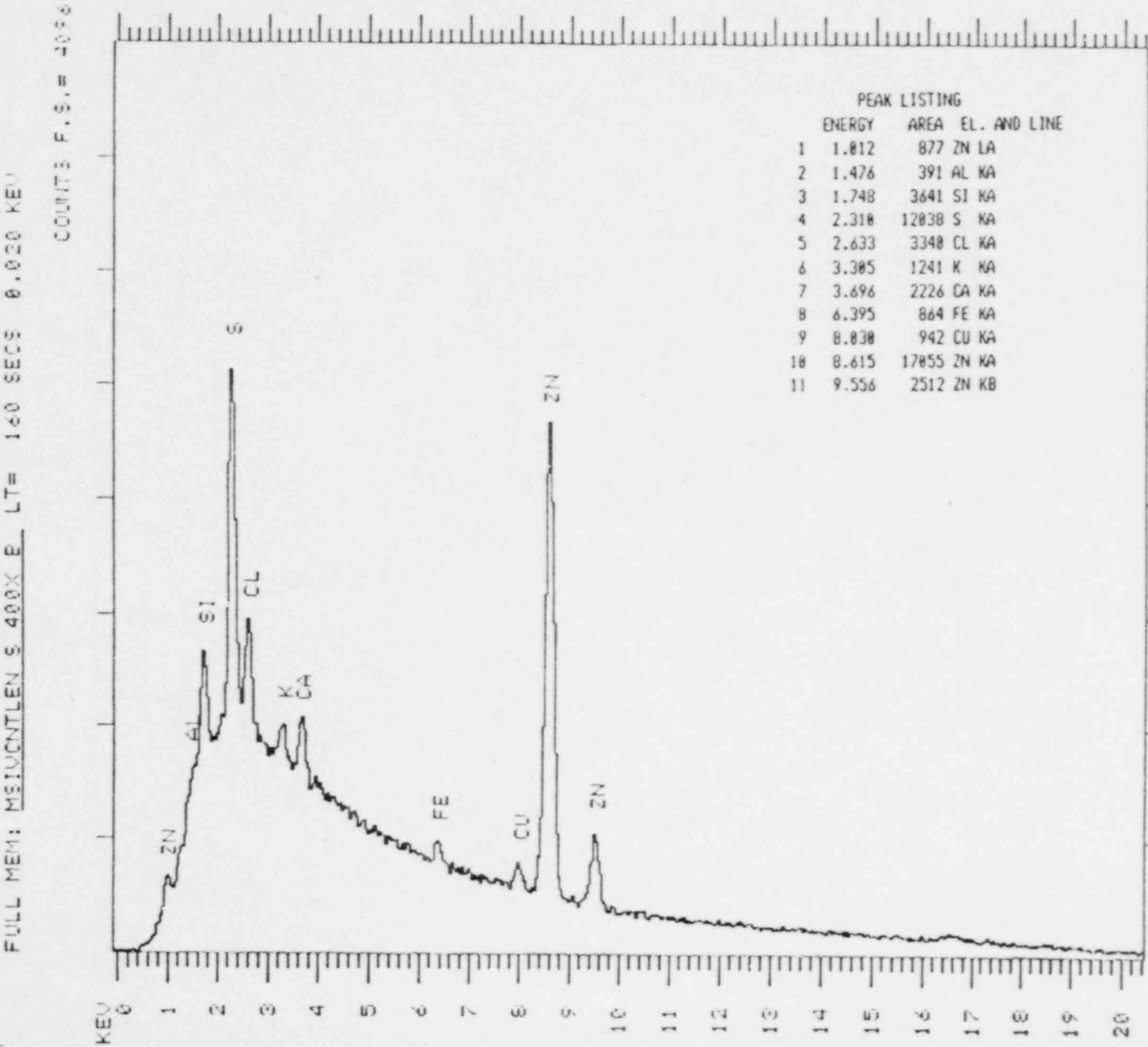
c. 18.8X Side 2 1mm=53μm



d. 30.7X Side 2 1mm=33μm

Figure 16. Optical Microscopy; Flow Control Valve; MSIV21; Center Cone

Plot 1 MSIV Control
Energized Elastomer Seat
Surface



PEAK LISTING

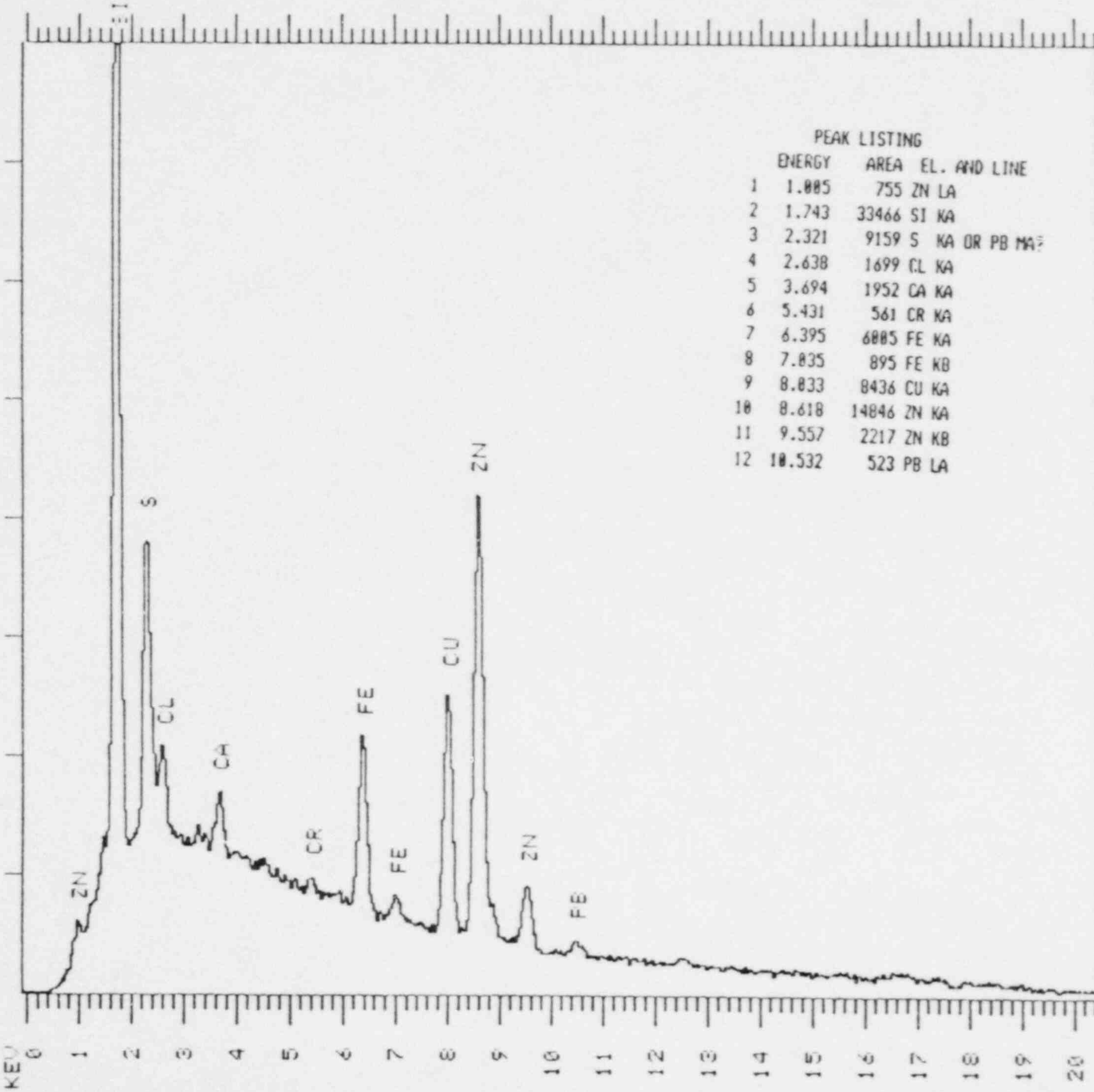
	ENERGY	AREA	EL. AND LINE
1	1.012	877	ZN LA
2	1.476	391	AL KA
3	1.748	3641	SI KA
4	2.310	12038	S KA
5	2.633	3340	CL KA
6	3.305	1241	K KA
7	3.696	2226	CA KA
8	6.395	864	FE KA
9	8.030	942	CU KA
10	8.615	17055	ZN KA
11	9.556	2512	ZN KB

Plot 2 MSIV24
Energized Elastomer Seat
Surface - Failed
Area A = Indent

TRACOR-NORTHERN SPECTRAL PLOT

FULL MEM: MSIV 24 400X A4 ENS LT= 160 SECS 0.020 KEV

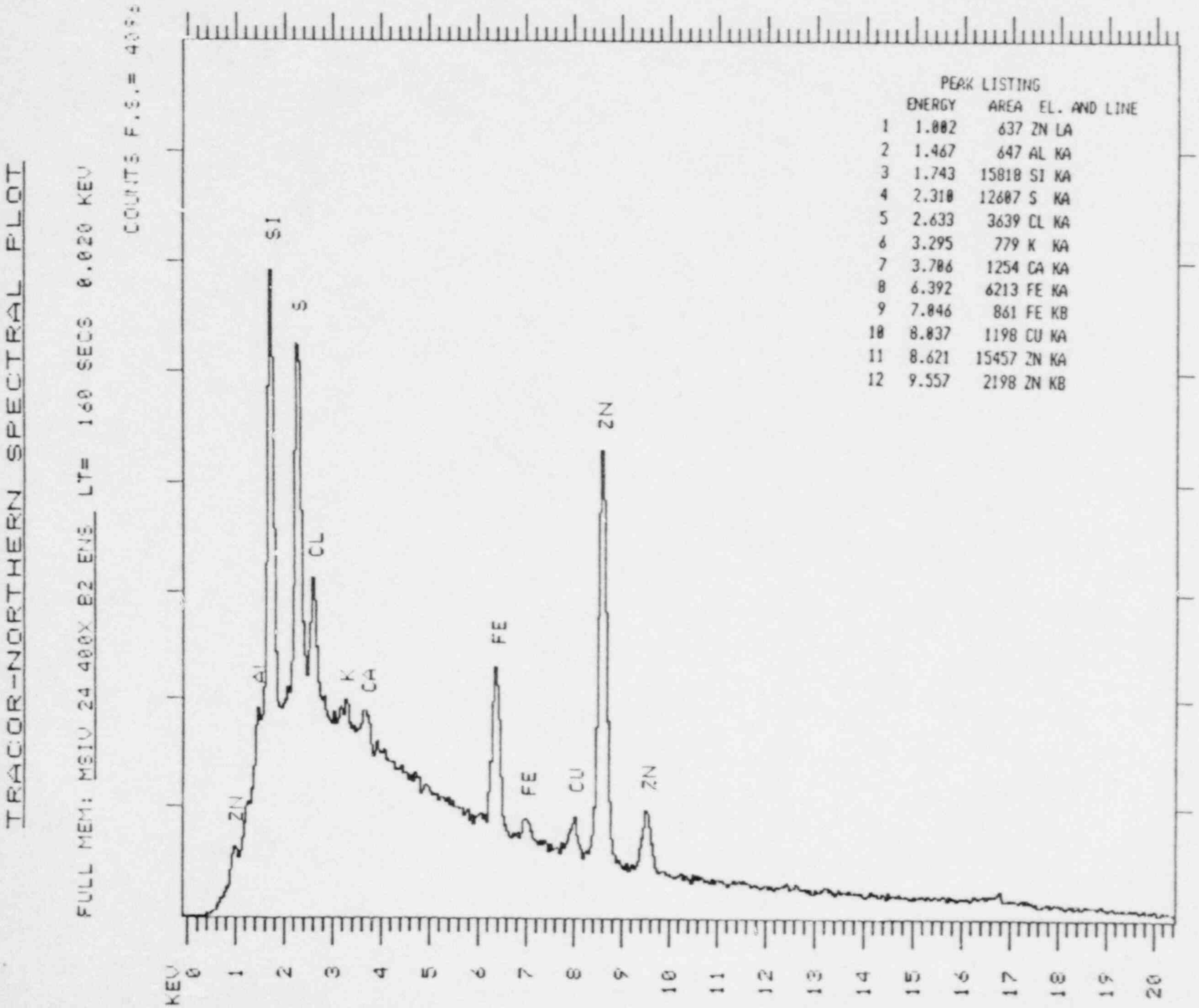
COUNTS F.S.= 4096



PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.005	755	ZN LA
2	1.743	33466	SI KA
3	2.321	9159	S KA OR PB MA?
4	2.638	1699	CL KA
5	3.694	1952	CA KA
6	5.431	561	CR KA
7	6.395	6005	FE KA
8	7.035	895	FE KB
9	8.033	8436	CU KA
10	8.618	14846	ZN KA
11	9.557	2217	ZN KB
12	10.532	523	PB LA

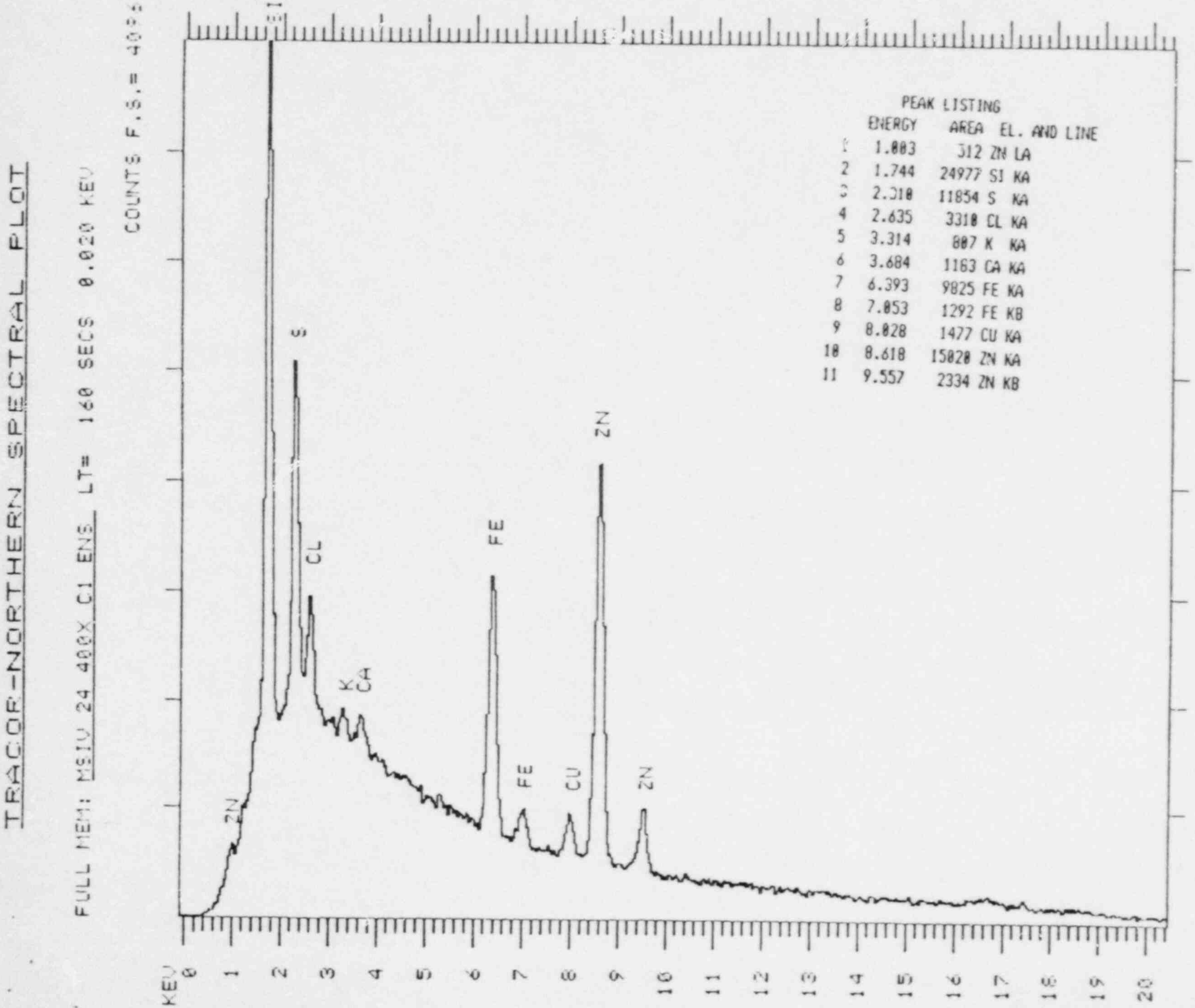
Plot 3 MSIV24
Energized Elastomer Seat
Surface - Failed
Area B = Center



PEAK LISTING

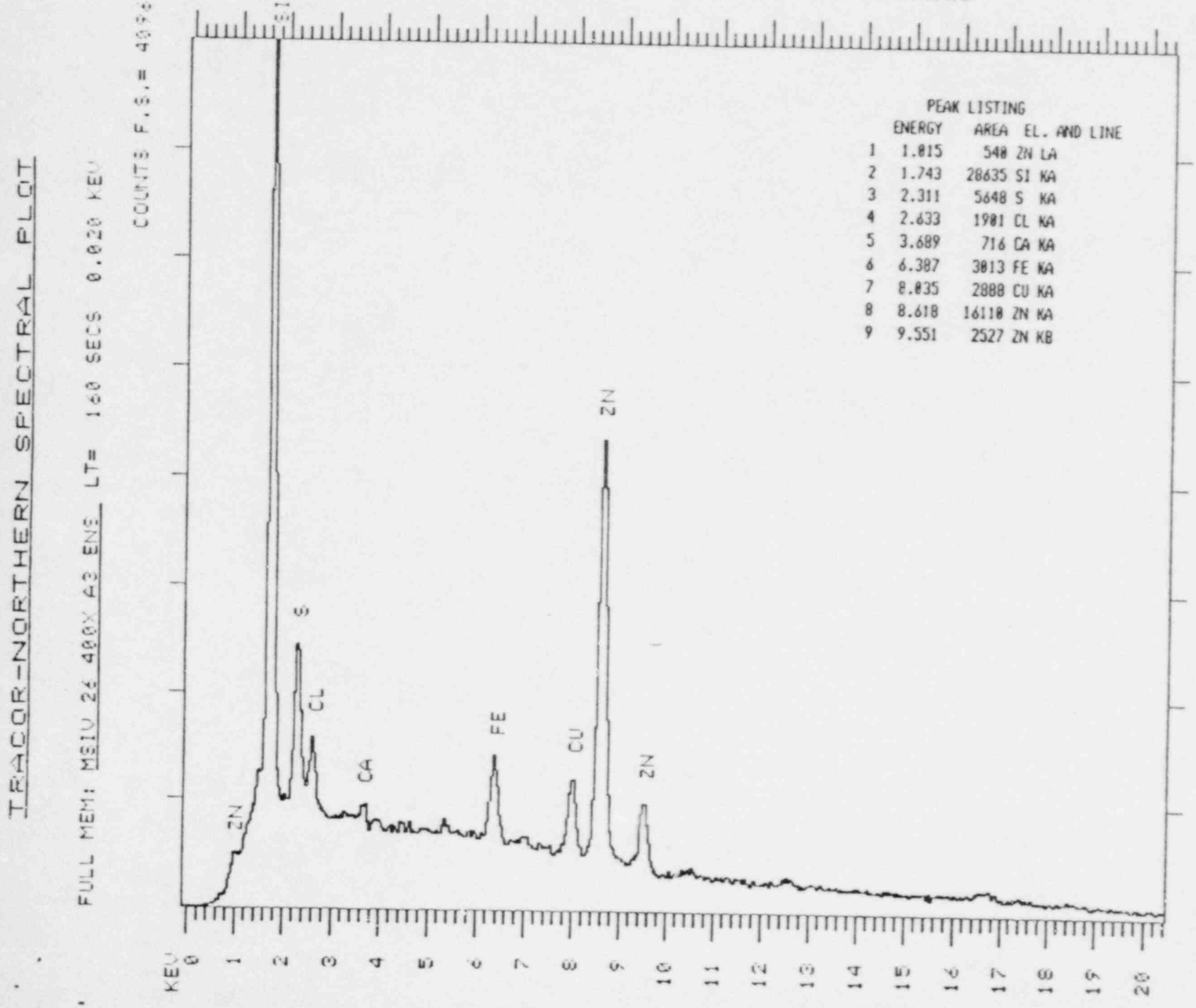
	ENERGY	AREA	EL. AND LINE
1	1.002	637	ZN LA
2	1.467	647	AL KA
3	1.743	15818	SI KA
4	2.310	12607	S KA
5	2.633	3639	CL KA
6	3.295	779	K KA
7	3.706	1254	CA KA
8	6.392	6213	FE KA
9	7.046	861	FE KB
10	8.037	1198	CU KA
11	8.621	15457	ZN KA
12	9.557	2198	ZN KB

Plot 4 MSIV24
Energized Elastomer Seat
Surface - Failed
Area C = Outside

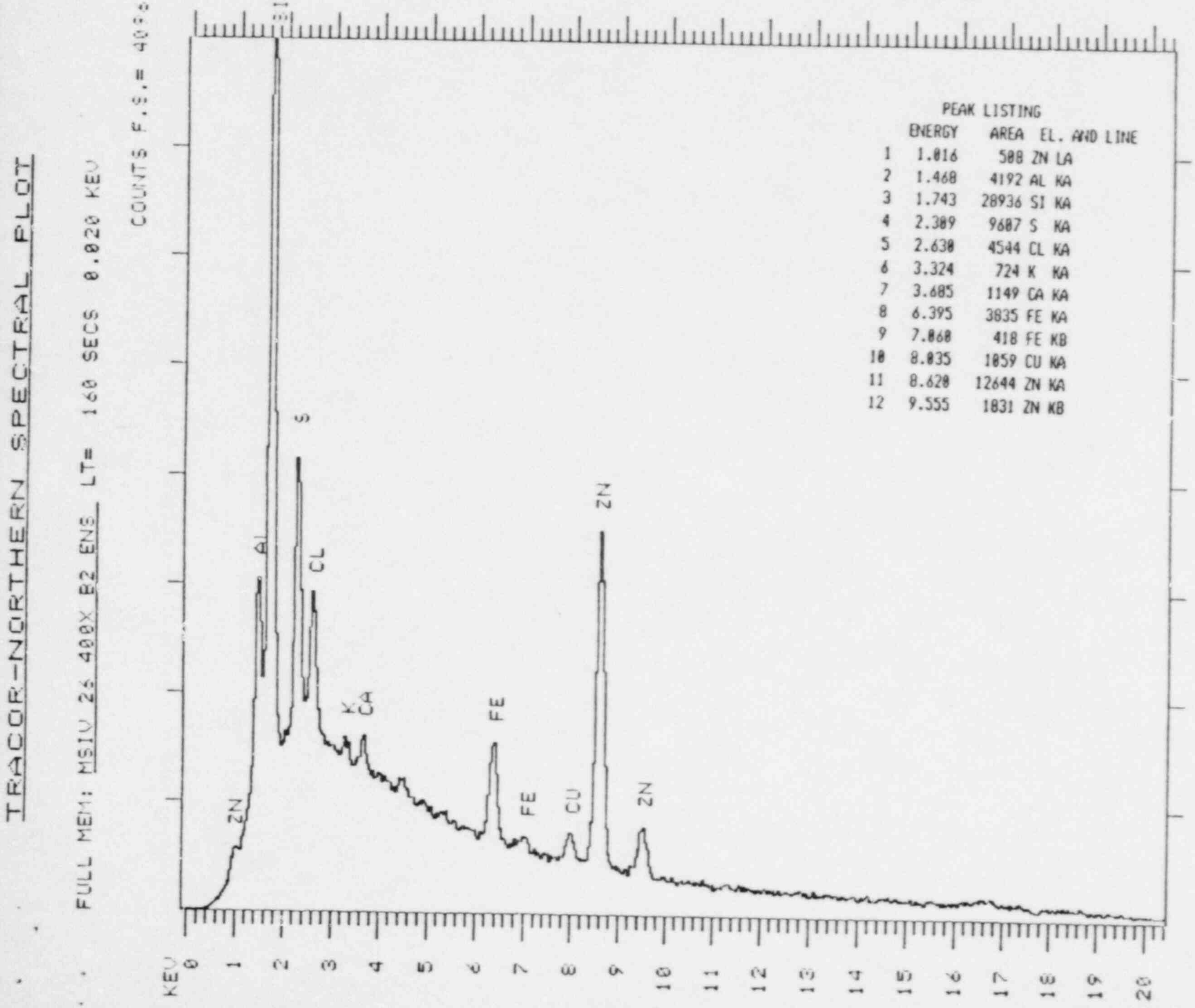


	ENERGY	AREA	EL. AND LINE
1	1.003	312	ZN LA
2	1.744	24977	SI KA
3	2.310	11854	S KA
4	2.635	3310	CL KA
5	3.314	807	K KA
6	3.684	1163	CA KA
7	6.393	9825	FE KA
8	7.053	1292	FE KB
9	8.028	1477	CU KA
10	8.618	15020	ZN KA
11	9.557	2334	ZN KB

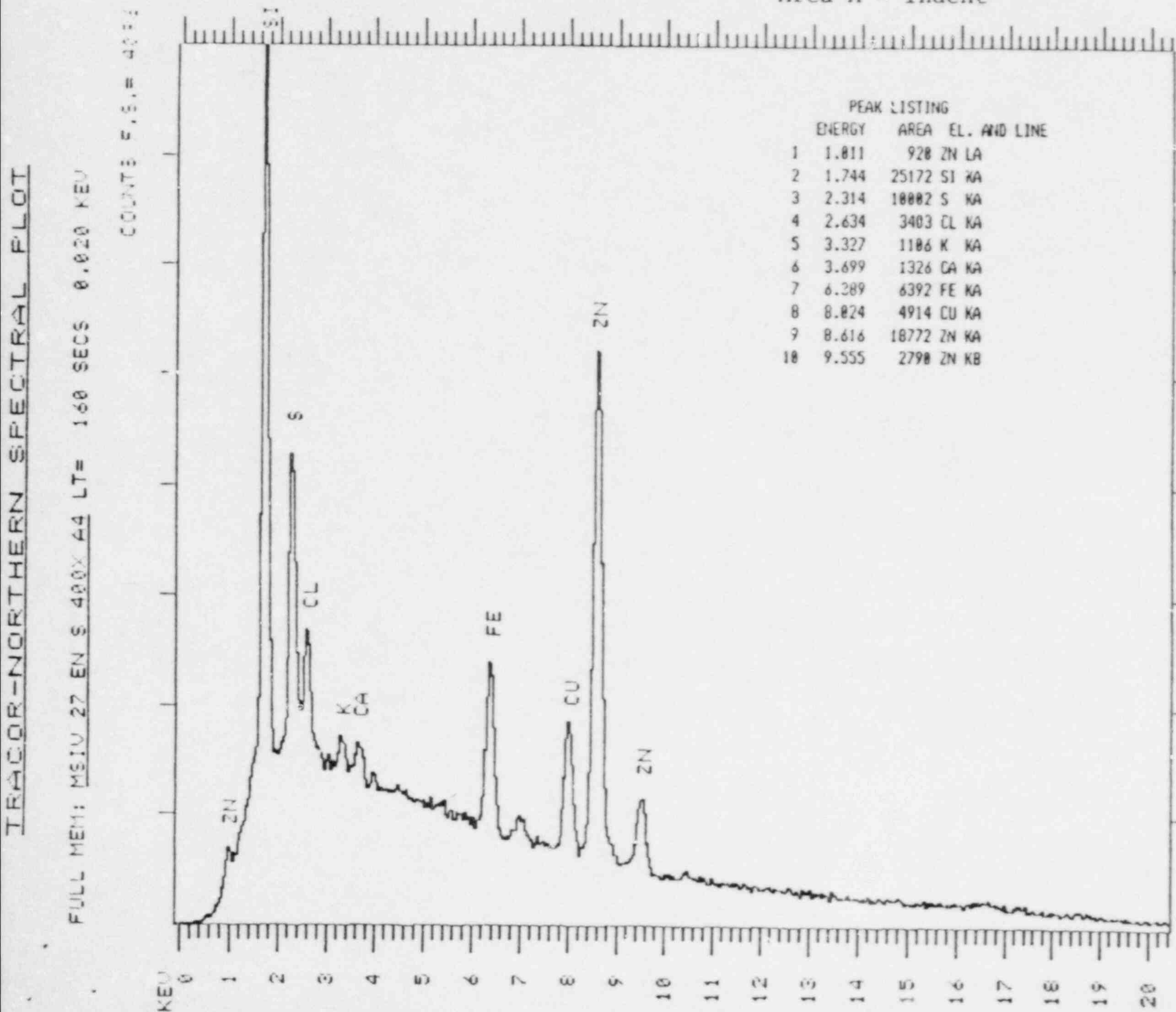
Plot 5 MSIV26
Energized Elastomer Seat
Surface - Not Failed
Area A - Indent



Plot 6. MSIV26
Energized Elastomer Seat
Surface - Not Failed
Area B = Center



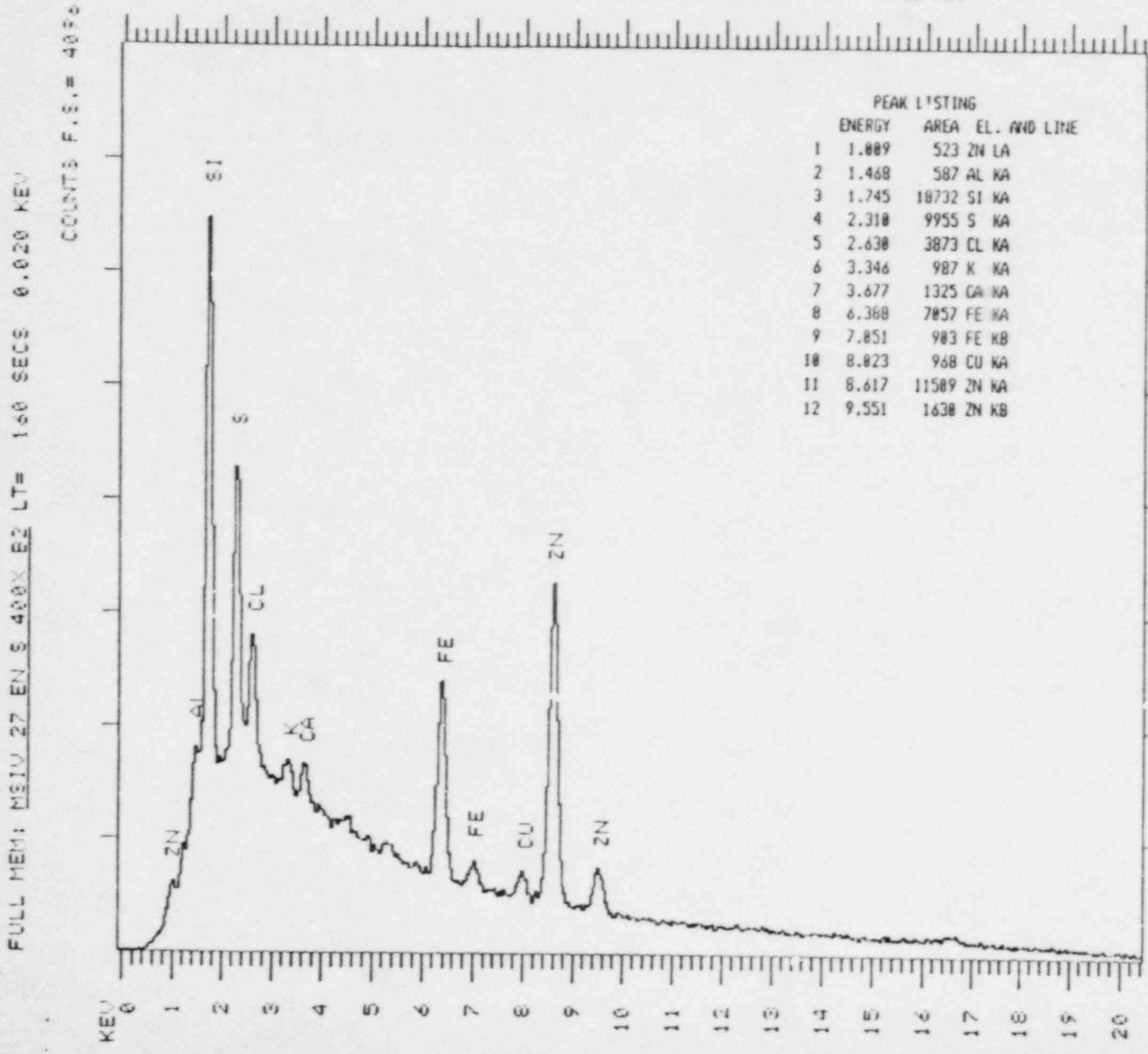
Plot 8 MSIV27
Energized Elastomer Seat
Surface - Failed
Area A = Indent



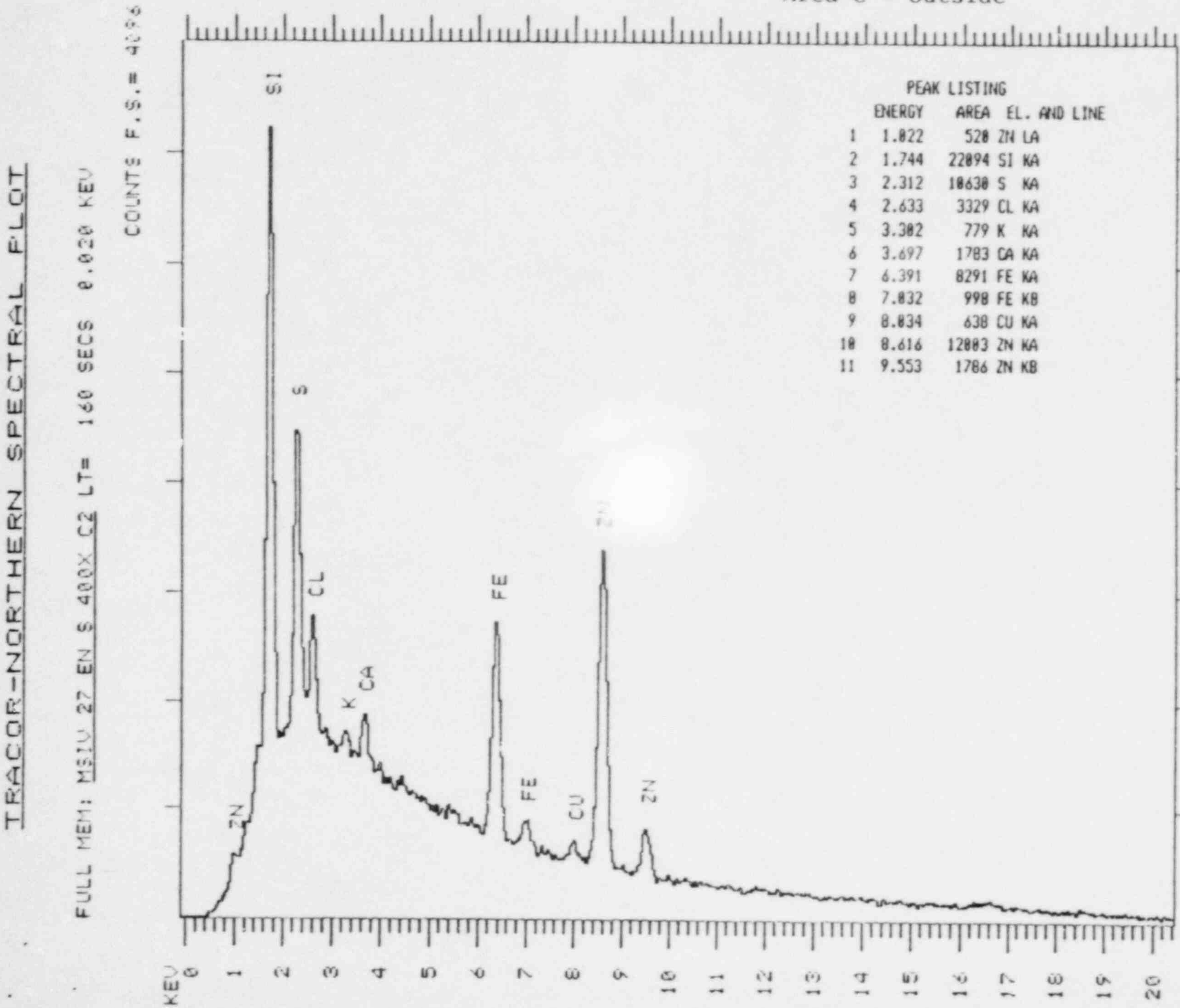
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.011	920	ZN LA
2	1.744	25172	SI KA
3	2.314	10002	S KA
4	2.634	3403	CL KA
5	3.327	1106	K KA
6	3.699	1326	CA KA
7	6.389	6392	FE KA
8	8.024	4914	CU KA
9	8.616	18772	ZN KA
10	9.555	2790	ZN KB

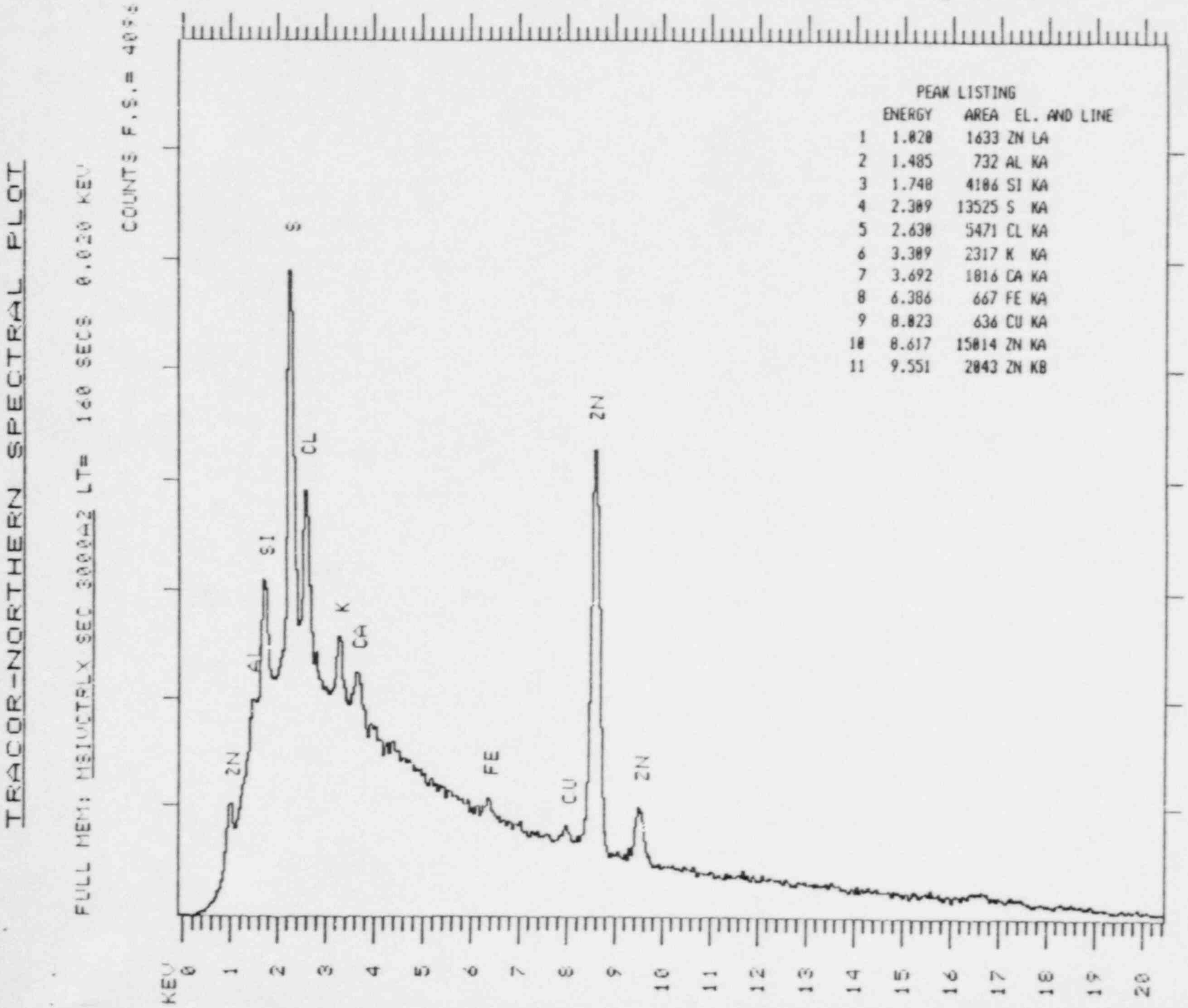
Plot 9 MSIV27
Energized Elastomer Seat
Surface - Failed
Area B = Center



Plot 10 MSIV27
Energized Elastomer Seat
Surface - Failed
Area C = Outside



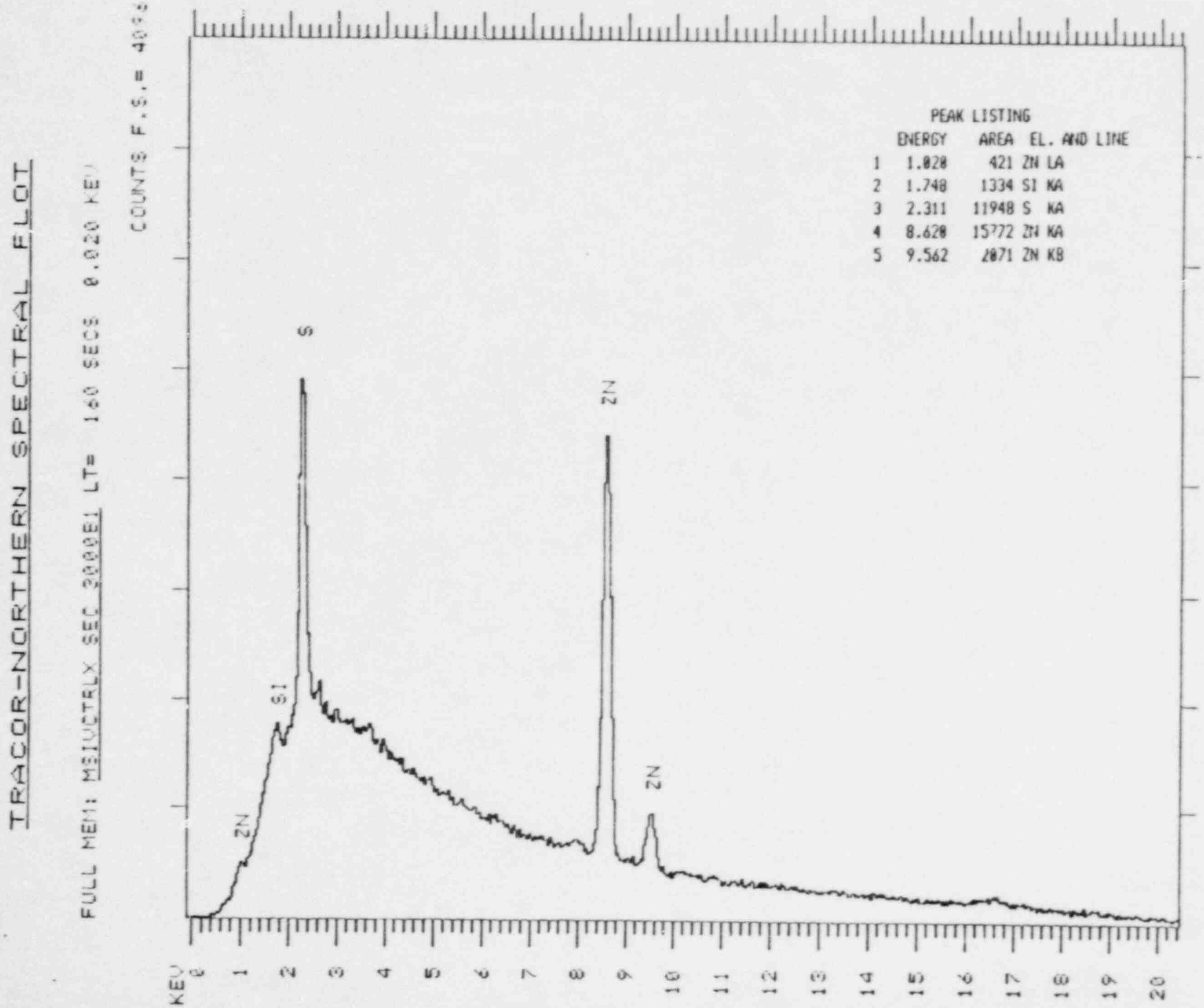
Plot 13 MSIV Control
Energized Elastomer Seat
Cross-section
Area A - Figure 9a



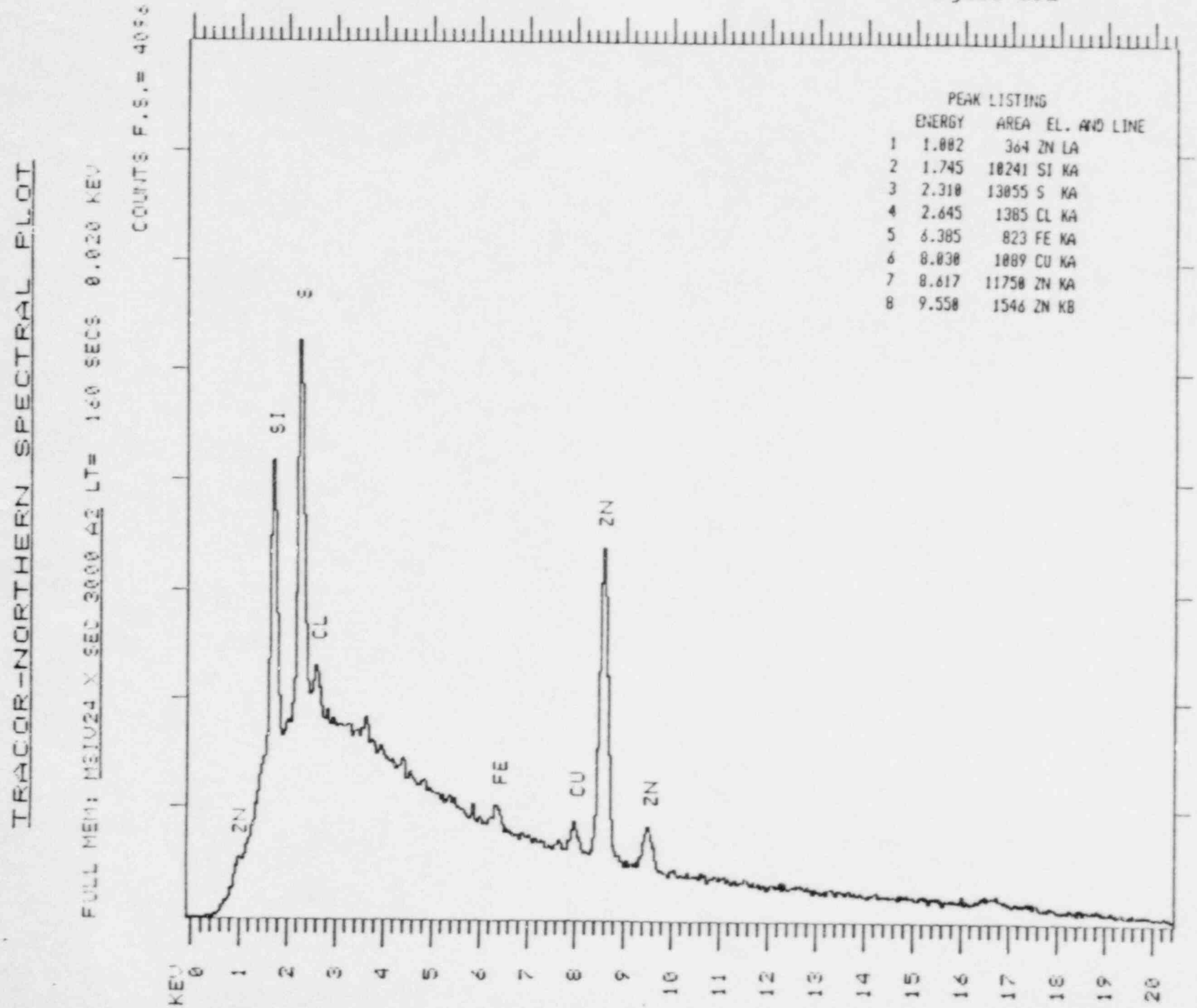
PEAK LISTING

	ENERGY	AREA	EL. AND LINE
1	1.020	1633	ZN LA
2	1.485	732	AL KA
3	1.740	4106	SI KA
4	2.309	13525	S KA
5	2.630	5471	CL KA
6	3.309	2317	K KA
7	3.692	1816	CA KA
8	6.386	667	FE KA
9	8.023	636	CU KA
10	8.617	15014	ZN KA
11	9.551	2043	ZN KB

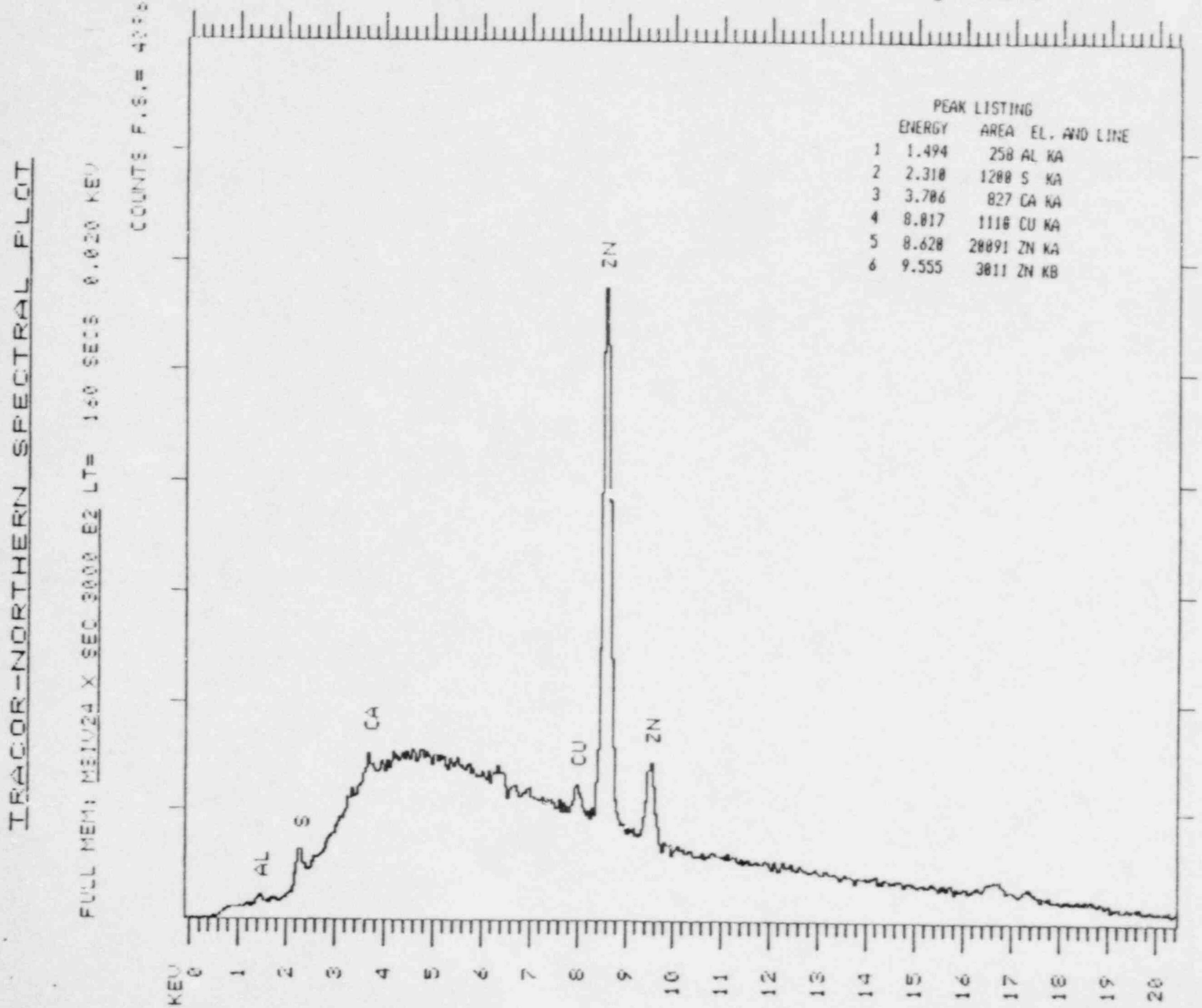
Plot 12 MSIV Control
Energized Elastomer Seat
Cross-section
Area B - Figure 9a



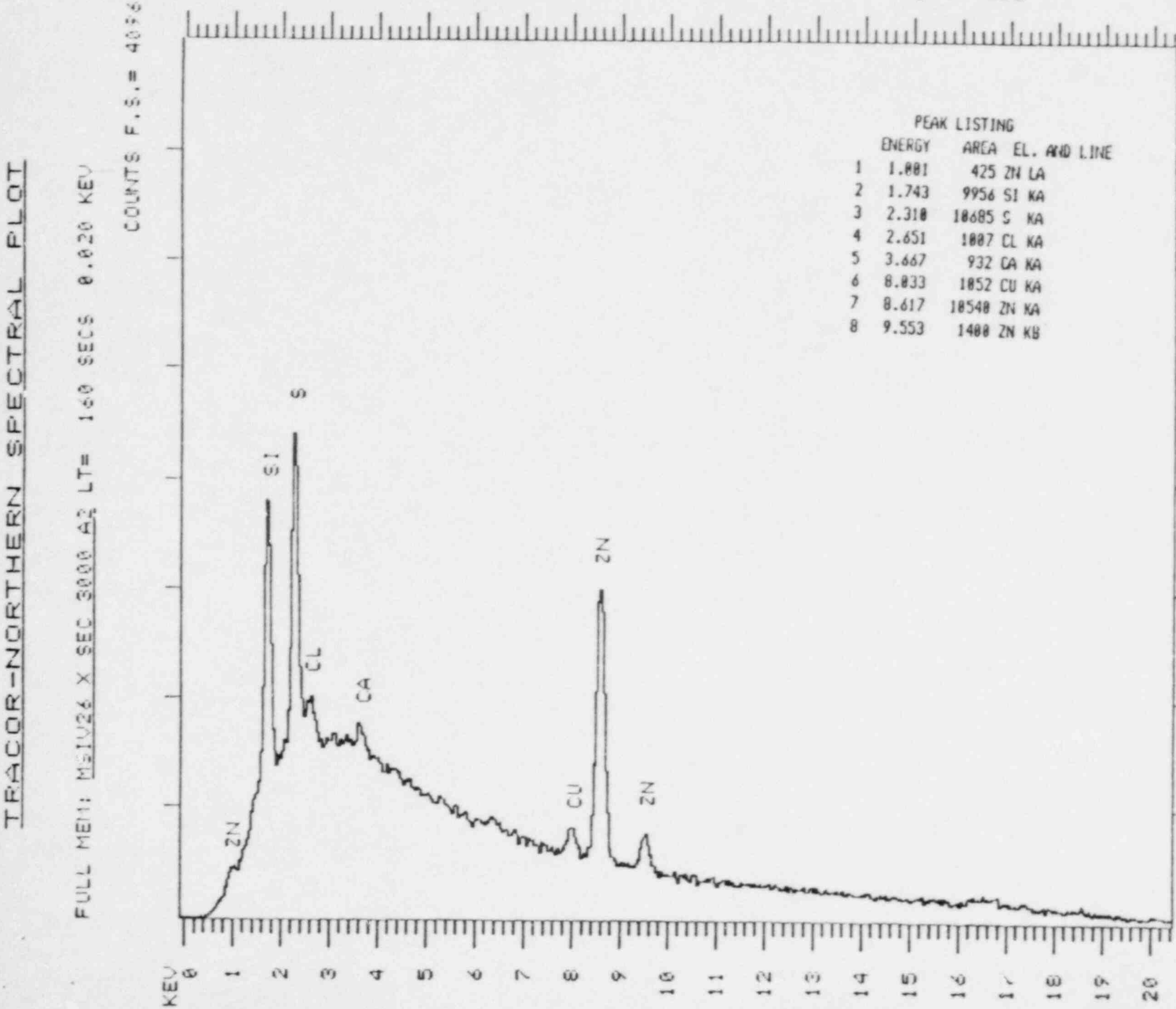
Plot 13 MSIV24
Energized Elastomer Seat
Cross-section - Failed
Area A - Figure 10a



Plot 14 MSIV24
Energized Elastomer Seat
Cross-section - Failed
Area B - Figure 10a

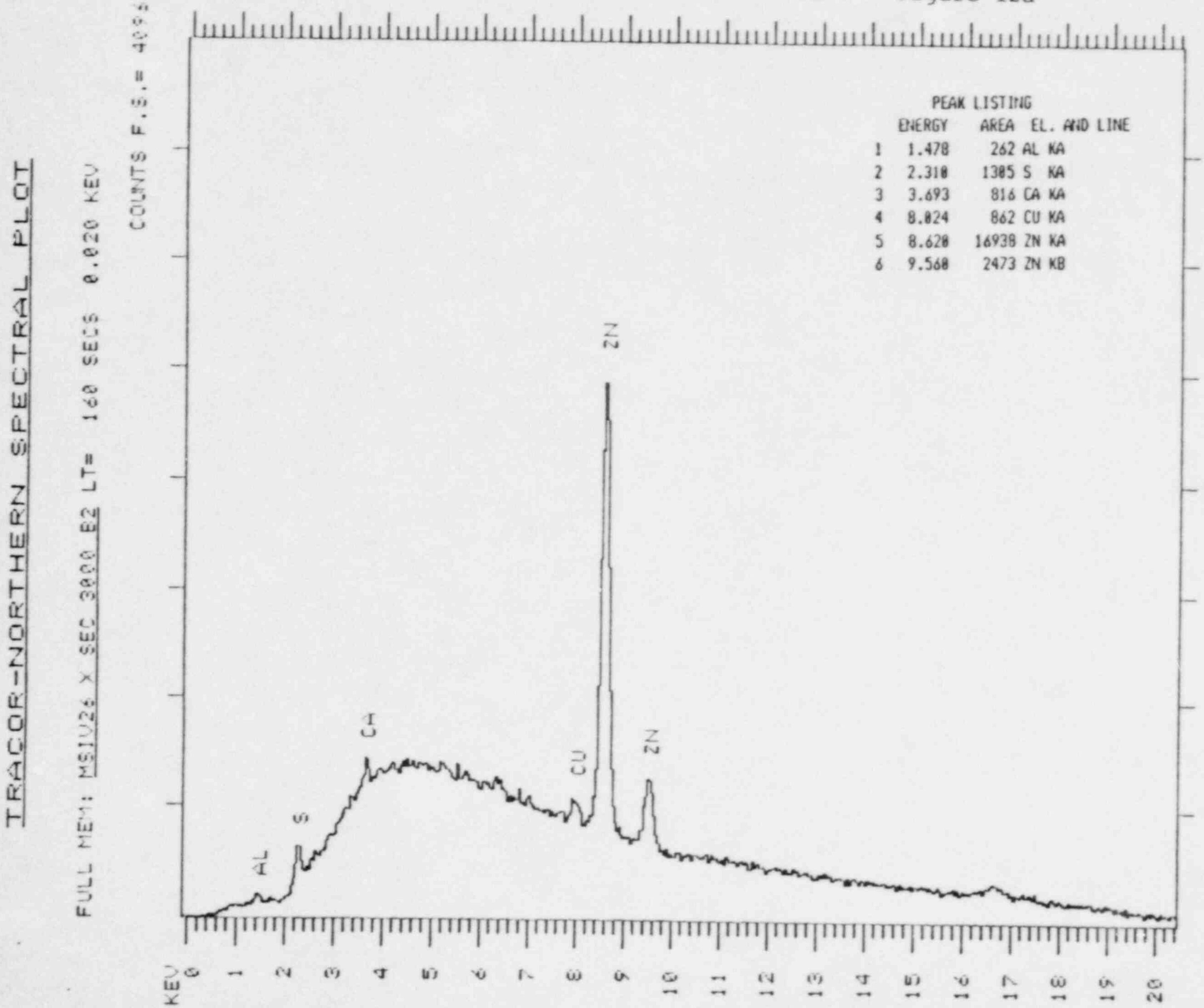


Plot 15 MSIV26
Energized Elastomer Seat
Cross-section - Not Failed
Area A - Figure 12a

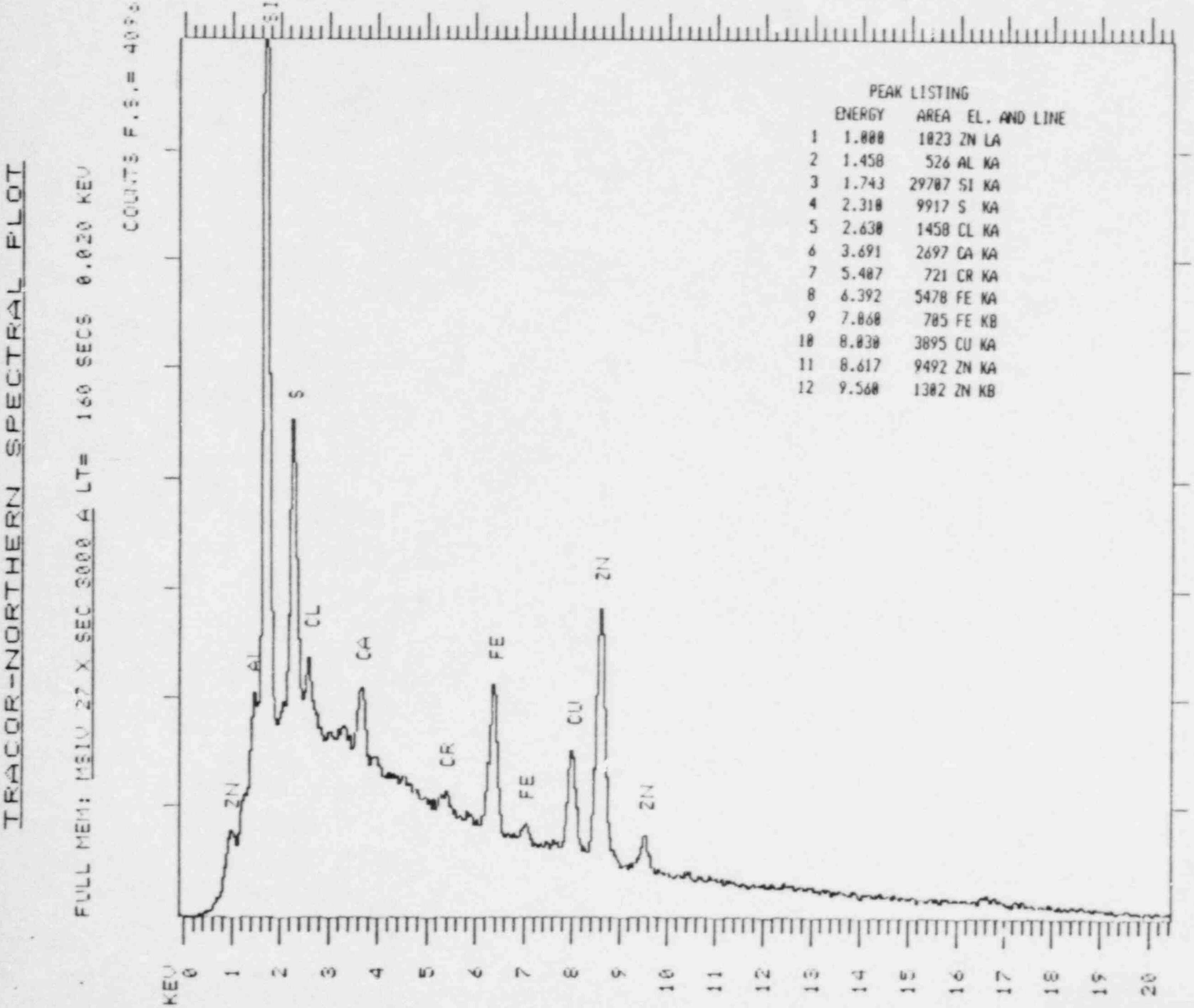


	ENERGY	AREA	EL. AND LINE
1	1.001	425	ZN LA
2	1.743	9956	SI KA
3	2.310	10685	S KA
4	2.651	1007	CL KA
5	3.667	932	CA KA
6	8.033	1052	CU KA
7	8.617	10540	ZN KA
8	9.553	1400	ZN KB

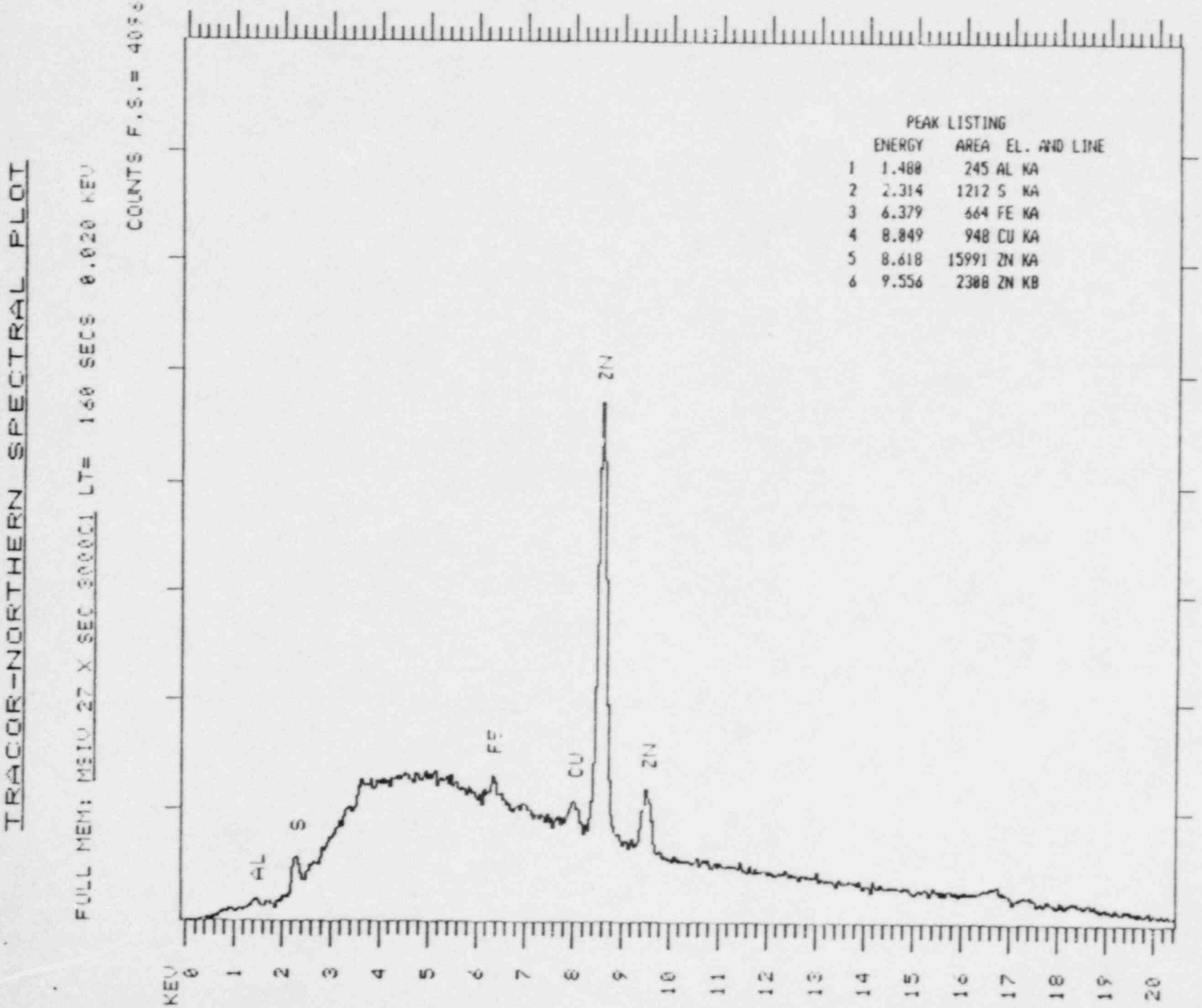
Plot 16 MSIV26
Energized Elastomer Seat
Cross-section - Not Failed
Area B - Figure 12a



Plot 17 MSIV27
Energized Elastomer Seat
Cross-section - Failed
Area A - Figure 14a



Plot 18 MSIV27
Energized Elastomer Seat
Cross-section - Failed
Area B - Figure 14a



APPENDIX I

Infrared Examinations of O-rings from MSIV Units

TO: John Grimm - CEI
FROM: J. M. Sanders
DATE: January 15, 1988

SUBJECT: **INFRARED EXAMINATIONS OF O-RINGS FROM MSIV UNITS**

INTRODUCTION

The purpose of this infrared study of the o-rings is to determine if this technique can detect possible chemical change in the o-ring material (EPDM) after usage. If such a change could be detected and identified, it is believed that the information would also apply to the valve seats since they are also composed of the same material and exposed to the same environment. Thus, it is feasible that an infrared study of the o-rings may lead to the cause of failure for some of the MSIV's in the fast close test.

EXPERIMENTAL

Infrared spectra were obtained with a Nicolet 7199 FT-IR spectrometer which was operated at a resolution of 4 cm^{-1}. A Barnes Model 300 ATR unit was used with both KRS-5 and germanium crystals. The angle of incidence was set to either 30° or 45°. The ATR is a surface technique with an average depth of penetration of approximately 10 µm. In an effort to obtain good quality spectra from the o-rings, some experimentation was necessary with some of the parameters used in the ATR technique. Infrared spectra were obtained from o-rings utilizing both germanium and KRS-5 crystals and for this work, the KRS-5 appeared to provide better results. Different angles (30 & 45°) of incidence were also used with the crystals but did not produce any significant difference in the results. The most important factors appeared to be the placement (position) of the o-ring segments on the crystals and the pressure used to hold them against the crystal. It was not possible to reproduce these parameters and repeats were made as necessary to obtain good spectra. Efforts were also made to grind a portion of the o-rings in order to utilize the KBr technique; however, the results from these efforts were questionable and it was abandoned.

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RESULTS

The first set (N-6968-74) of spectra represent those obtained during the experimental stage of this investigation. In general, these spectra, except the KBr ones, are of fairly good quality but do represent some effects from varying parameters as discussed above. For this reason, there may be some differences when comparing these spectra to similar ones acquired at a later period. However, such differences are not artifacts but result from the infrared beam "seeing" a somewhat different overall portion of the sample due to a second sampling and the inhomogeneity of the used o-ring.

A second set (N-6980-88) contains spectra from all the o-rings and was obtained under similar conditions. In comparing these spectra, the most significant observation seems to be the formation of two strong infrared bands near 1530 and 1425 cm^{-1}. This does not occur in all the spectra but is most apparent in the spectra from the MSIV22, 24, and 28 o-rings. These bands strongly suggest the presence of a carboxylic acid salt. The bands (1530 & 1425 cm^{-1}) are very characteristic of carboxylic acid salts and their positions are fairly constant regardless of the type of salt (i.e., Na, Ca, Mg, Zn, etc.) The most likely possibility would be zinc stearate since both zinc oxide and stearic acid are used in many EPDM formulations. In addition, many of the spectra show evidence for the presence of silicone oil (lubricant) on the o-rings by showing infrared bands at 1252, 1025, and 800 cm^{-1}. The following list provides a summary of the information obtained from the spectra of the o-rings.

O-ring	Spectra	Comments
MSIV22	N-6982	Alkyl acid salt, silicone oil
MSIV24	N-6986	Alkyl acid salt, silicone oil
MSIV25	N-6981	Alkyl acid salt, silicone oil
MSIV26	N-6980	Spectrum fairly similar to control
MSIV27	N-6987	Spectrum fairly similar to control
MSIV28	N-6988	Alkyl acid salt, silicone oil

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Although the alkyl acid salt and silicone oil were not detected on some rings, this does not indicate that these materials are absent in these cases but that they were not detected on the particular examination represented by the spectrum. However, it is fair to assume in such cases that, if present, the materials would likely be at a low level compared to the ones which showed strong evidence for the presence of the acid salt and silicone oil.

In addition to the o-rings, some of the black material from the area where the o-ring had contacted the valve body was removed from MSIV20 & 21 for infrared examination. This material was ground and the KBr technique was used to obtain spectra (N-6999 & N-7000). These spectra were very similar and like some of the above, strongly suggest the presence of an alkyl acid salt and silicone oil.

CONCLUSIONS

The infrared examinations suggest that none of the o-rings have undergone severe oxidation since none of the spectra show the presence of a strong carbonyl band. However, as indicated previously, many of the infrared spectra do show the presence of carboxylate bands. Such bands could possibly result from oxidation but, in these cases, are strongly believed to be due to the presence of a compound formed in the EPDM formulation. Many EPDM formulations contain ZnO and stearic acid which react to form zinc stearate during the cure of the rubber. The zinc stearate can and is known to migrate to the surface ('bloom') of EPDM rubbers and this process would be accelerated with the addition of heat. As a result, it seems very likely and highly probable that the alkyl acid salt on the surface of some of the o-rings originated from the EPDM. It was not possible to perform an infrared examination of the valve seats because of their small size and unique shape. However, it seems reasonable to assume that some of the valve seats also have an alkyl acid salt on their surfaces since they are also composed of EPDM and are also in close proximity to the o-rings. If this is the case, the following rationalization may explain the cause or reason why some of the values failed the fast close test. The presence of an alkyl acid salt such as copper stearate or zinc stearate on the surface of the valve seat could act as a glue if the

Received

temperature of the valve exceeded $\sim 260^{\circ}F$. The reason for this is that copper and zinc stearates have melting points of $257^{\circ}F$ and $266^{\circ}F$, respectively. Thus, at these temperatures, the alkyl acid salt would liquefy and could 'wet' the brass outlet port seat in contact with EPDM. If the temperature elevation was an isolated event, the alkyl acid salt would solidify on cooling and could act as a glue to retard or prohibit the opening of the valves. While it's not possible to prove this theory, it could be tested by ensuring that the valves never exceeded a temperature of $\sim 240^{\circ}C$.

John M. Sanders

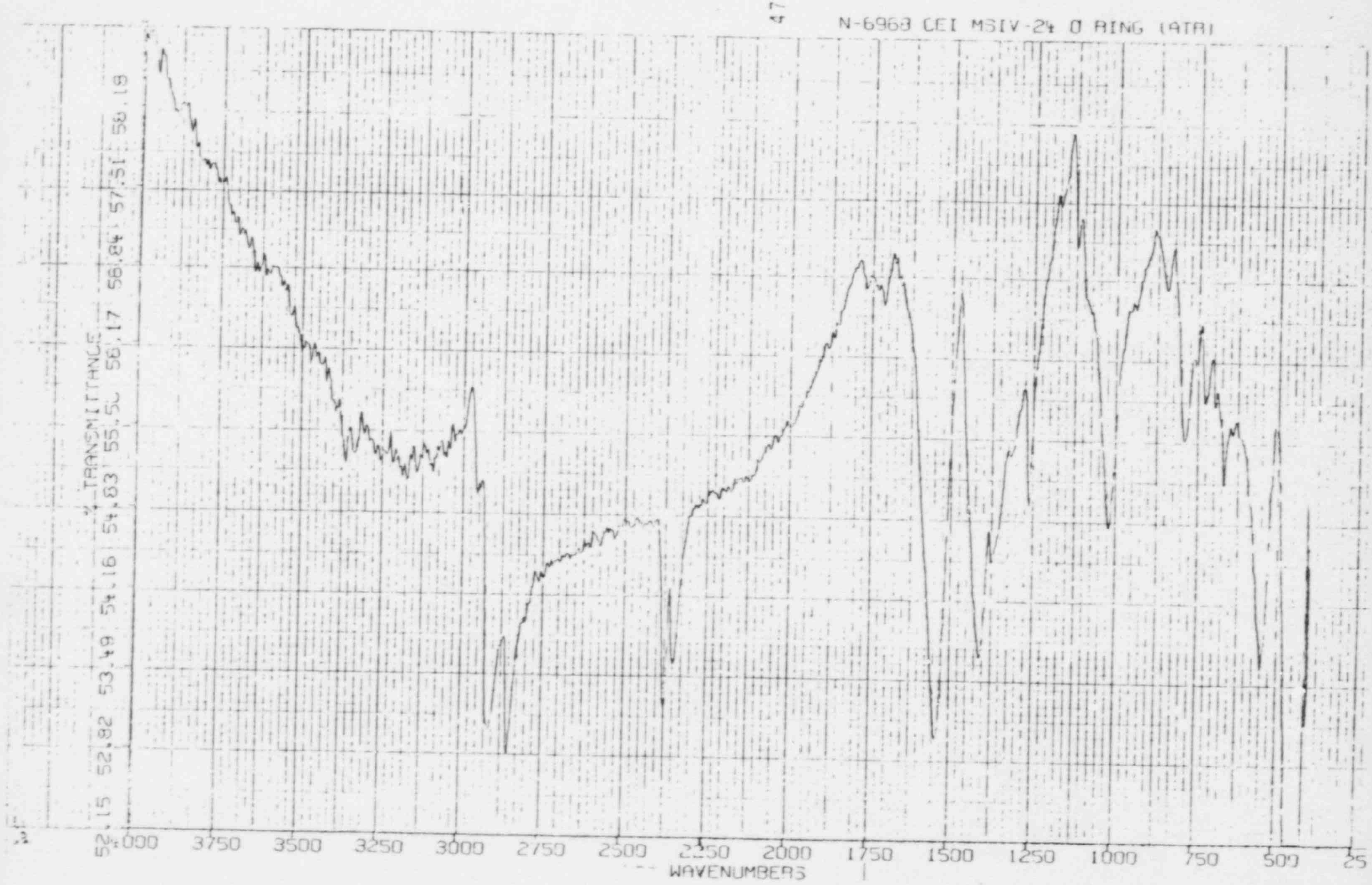
John M. Sanders

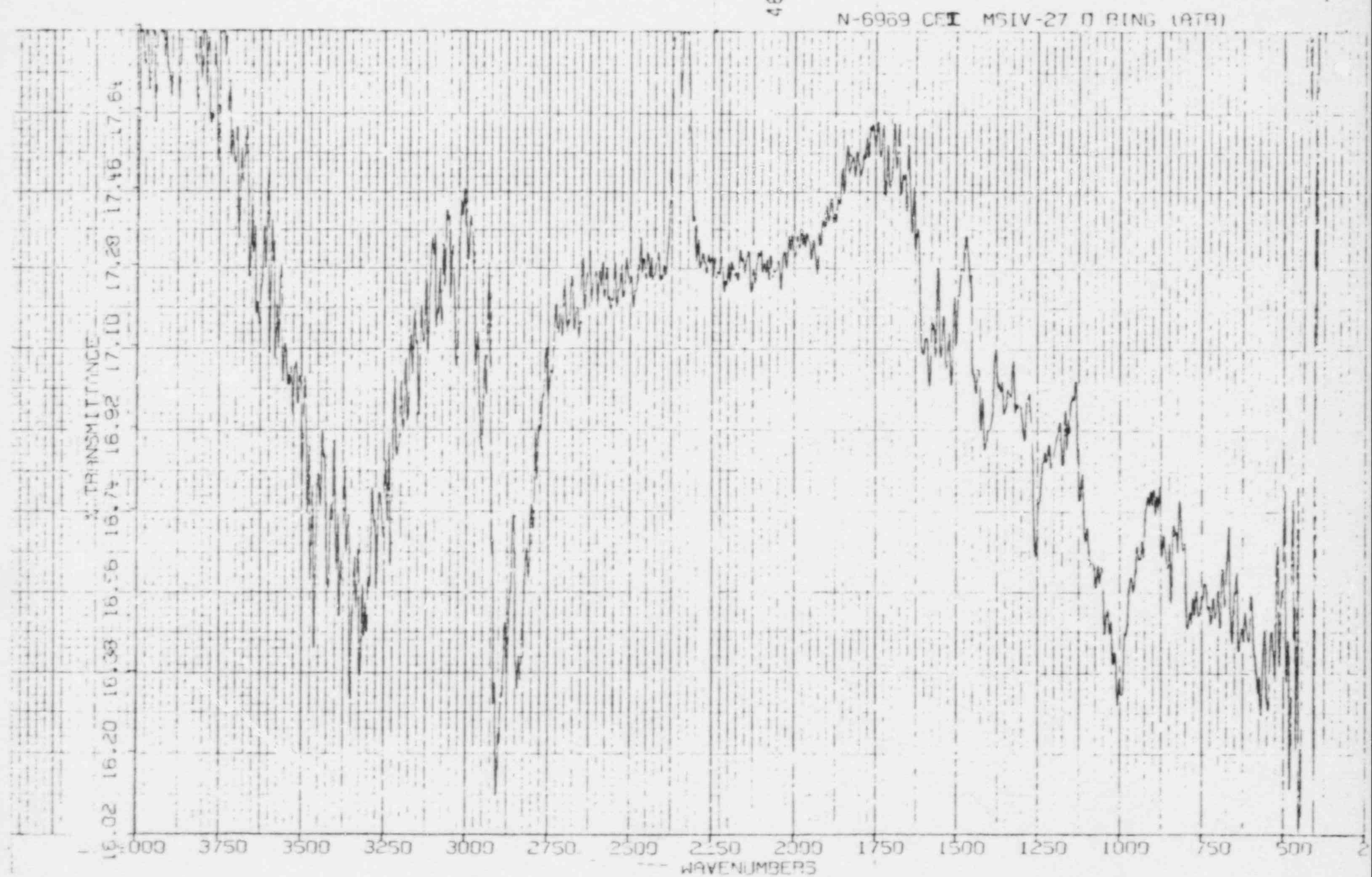
jsb

F!

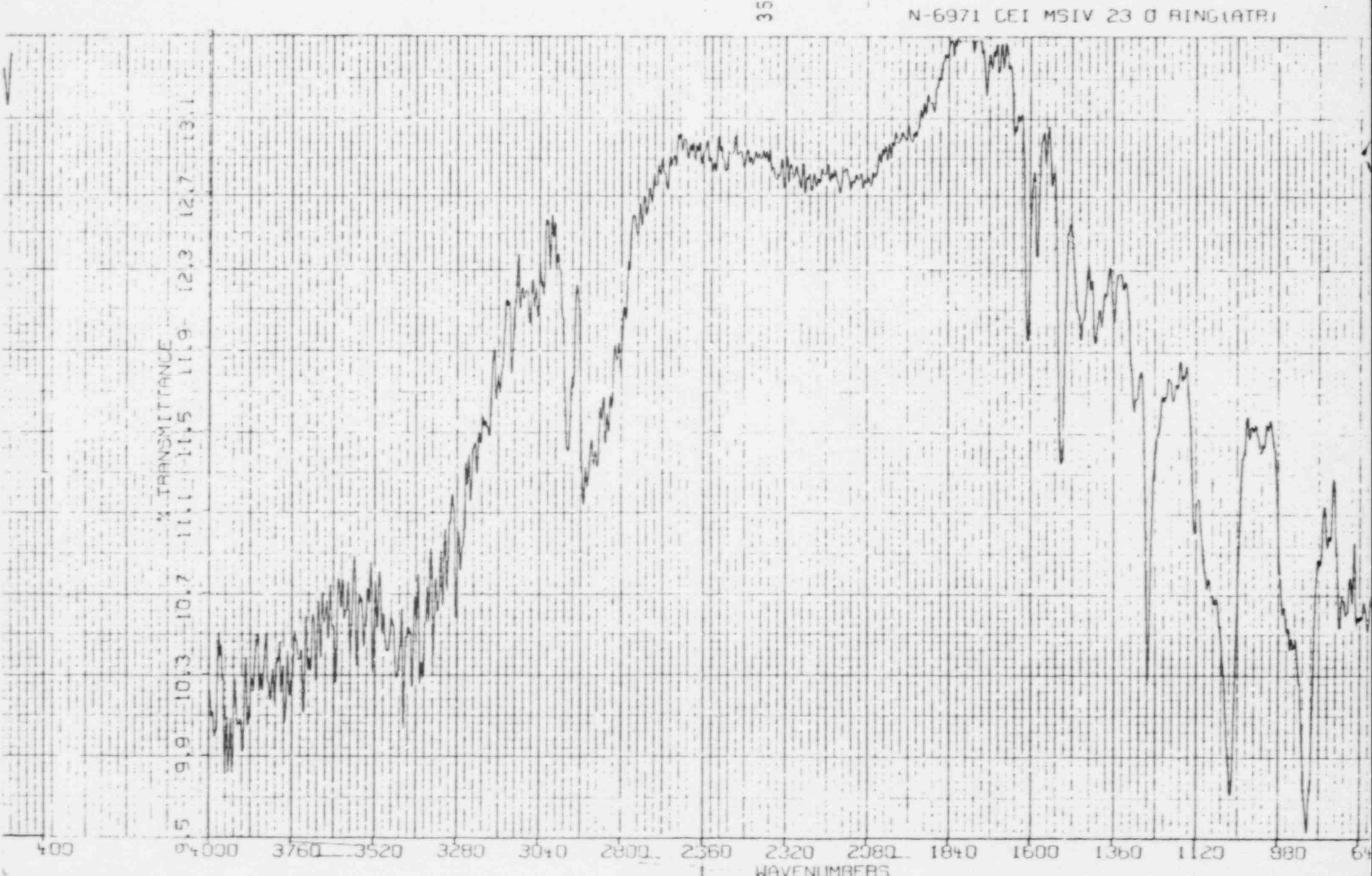
Notebook Ref.: 20353-8,9,12
File No's.: 8702086, 8702087
8702088, 8702089
8702091, 8702092
8702093, 8702094
8702095

Reviewed By: W R Bumstead


47
N-6968 CEI MSIV-24 O RING (ATR)
% TRANSMITTANCE
52.15 52.82 53.49 54.16 54.83 55.50 56.17 56.84 57.51 58.18
4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 500 25
WAVENUMBERS


N-6969 CEI MSIV-27 O RING (ATR)
% TRANSMITTANCE
16.02 16.20 16.38 16.56 16.74 16.92 17.10 17.28 17.46 17.64
4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 500
WAVENUMBERS

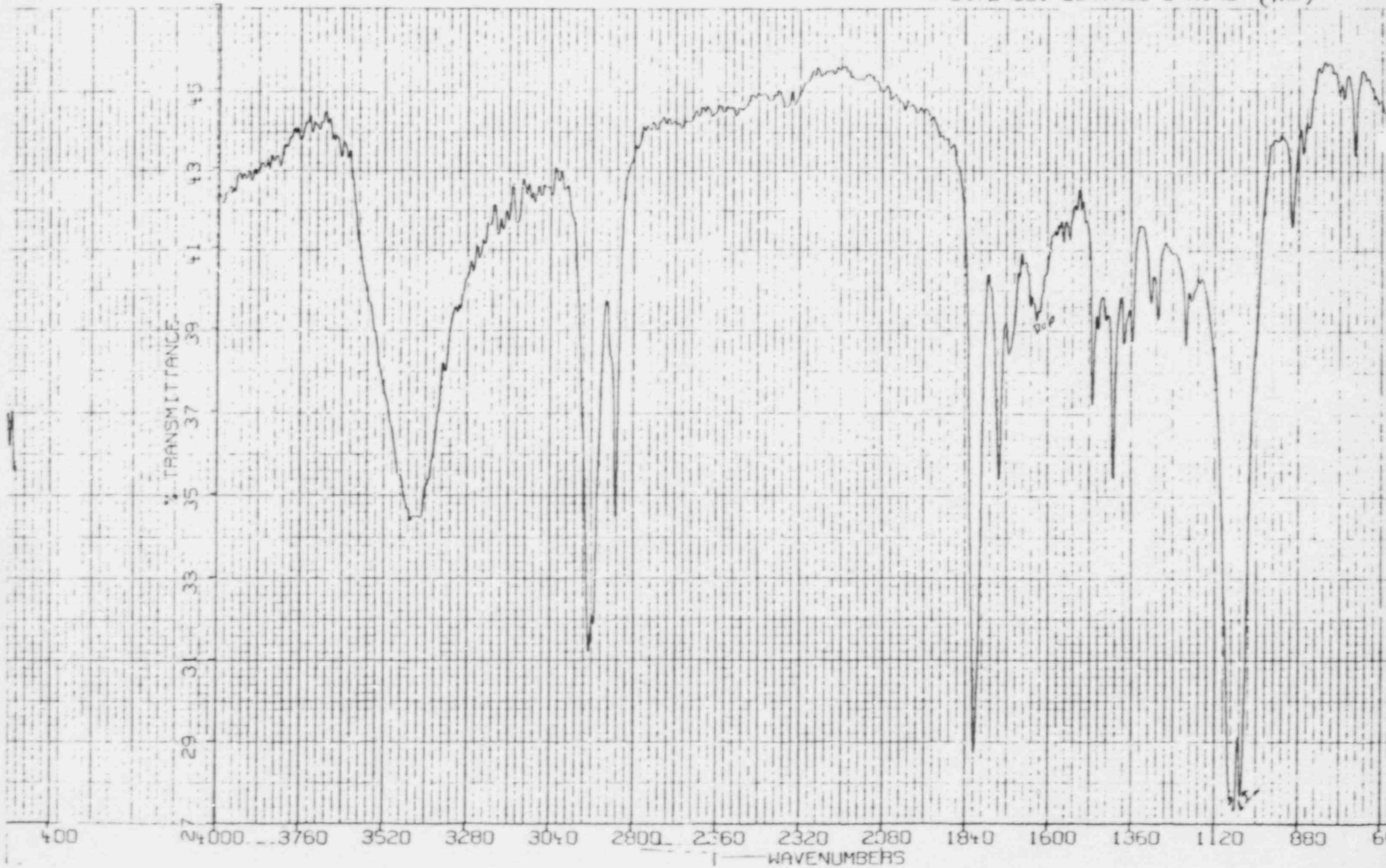
35

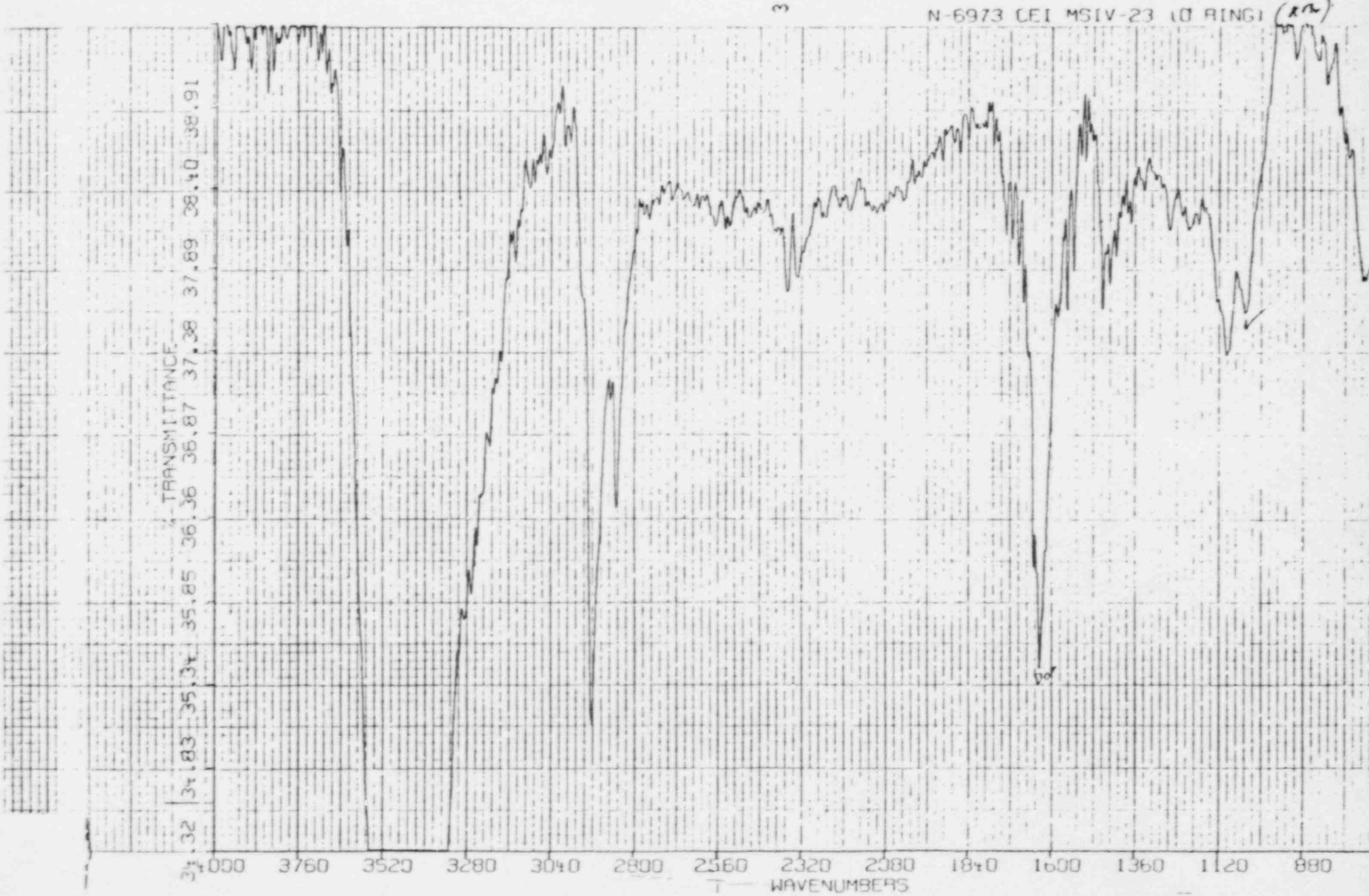


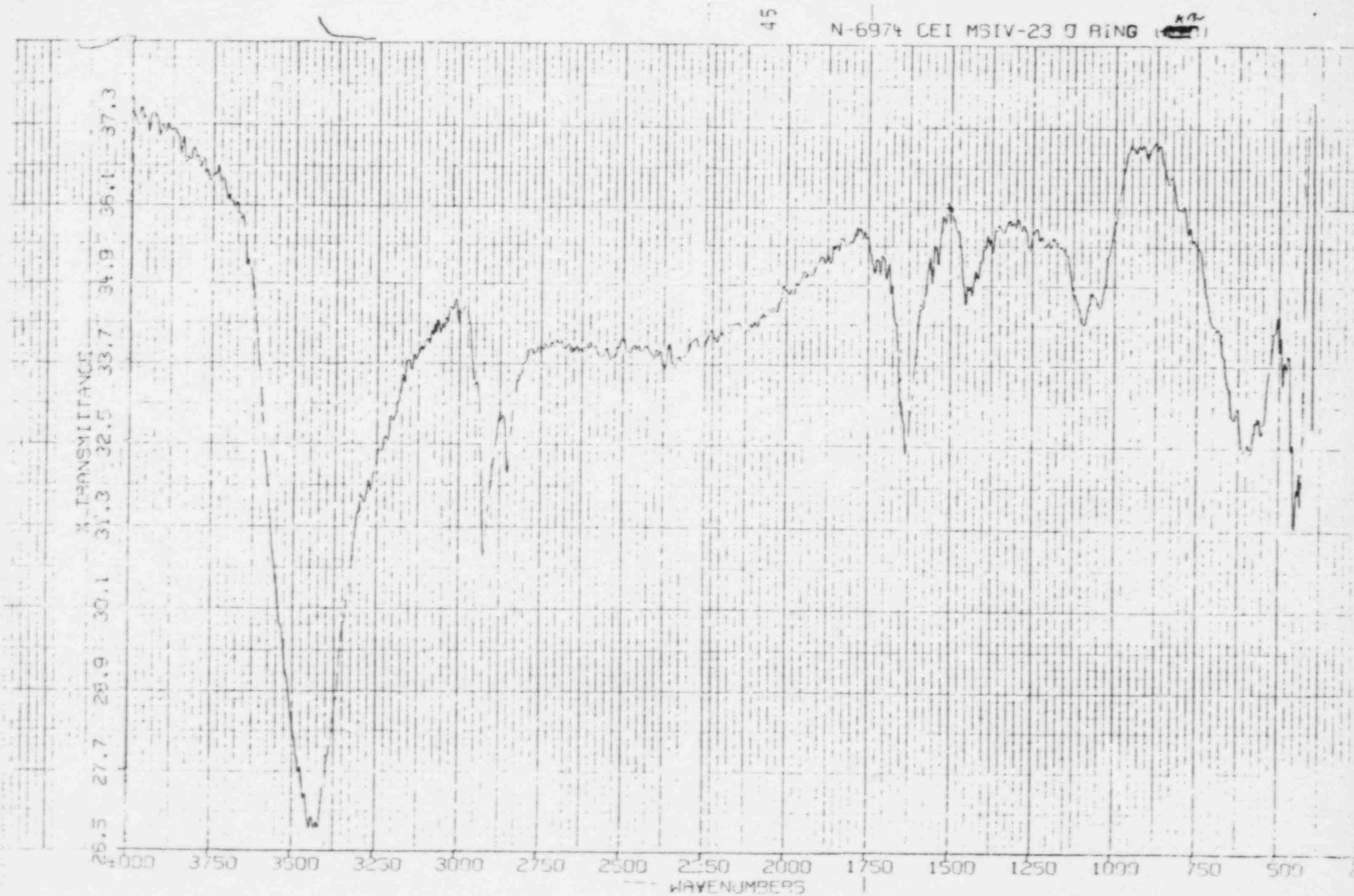
N-6971 CEI MSIV 23 O RING(ATR)
% TRANSMITTANCE
9.5
9.9
10.3
10.7
11.1
11.5
11.9
12.3
12.7
13.1
400
4000
3760
3520
3280
3040
2800
2560
2320
2080
1840
1600
1360
1120
880
WAVENUMBERS

36

N-6972 LEI CONTROL O RING (KBr)



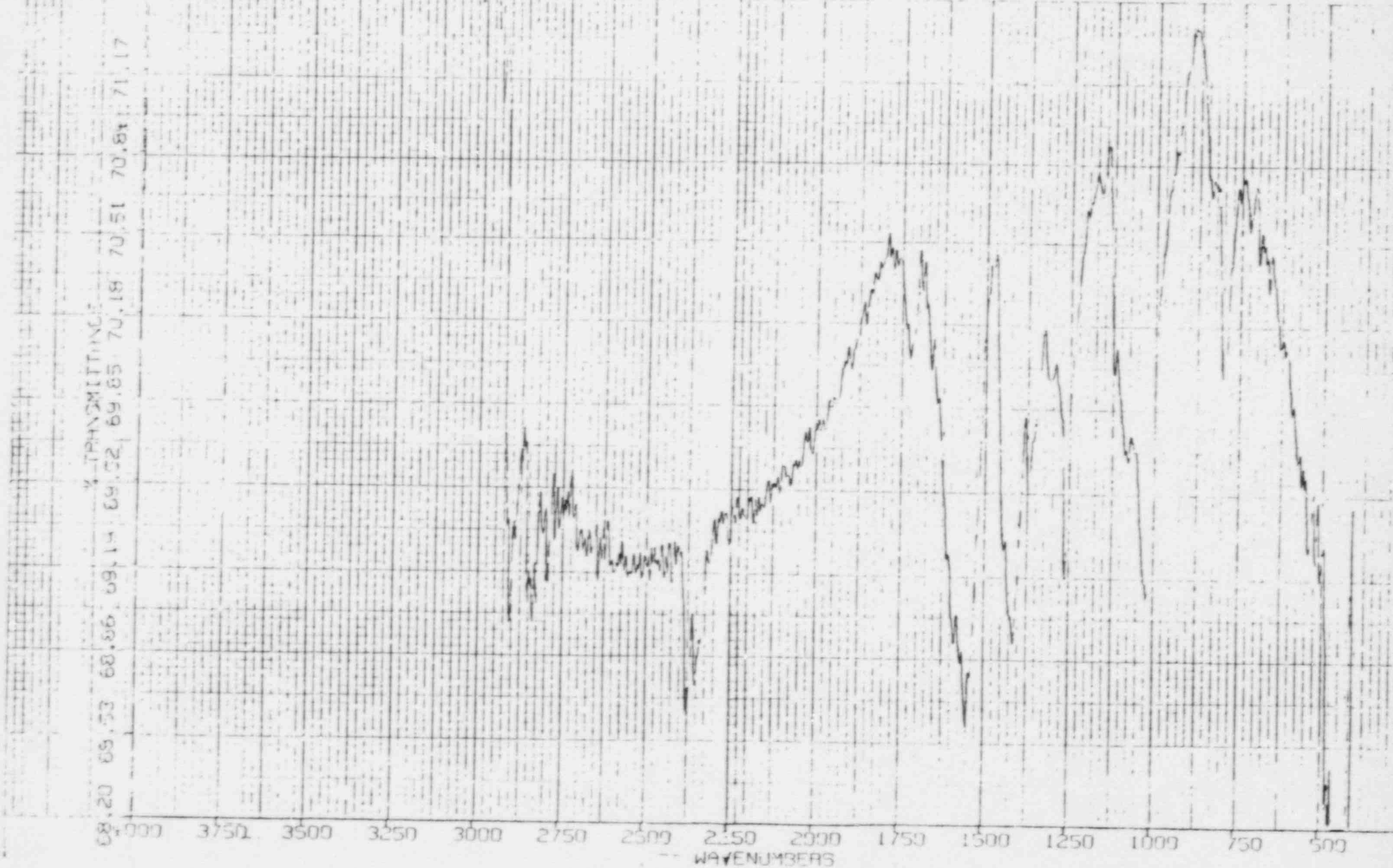

N-6973 CEI MSIV-23 (O RING) (IR)
% TRANSMITTANCE
34.32 34.83 35.34 35.85 36.36 36.87 37.38 37.89 38.40 38.91
4000 3760 3520 3280 3040 2800 2560 2320 2080 1840 1600 1360 1120 880
WAVENUMBERS

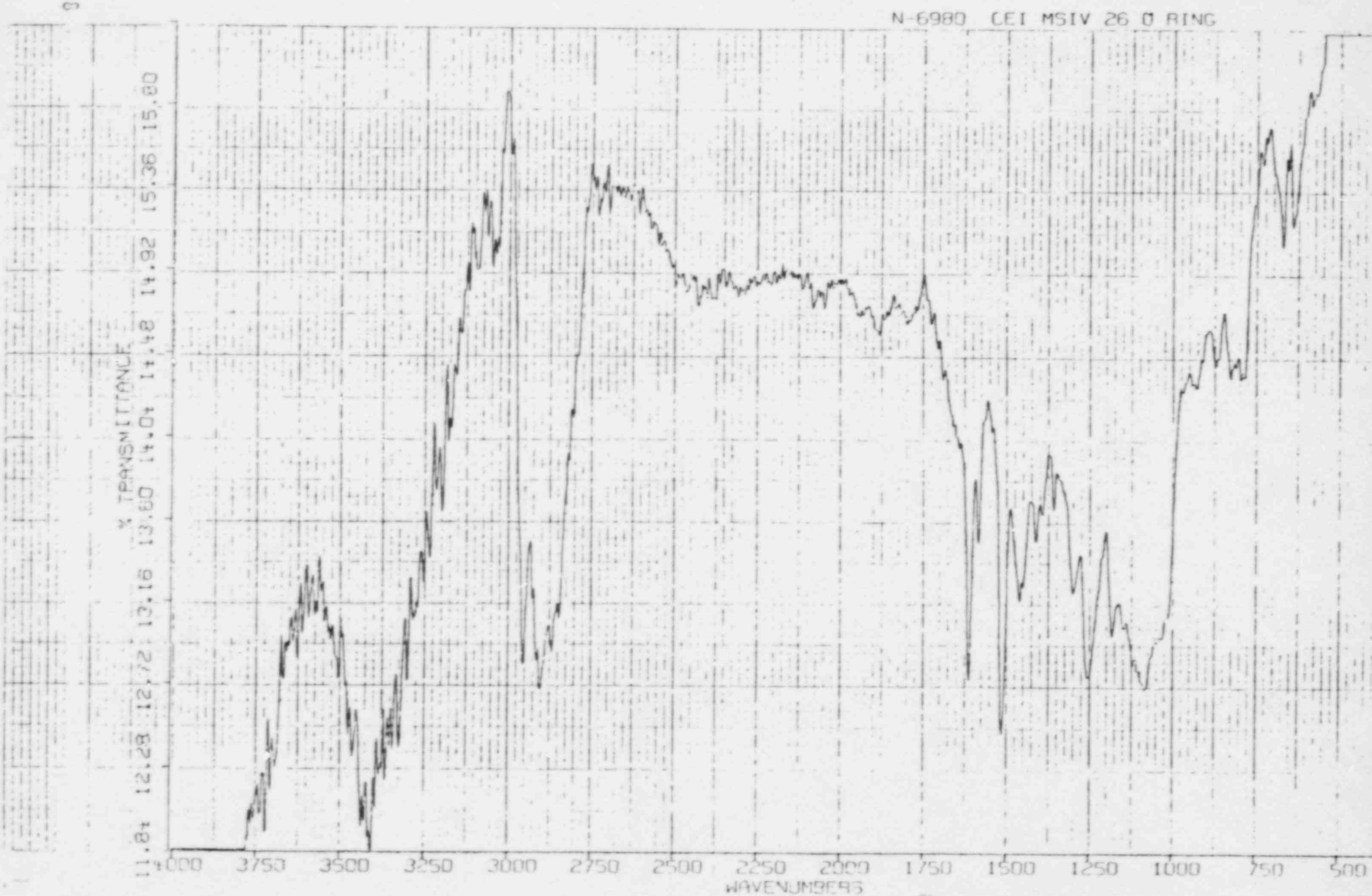


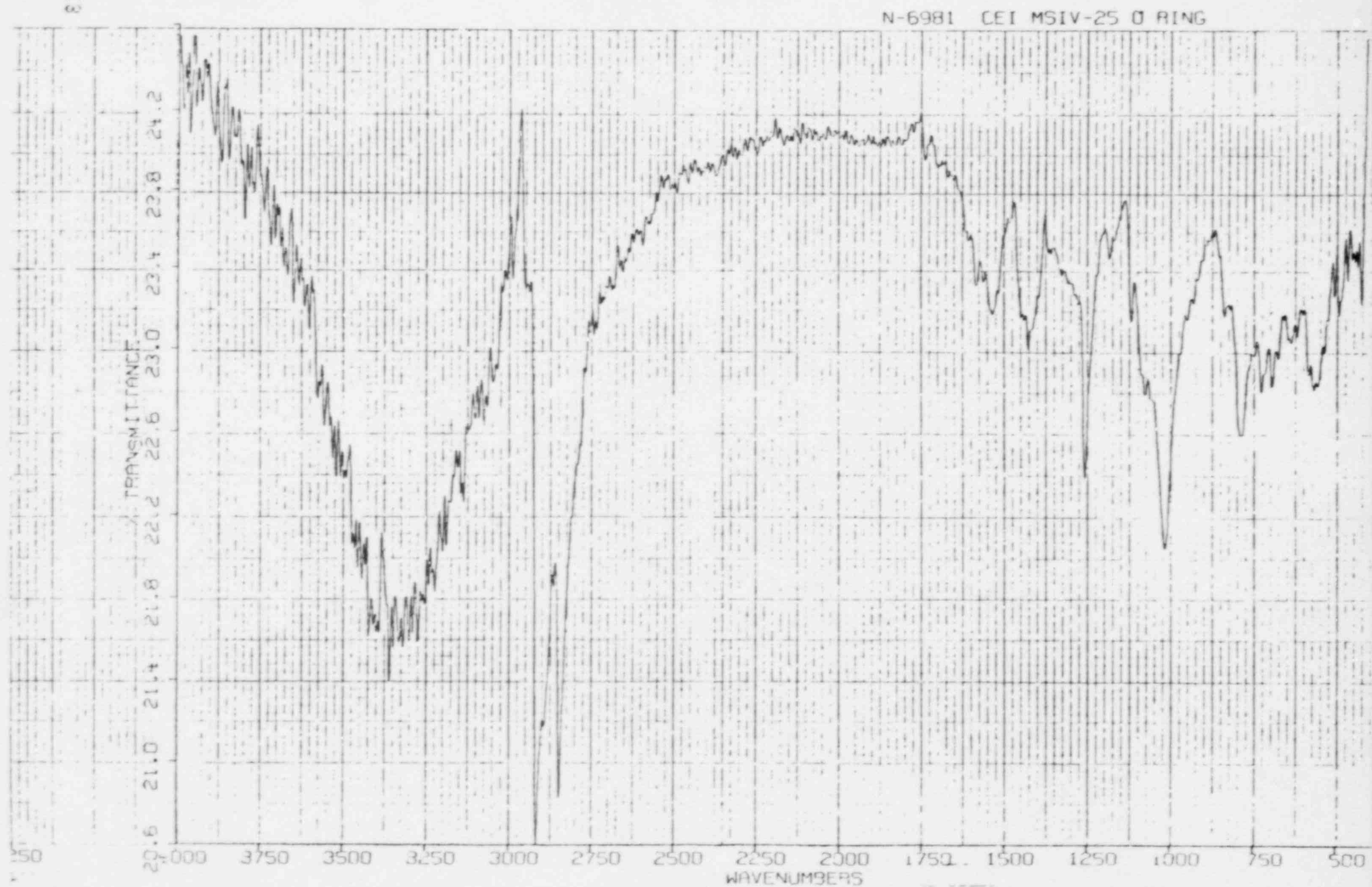
45
N-6974 CEI MSIV-23 O RING
% TRANSMITTANCE
37.3
36.1
34.9
33.7
32.5
31.3
30.1
28.9
27.7
26.5
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
WAVENUMBERS

44

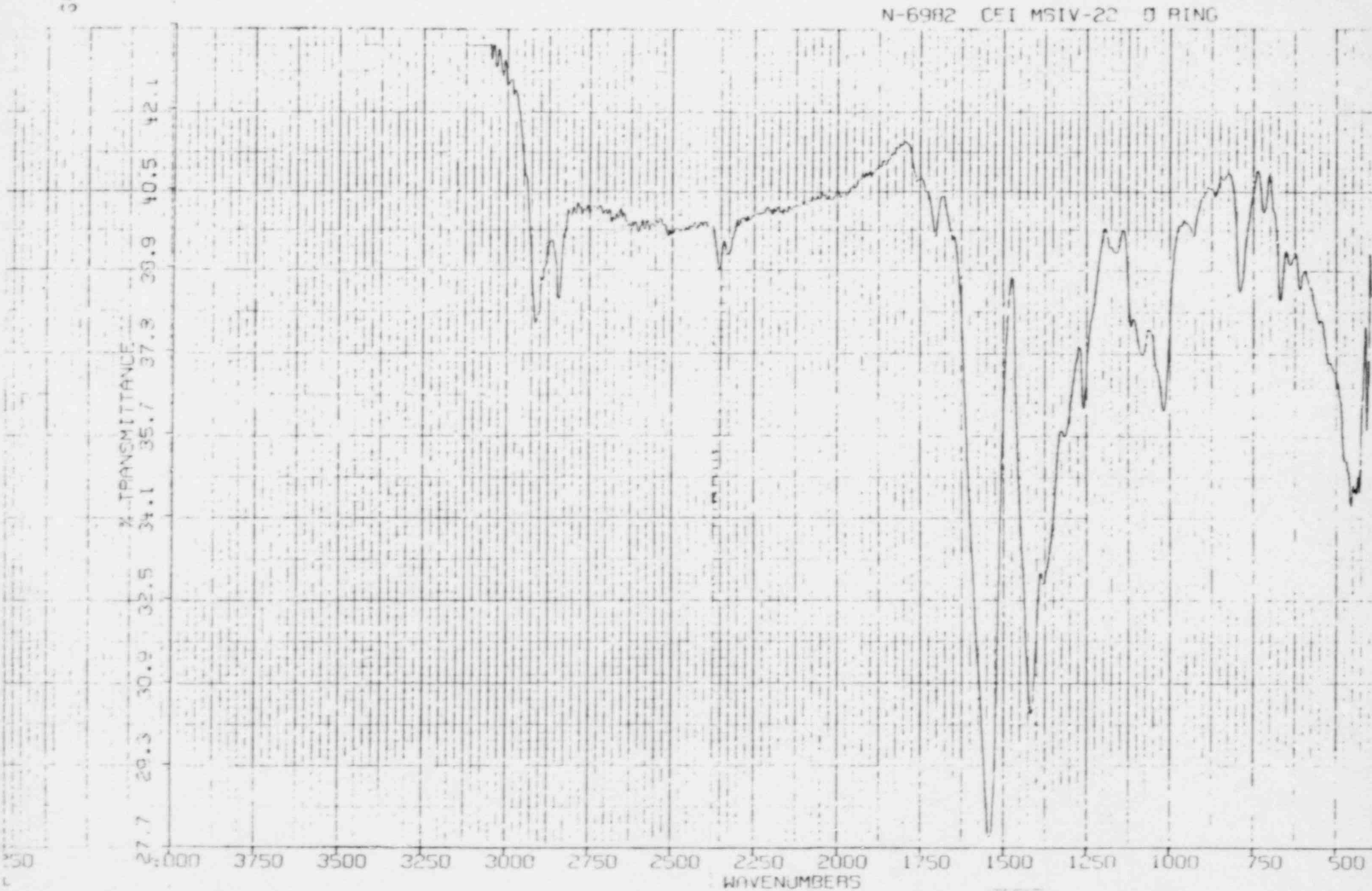
N-6375 CEI MSIV-28 O RING (ATP)



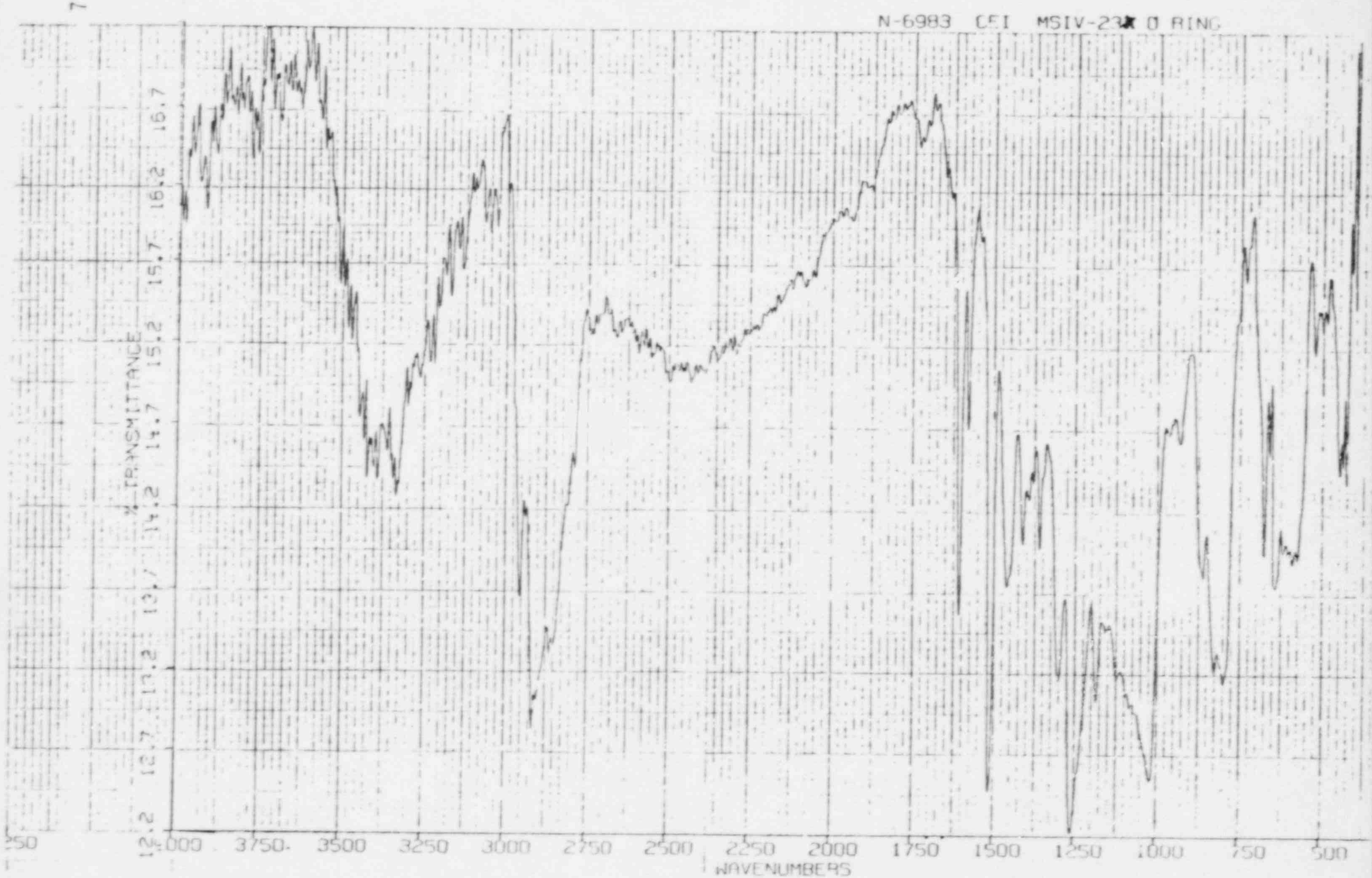

N-6980 CEI MSIV 26 O RING
% TRANSMITTANCE
11.84 12.28 12.72 13.16 13.60 14.04 14.48 14.92 15.36 15.80
4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 500
WAVENUMBERS



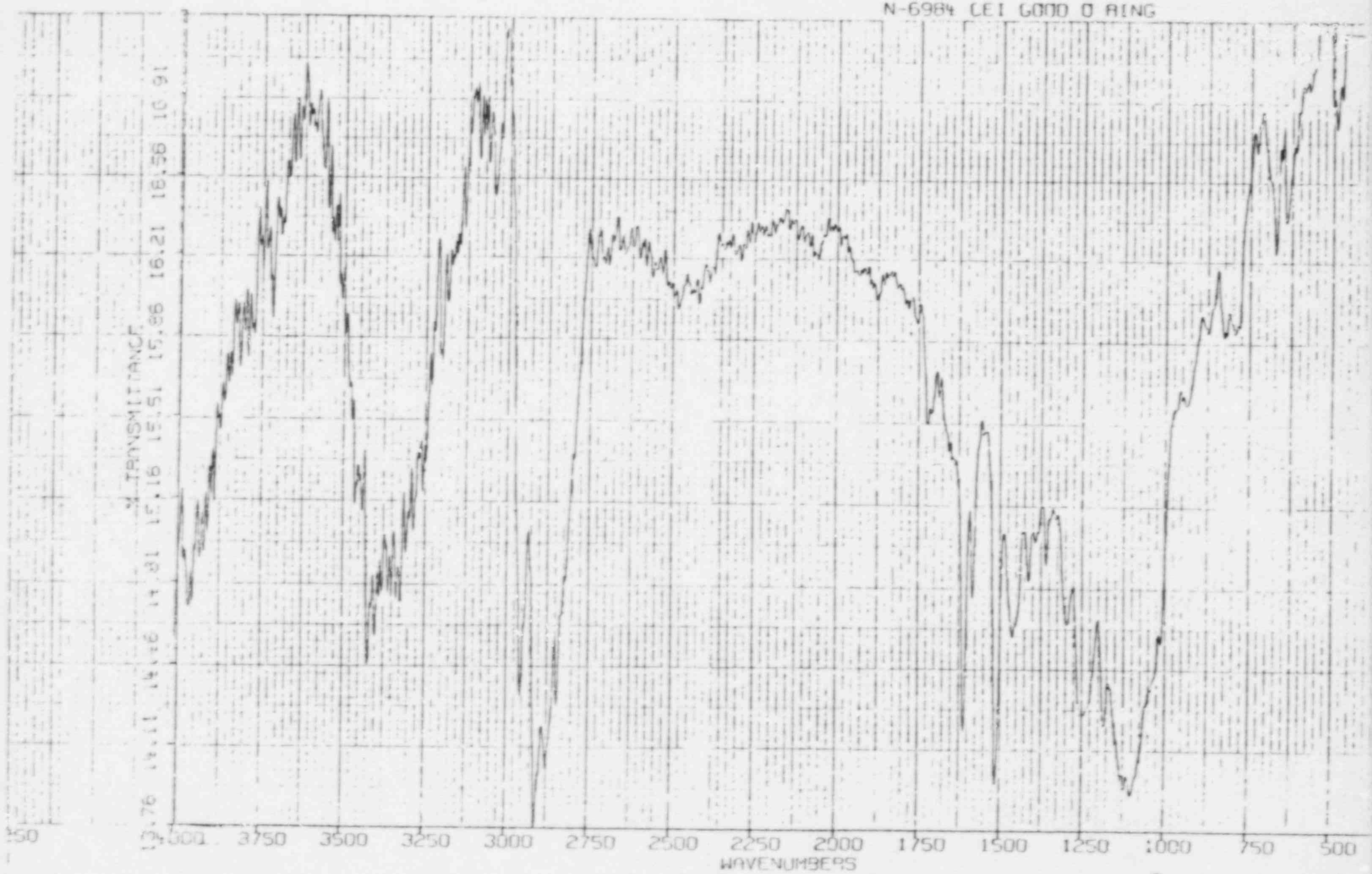
N-6981 CEI MSIV-25 O RING
% TRANSMITTANCE
24.2
23.8
23.4
23.0
22.6
22.2
21.8
21.4
21.0
20.6
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
WAVENUMBERS

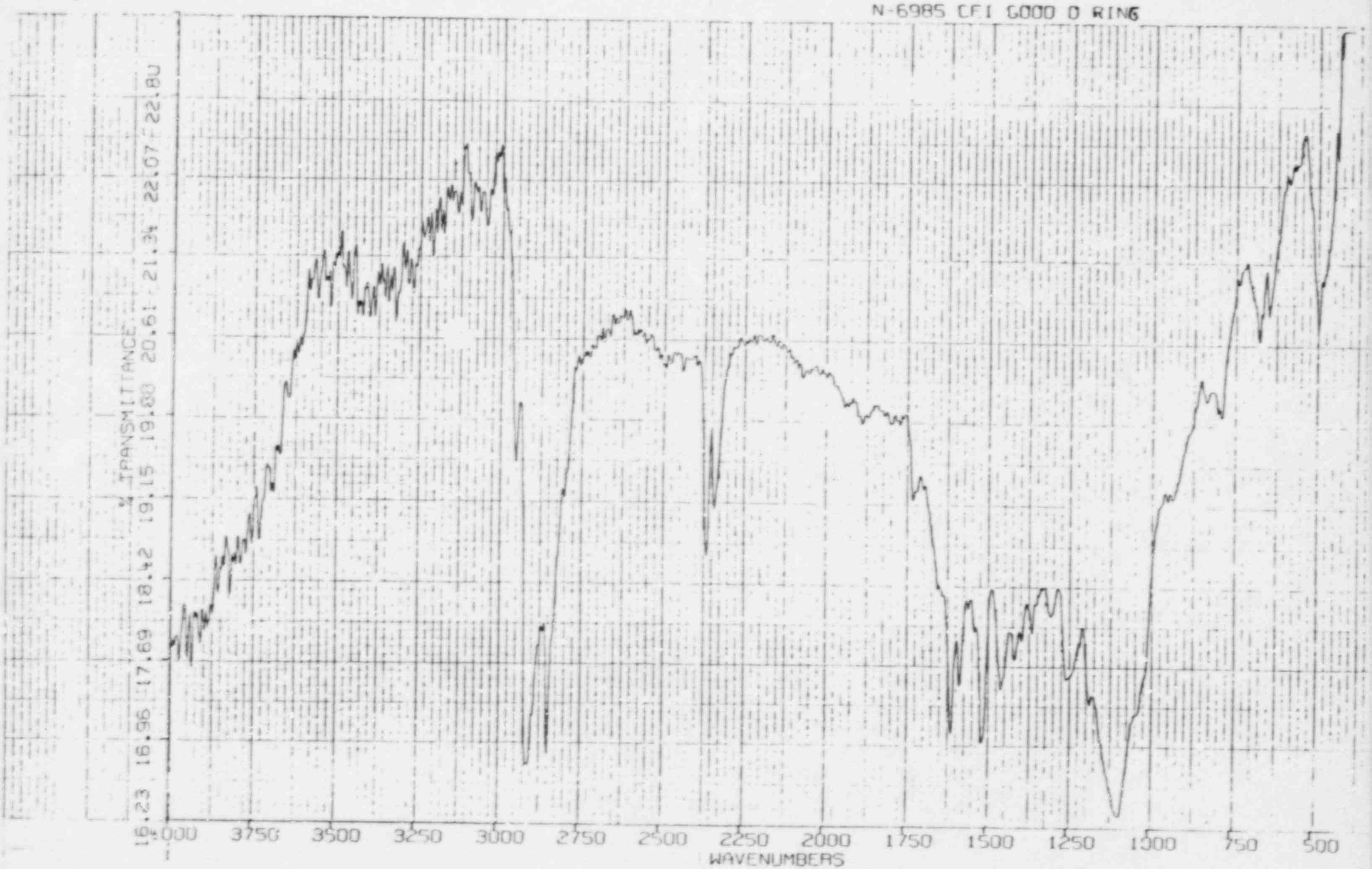


N-6982 CEI MSIV-22 O RING
% TRANSMITTANCE
27.7
29.3
30.9
32.5
34.1
35.7
37.3
38.9
40.5
42.1
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
WAVENUMBERS

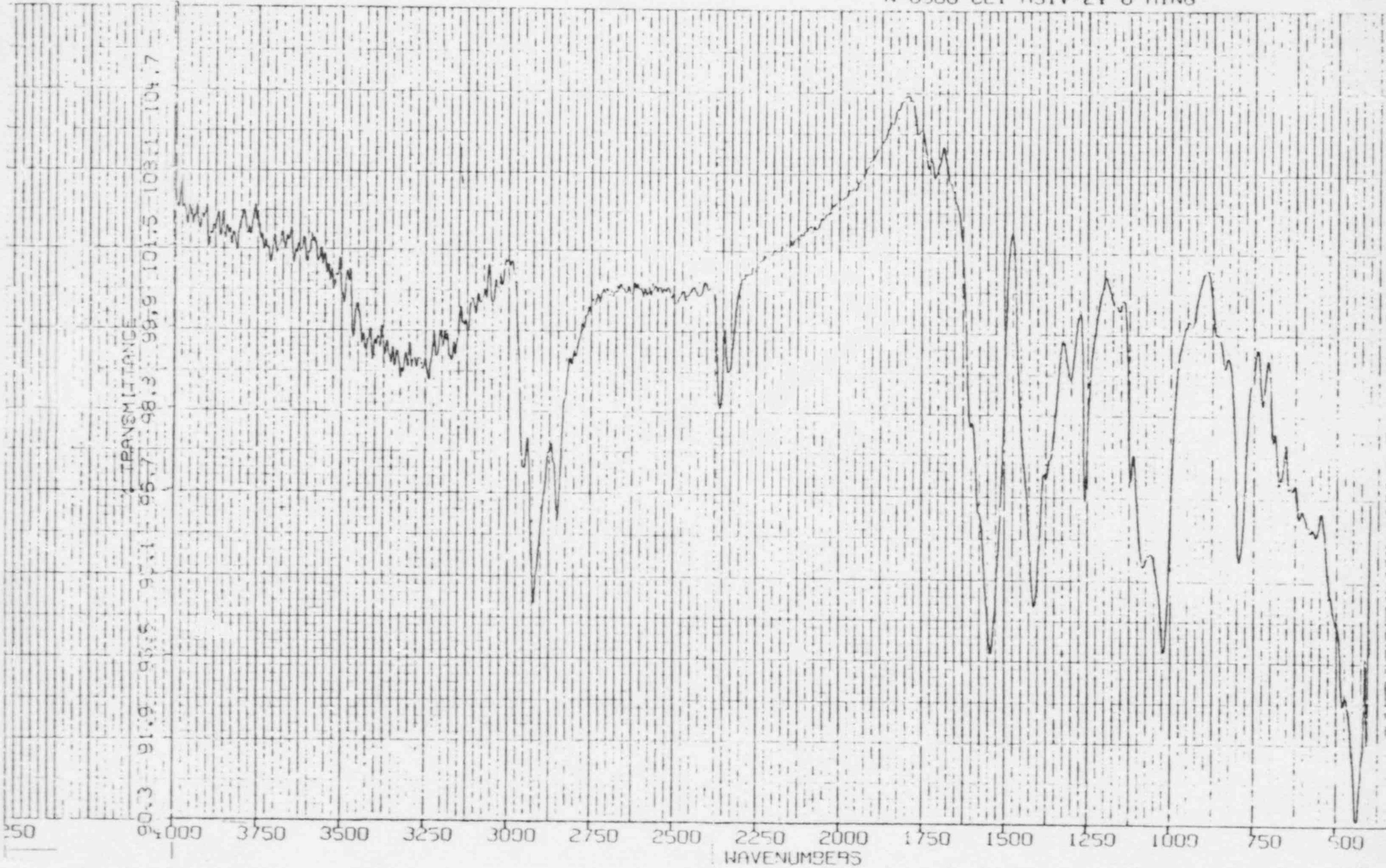

N-6983 CEI MSIV-23X O RING
% TRANSMITTANCE
16.7
16.2
15.7
15.2
14.7
14.2
13.7
13.2
12.7
12.2
250
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
WAVENUMBERS

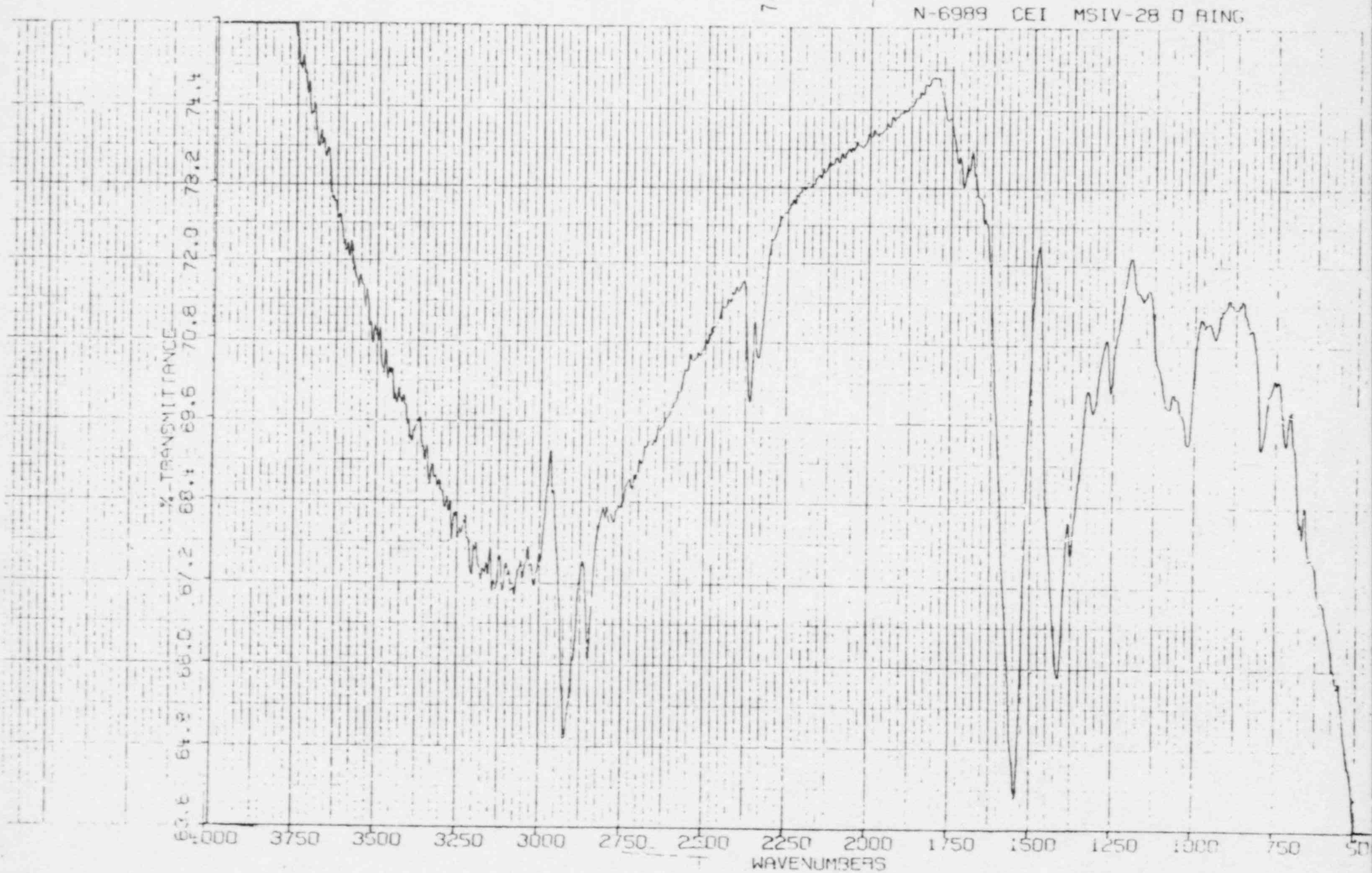
N-6984 CEI GOOD O RING

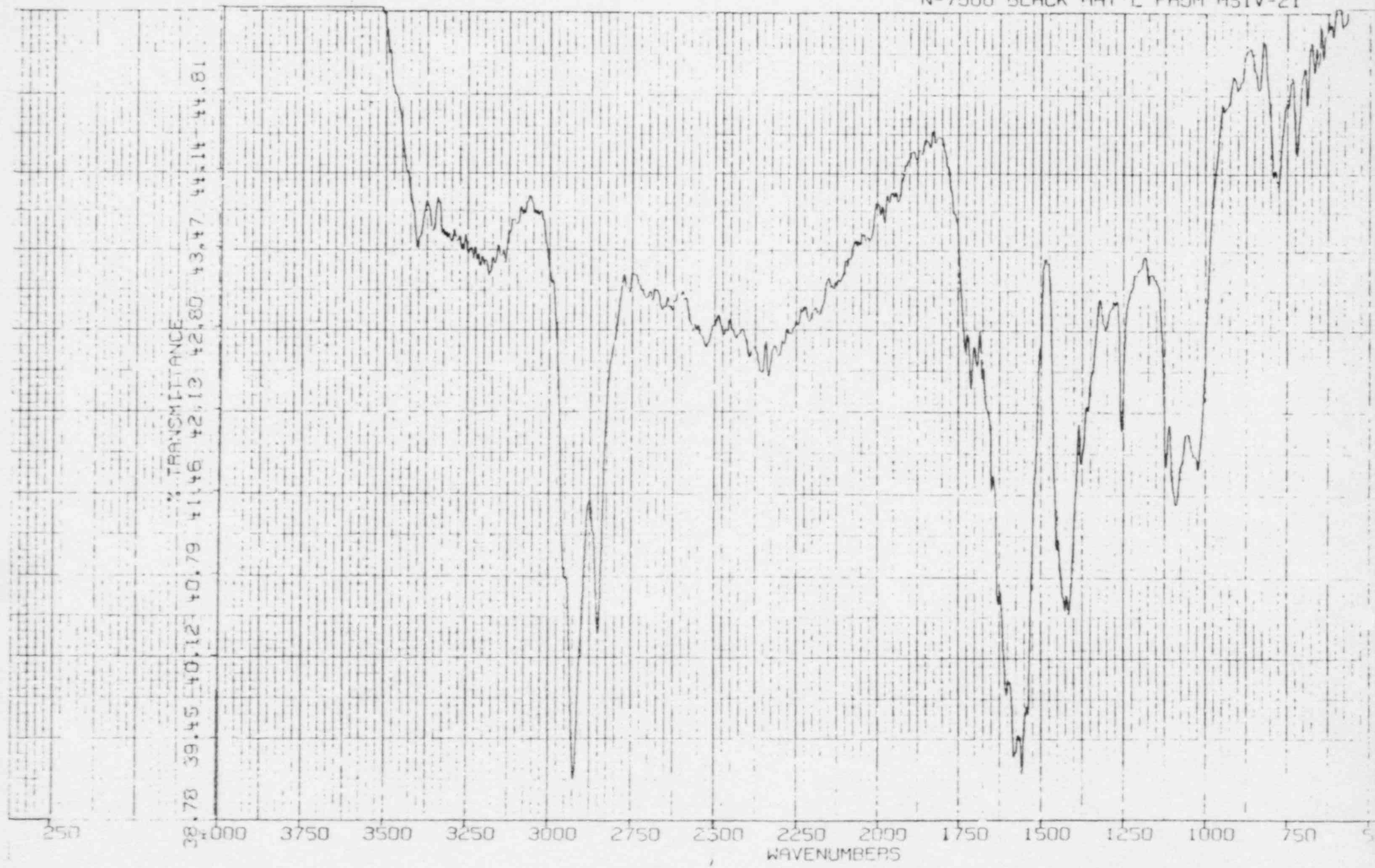


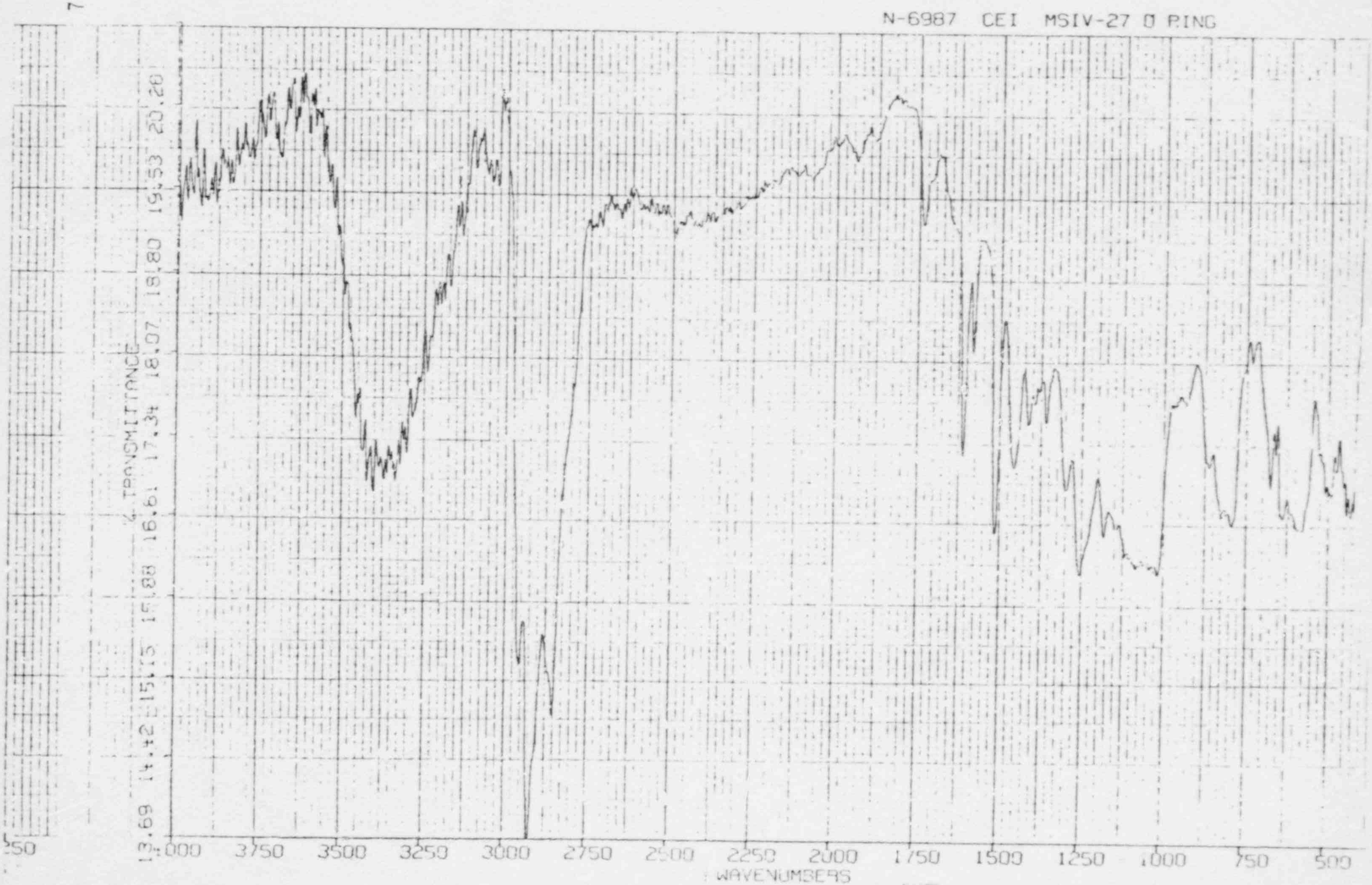

N-6985 CFI GOOD O RING
% TRANSMITTANCE
16.23
16.96
17.69
18.42
19.15
19.88
20.61
21.34
22.07
22.80
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
WAVENUMBERS

N-6986 CEI MSIV-24 O RING

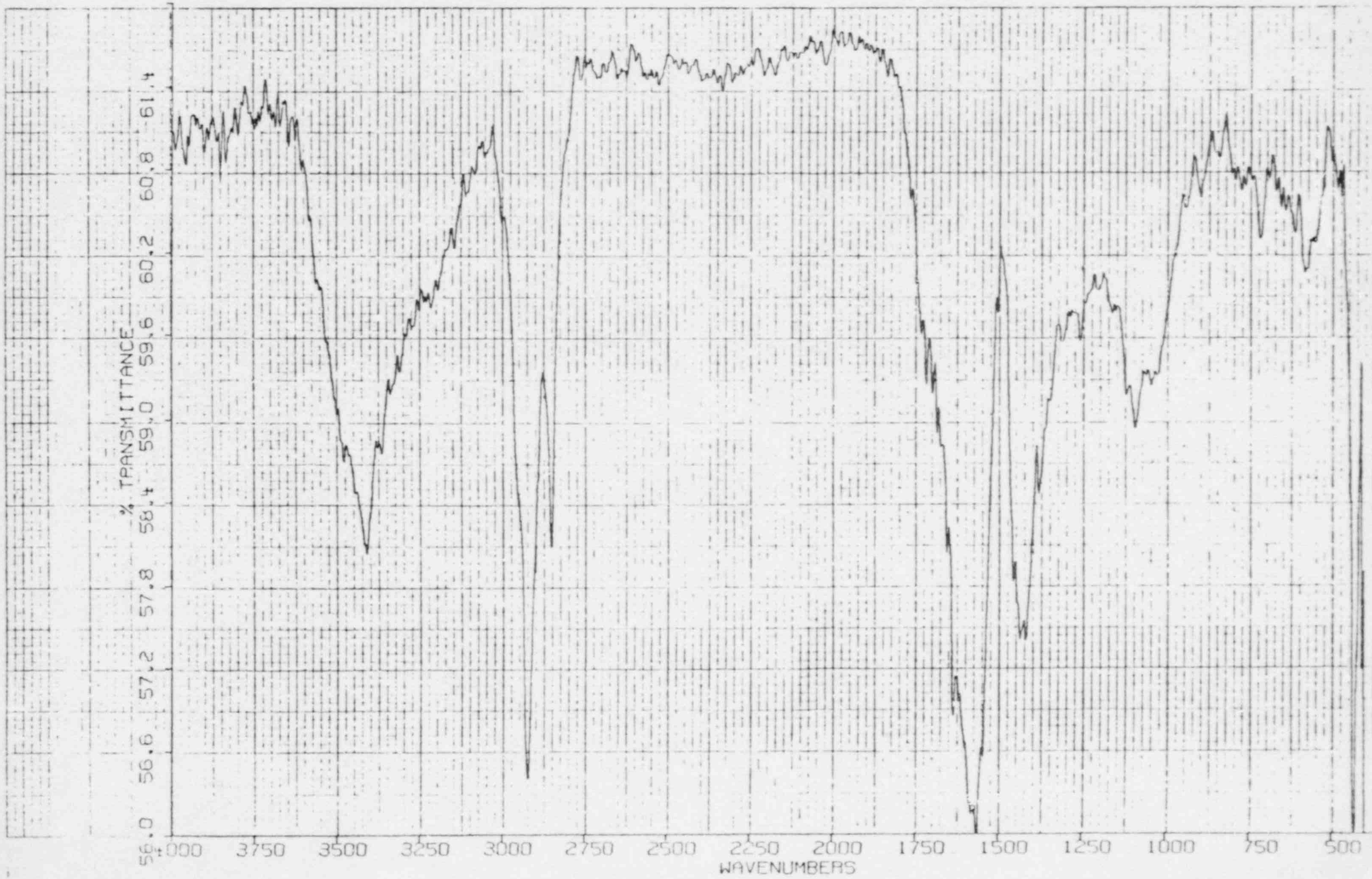



74
N-6989 CEI MSIV-28 O RING
%-TRANSMITTANCE
63.6
64.8
66.0
67.2
68.4
69.6
70.8
72.0
73.2
74.4
4000
3750
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
WAVENUMBERS


N-7000 BLACK MAT'L FROM MSIV-21
% TRANSMITTANCE
38.78 39.45 40.12 40.79 41.46 42.13 42.80 43.47 44.14 44.81
4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 250
WAVENUMBERS


N-6987 CEI MSIV-27 O RING
% TRANSMITTANCE
13.69 14.42 15.15 15.88 16.61 17.34 18.07 18.80 19.53 20.26
4000 3750 3500 3250 3000 2750 2500 2250 2000 1750 1500 1250 1000 750 500
WAVENUMBERS

N-6999 BLACK MAT'L FROM MSIV-20



APPENDIX J

Thermal Examinations of O-rings from Control MSIV Units

TO: John Grimm - CEI
FROM: J. M. Sanders
DATE: January 15, 1988

SUBJECT: **THERMAL EXAMINATIONS OF O-RINGS FROM CONTROL MSIV UNITS**

INTRODUCTION

The thermal characteristics of virgin (control) o-rings were investigated by DSC and TGA techniques. The purpose of these investigations was to determine the thermal stability of the o-rings. Such information should be useful as a guideline for plant operation and/or maintenance. The effect of copper on the thermal stability of the o-rings was also investigated because they are in contact with a brass valve body and other reports[1] had indicated a deleterious effect on the o-rings due to copper.

EXPERIMENTAL

A Perkin Elmer TGS-2 thermogravimetric system was used for weight loss experiments. A scan rate of 10°C/min. was used and segments of the o-rings were placed in a platinum pan. A Perkin Elmer DSC-2 differential scanning calorimeter was used to detect the occurrence of oxidation. This instrument detects the evolution or absorption of heat from a sample as it is heated over a given temperature range. A thermal change such as oxidation would be indicated by an exothermic peak in the thermogram. To determine the effects of copper on the thermal stability, chips of copper metal were intimately mixed with o-ring segments. For both the TGS and DSC experiments, the samples were maintained in an air atmosphere. Graphite sample holders were used for the DSC experiments.

[1] Brunswick Plant - Metallurgy Unit File, MSL 10-155.

7528 Auburn Road • Box 1000 • Painesville, Ohio 44077
216/357-3300

Ricerca

RESULTS

The TGS examination of the o-rings showed that a weight loss degradation started to occur around 300°C (572°F). This experiment suggested (extrapolation) that, with a scan rate of 10°C/min., a 10% weight loss could be expected at a temperature of 360°C (680°F). No significant change could be detected in the onset of weight loss degradation with the addition of copper metal to the o-ring segments.

DSC experiments failed to show any evidence for oxidation of the o-ring over a temperature range of 50-200°C (392°F). This was also the case when copper (metal chips) were added and mixed with the o-ring segments. These DSC experiments were terminated at 390°F because this temperature exceeded any expected for the valve body. However, in order to determine at what temperature oxidation would occur, a DSC experiment was performed to a temperature of 300°C (572°F). This experiment indicated that oxidation would occur near 270°C (518°F).

CONCLUSIONS

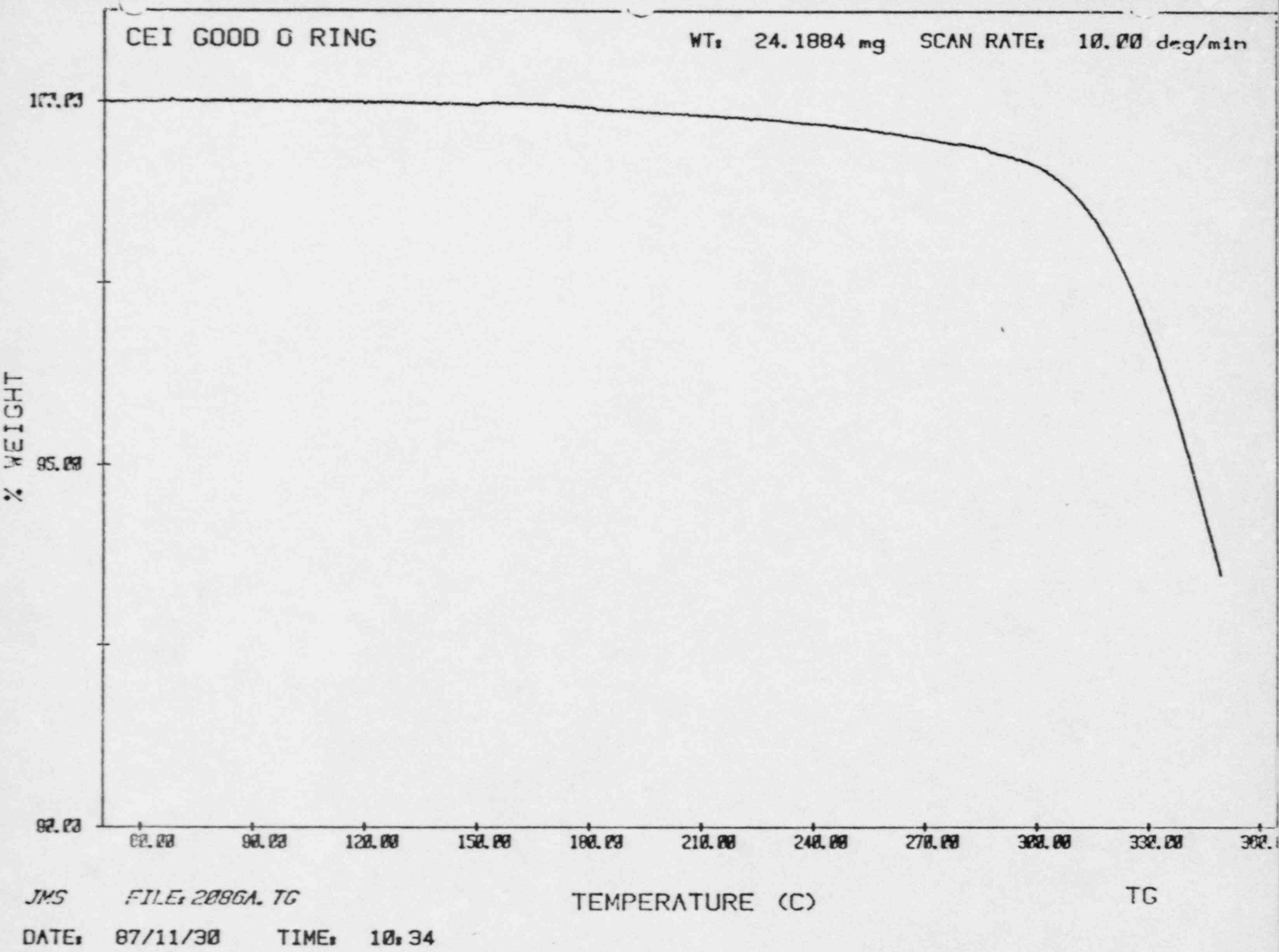
The results from this study suggest that the o-rings have good thermal stability up to a temperature of nearly 270°C (518°F). This stability appears to be unaffected by the presence of metallic copper. However, the tests were dynamic in that temperature increases of either 10° to 20°C/min. were used. Hence, the tests are accelerated ones and would provide little information on the long-term stability of the o-rings at lower temperatures. If such information is needed, additional tests would be needed or possibly could be obtained from the manufacturer.

John M. Sanders

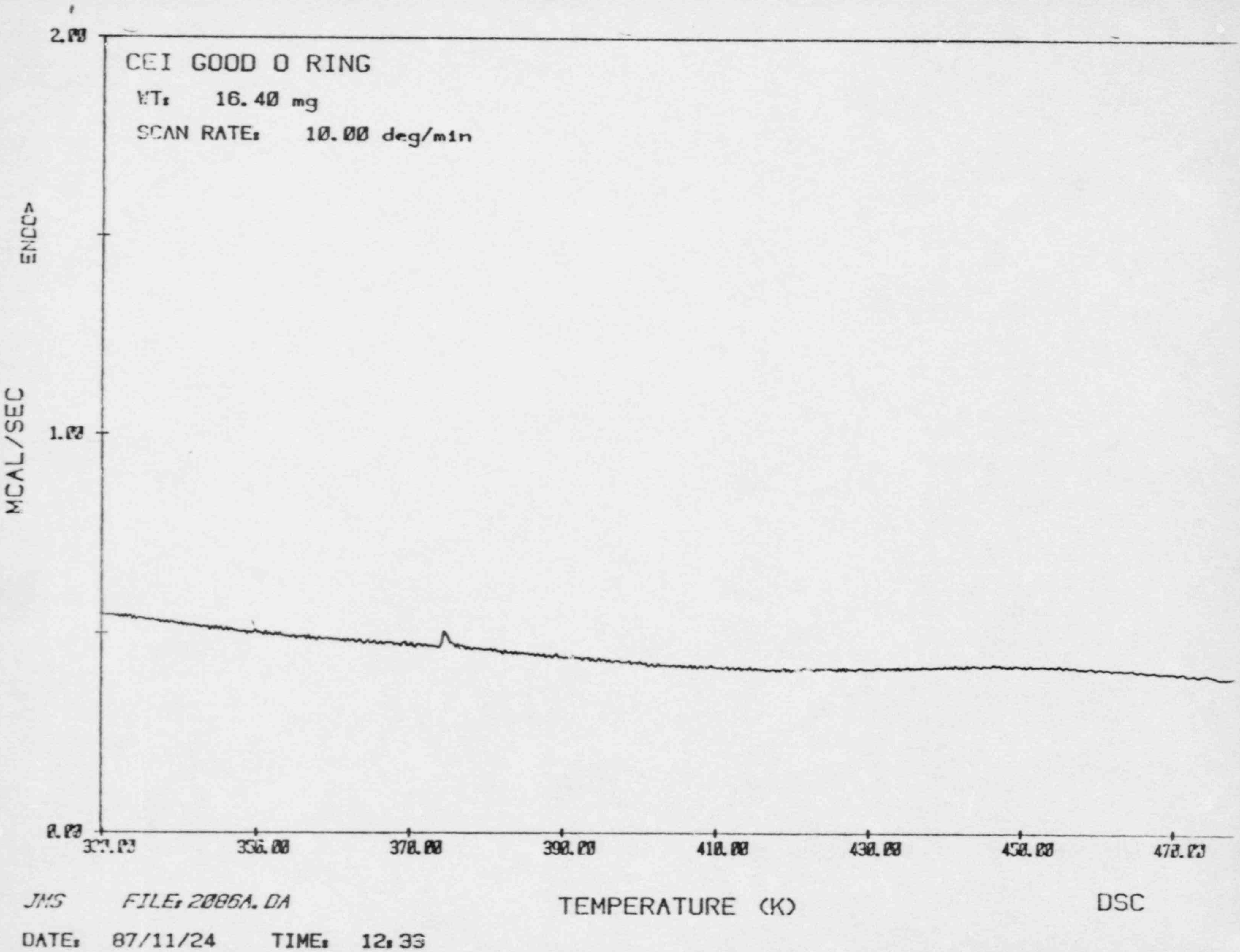
jsb

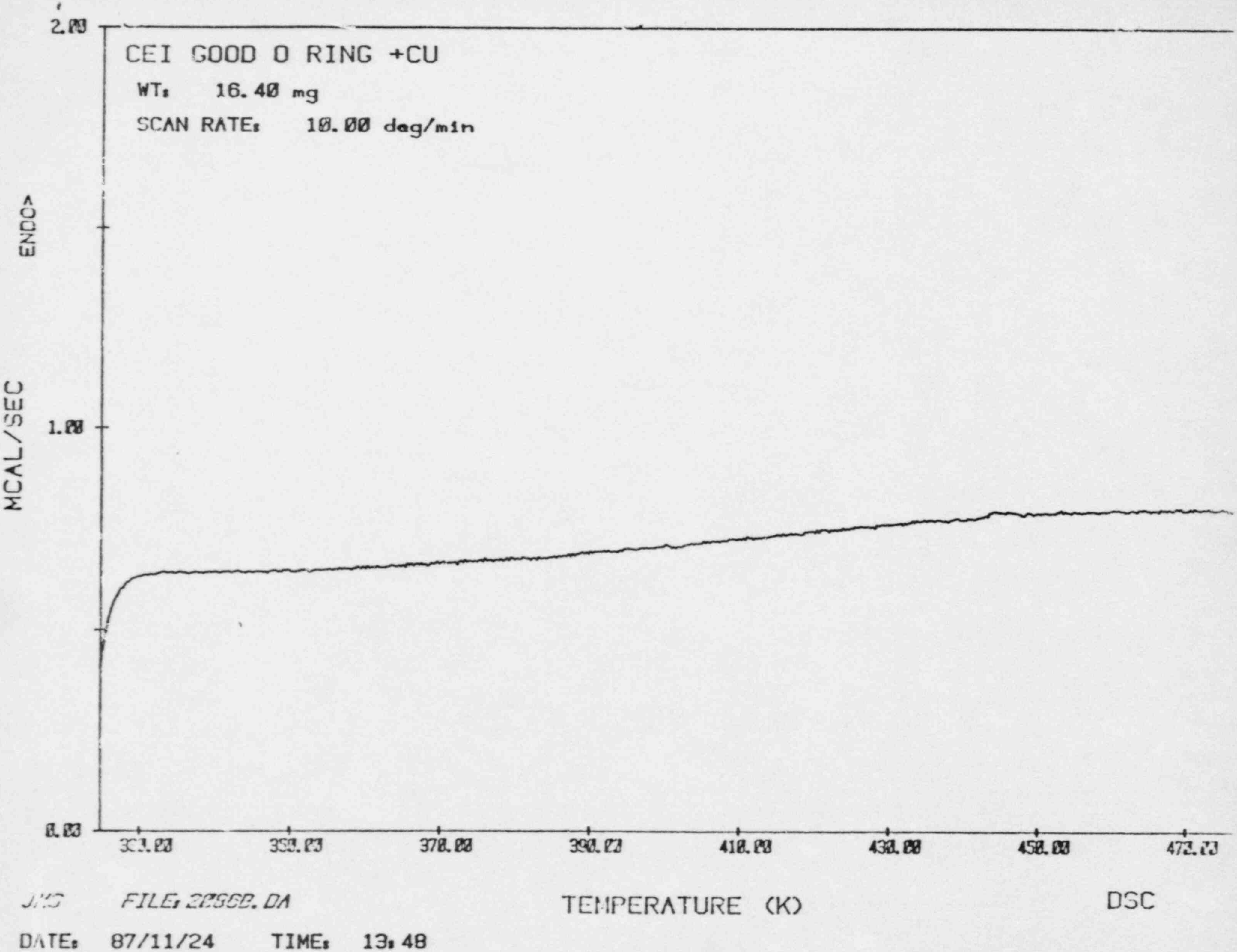
Notebook Ref.: 20117-99
File No.: 8702086T

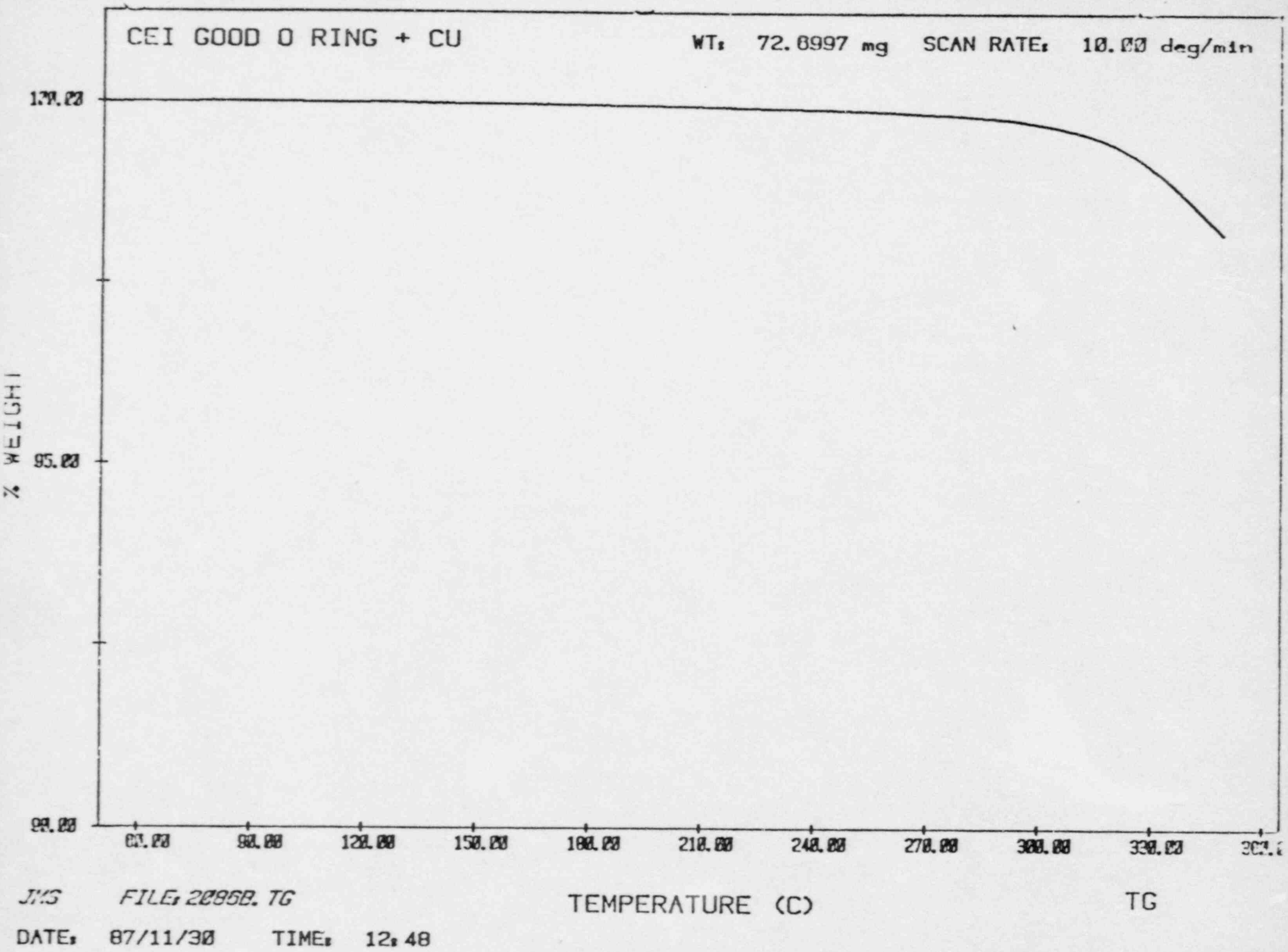
Reviewed By: WR Bramstedt

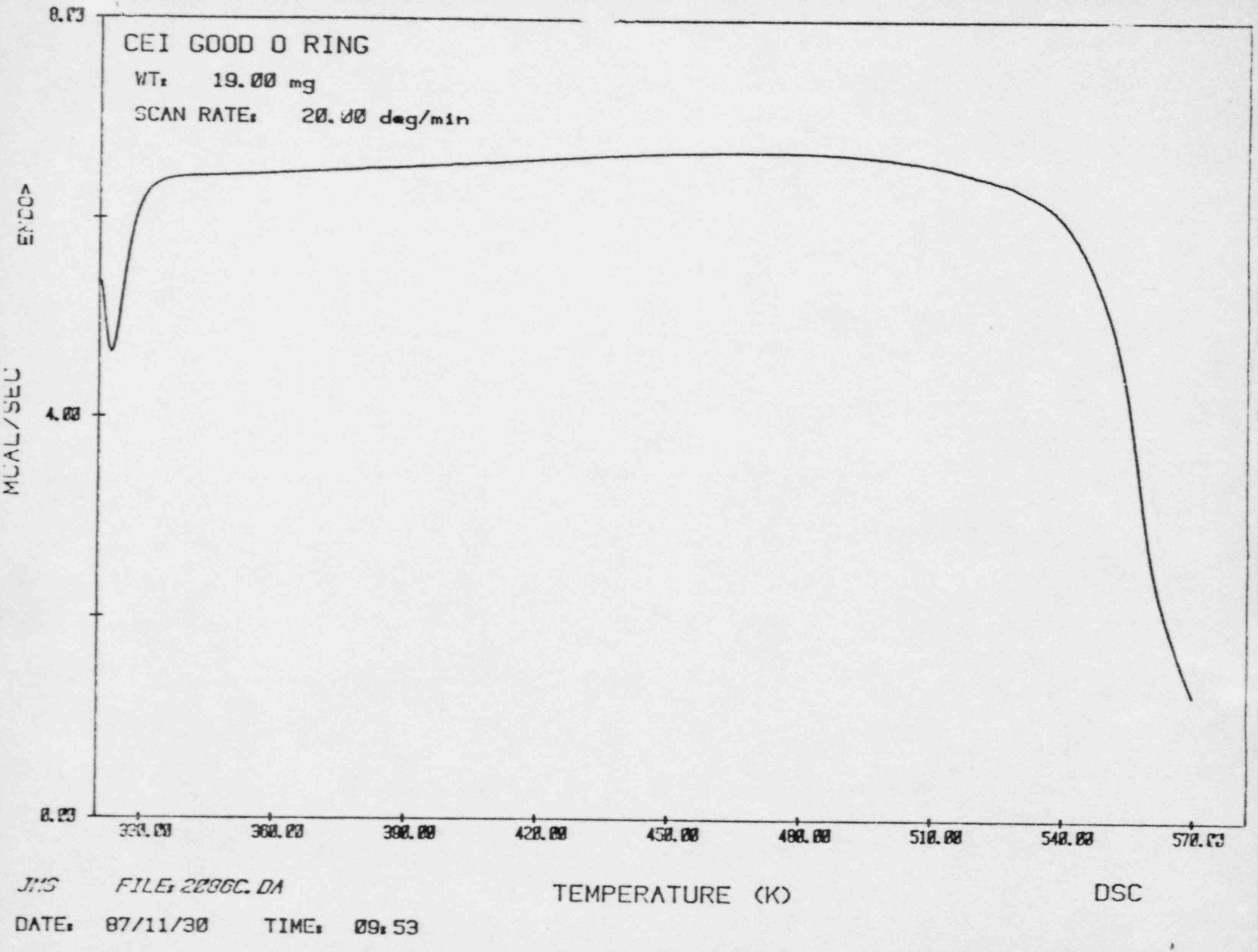


CEI GOOD O RING
WT: 24.1884 mg
SCAN RATE: 10.00 deg/min
95.00
% WEIGHT
90.00
60.00
90.00
120.00
150.00
180.00
210.00
240.00
270.00
300.00
330.00
JMS
FILE: 2086A. TG
TEMPERATURE (C)
TG
DATE: 87/11/30
TIME: 10:34


CEI GOOD O RING
WT: 16.40 mg
SCAN RATE: 10.00 deg/min
ENDO>
MCAL/SEC
2.00
1.00
0.00
336.00
370.00
390.00
410.00
430.00
450.00
JMS FILE: 2086A.DA
TEMPERATURE (K)
DSC
DATE: 87/11/24 TIME: 12:33


CEI GOOD O RING +CU
WT: 16.40 mg
SCAN RATE: 10.00 deg/min
2.00
ENDO>
MCAL/SEC
1.00
0.00
350.00
370.00
390.00
410.00
430.00
450.00
470.00
TEMPERATURE (K)
DSC
DATE: 87/11/24
TIME: 13:48


CEI GOOD O RING + CU
WT: 72.6997 mg
SCAN RATE: 10.00 deg/min
100.00
95.00
90.00
% WEIGHT
60.00
90.00
120.00
150.00
180.00
210.00
240.00
270.00
300.00
330.00
TEMPERATURE (C)
TG
JMS
FILE: 2085B.TG
DATE: 87/11/30
TIME: 12:48


CEI GOOD O RING
WT: 19.00 mg
SCAN RATE: 20.00 deg/min
8.00
4.00
0.00
ENDO>
MCAL/SEC
330.00
360.00
390.00
420.00
450.00
480.00
510.00
540.00
570.00
JMS
FILE: 208GC.DA
TEMPERATURE (K)
DSC
DATE: 87/11/30
TIME: 09:53

PERRY 1 9/8/86 Time of Event 21:35

UNIT WAS AT ABOUT 1% RTP PRIOR TO THE EVENT. OPERATORS WERE TESTING ADS VALVES AND FOUND THAT ONE OF THE VALVES WOULDN'T CLOSE. THEY CYCLED THE VALVE AND IT CLOSED. AT THIS TIME OPERATORS OBSERVED THAT THE "A" SIDE INSTRUMENT AIR HEADER PRESSURE THAT SUPPLIES THE DIV 1 ADS VALVES WAS DRIFTING DOWNWARD. THIS EVENTUALLY RESULTED IN A LOW PRESSURE ALARM. AN EQUIPMENT OPERATOR WAS DISPATCHED TO THE LOCAL PRESSURE INDICATOR NEAR THE REGULATOR AND CONFIRMED THAT PRESSURE WAS LOW--ABOUT 94 PSIG INSTEAD OF THE NORMAL 150 PSIG. OPERATORS THEN CLOSED THE INBOARD ISOLATION VALVE ON THE INSTRUMENT AIR LINE AND HEADER PRESSURE CAME BACK TO NORMAL. THIS INDICATES THAT THERE IS AN AIR LINE LEAK WITHIN THE DRYWELL, POSSIBLY ON THE SUPPLY LINES TO ONE OF THE ADS VALVES. THUS, WITHOUT INSTRUMENT AIR, THE DIV 1 ADS VALVES ARE INCAPABLE OF BEING OPENED. THE LICENSEE IS CURRENTLY IN SEVERAL T.S. ACTION STATEMENTS: 3.4.2.1, 3.5.1 AND 3.4.2.2. THE MOST LIMITING IS 3.5.1 WHICH REQUIRES THAT WITH 2 OR MORE ADS VALVES INOPERABLE, THE UNIT BE IN HOT SHUTDOWN WITHIN 12 HOURS. LICENSEE IS DECREASING POWER (STILL CRITICAL) AND PLANS TO MAKE A DRYWELL ENTRY. NOTIFIED RDO (GREGER). LICENSEE PLANS TO NOTIFY THE RESIDENT.

HQ

IE follow up

REPORTABLE EVENT NUMBER 06166 .

FACILITY : BROWNS FERRY	DATE NOTIFIED : 09/08/86
UNIT : 3	TIME NOTIFIED : 22:40
REGION : 2	DATE OF EVENT : 09/08/86
VENDOR : GE,GE,GE	TIME OF EVENT : 21:57
OPERATIONS OFFICER : JOSEPH GIITTER	CLASSIFICATION : 10 CFR 50.72
NRC NOTIFIED BY : JAMES BRETHNER	CATEGORY 1 : 3
RAD RELEASE : NO	CATEGORY 2 :
CAUSE :	CATEGORY 3 :
COMPONENT :	CATEGORY 4 :

1367

DAILY REPORT RIII

DATE 09/09/86

FACILITY/LICENSEE: PERRY UNIT 1/CLEVELAND ELECTRIC ILLUMINATING COMPANY

NOTIFICATION: SENIOR RESIDENT INSPECTOR

SUBJECT: INITIATION OF REACTOR SHUTDOWN REQUIRED BY TECHNICAL SPECIFICATIONS

EVENT: AT APPROXIMATELY 9:15 P.M. ON SEPTEMBER 8, 1986, WHILE STROKE TESTING SAFETY RELIEF VALVES (SRVS), SRV F041B DID NOT RECLOSE WHEN THE CONTROL SWITCH WAS RETURNED TO AUTO. OPERATING PERSONNEL TOOK IMMEDIATE ACTIONS PRESCRIBED IN ABNORMAL OPERATING PROCEDURES AND SUCCESSFULLY RECLOSED THE SRV. SUBSEQUENTLY, THE SAFETY RELATED INSTRUMENT AIR SYSTEM WHICH PROVIDES AIR FOR ACTUATING THE "A" TRAIN AUTO DEPRESSURIZATION SYSTEM SRVS BEGAN TO DEPRESSURIZE. BASED UPON CONTROL ROOM AND LOCAL INSTRUMENTATION, OPERATING PERSONNEL CONCLUDED THAT THE AIR SYSTEM HAD BEEN BREACHED INSIDE THE DRYWELL. A DRYWELL ENTRY WAS MADE AND IT WAS OBSERVED THAT AIR WAS LEAKING PASSED THE "A" SOLENOID OPERATED PILOT VALVE FOR SRV F041B. THE SAFETY RELATED INSTRUMENT AIR SYSTEM WAS ISOLATED AT THE OUTBOARD CONTAINMENT ISOLATION VALVE AND THE "A" TRAIN OF THE AUTO DEPRESSURIZATION SYSTEM WAS DECLARED INOPERABLE. A REACTOR SHUTDOWN WAS COMMENCED IN ACCORDANCE WITH TECHNICAL SPECIFICATION 3.5.1 AND REACTOR PRESSURE WAS REDUCED BELOW 100 PSIG. CONCURRENTLY, THE AFFECTED SRV PILOT VALVE WAS CYCLED SEVERAL TIMES AND VERIFIED TO PROPERLY SEAT. THE SAFETY RELATED INSTRUMENT SYSTEM WAS REPRESSURIZED AND THE REACTOR SHUTDOWN TERMINATED. SRV F041B WAS DECLARED INOPERABLE PENDING SUCCESSFUL REPERFORMANCE OF VALVE STROKE TESTING.

Hal O.
Info

REGIONAL ACTION: FOLLOWUP BY THE RESIDENT INSPECTION STAFF IN ACCORDANCE WITH MC 2515.

FACILITY/LICENSEE: ZION UNIT 1

NOTIFICATION: ENS PHONE CALLS

SUBJECT: ACTUATIONS OF ENGINEERED SAFEGUARDS FEATURES (ESF)

EVENT: ON SEPTEMBER 5, 1986, AT 01:19 A.M. WHILE PERFORMING TESTING IN ACCORDANCE WITH PROCEDURE TSS 15.6.35-1, ALL FIVE REACTOR CONTAINMENT FAN COOLERS (RCFC) AND ALL THREE AUXILIARY FEEDWATER (AFW) PUMPS STARTED. THE LICENSEE WAS PERFORMING BUS DROPS OF ESF BUSES 147 AND 149 AND EXPECTED TO HAVE ONLY THE ESF EQUIPMENT ASSOCIATED WITH THE APPROPRIATE BUS START AND SEQUENCE ON. THE LICENSEE HAS DETERMINED THAT THE RESULTS OBSERVED WERE CONSISTENT WITH THEIR TEST METHODS AND WILL CORRECT THEIR PROCEDURE.

ON SEPTEMBER 6, 1986, AT 10:50 A.M. WHILE TROUBLESHOOTING A FAILURE OF A FEEDWATER ISOLATION VALVE TO STROKE CLOSED, AN ELECTRICIAN INADVERTENTLY BUMPED A CONTACT ON THE BLACKOUT SEQUENCE TIMER WHICH CAUSED THE 1B AND 1E RCFCS TO SHIFT FROM FAST TO SLOW SPEED. THE CONTACTS ON THE BLACKOUT TIMER ARE EXPOSED, AND WERE ABOUT ONE INCH FROM THE POINT AT WHICH THE ELECTRICIAN WAS WORKING IN THE PANEL.

REGIONAL ACTION: FOLLOWUP BY THE RESIDENT INSPECTOR PER MC 2515.

13/68

PERRY 1
DELAYED CLOSURE OF MULTIPLE MSIVs
(POTENTIAL COMMON MODE FAILURE)
OCTOBER 29, 1987

PROBLEM

THREE OF EIGHT MSIVs DID NOT CLOSE WITHIN ALLOWED TECHNICAL SPECIFICATION TIME (3-5 SEC).

CAUSE

UNKNOWN, BUT BELIEVED TO BE DIRT IN THE AIR SYSTEM WHICH HUNG UP (DELAYED OPERATION) OF THE SOLENOIDS IN THE CONTROL CIRCUIT.

SIGNIFICANCE

DEGRADED MSIV PERFORMANCE MAY PRECLUDE REACTOR ISOLATION OR ESTABLISHMENT OF CONTAINMENT INTEGRITY IN THE EVENT OF AN ACCIDENT OR TRANSIENT.

DISCUSSION

- BOTH THE INBOARD AND OUTBOARD VALVES IN LINE D HUNG UP - 22 SEC. AND 77 SEC. RESPECTIVELY.
- NO PREVIOUS INSTANCES OF SLOW CLOSURE.
- LICENSEE CURRENTLY PLANS TO CONTINUE REACTOR OPERATION UNTIL AN MSIV ISOLATION TEST ON TUESDAY.
- LICENSEE WILL EXERCISE MSIVs TOMORROW, PRIOR TO TEST.
- LICENSEE DOES NOT KNOW ROOT CAUSE - PROCESS OF ELIMINATION INDICATES DIRT IN AIR SYSTEM.
- LICENSEE HAS A MAINTENANCE OUTAGE SCHEDULED TO START 12/01/87.

FOLLOWUPS

- REGIONAL STAFF WILL MONITOR TESTING AND EXERCISING OF MSIVs.

CONTACT: J. CARTER

B/69

Reportable Event number 10515 .

Facility : PERRY	Date Notified : 10/30/87
Unit : 1	Time Notified : 00:10
Region : 3	Date of Event : 10/30/87
Vendor : GE,GE	Time of Event : 21:44
Operations Officer : Don Marksberry	Classification : 10 CFR 50.72
NRC Notified By : ROGER STIFFLER	Category 1 : LCO Action Statement
Rad Release : No	Category 2 :
Cause : Unknown	Category 3 :
Component :	Category 4 :

EVENT DESCRIPTION :

WITH THE REACTOR AT 62%, FULL CLOSURE TESTS ON MSIVs FOUND THREE VALVES WITH CLOSURE TIMES EXCEEDING THE 5 SECOND LIMIT. THE FIRST MSIV, F022-D (INBOARD), CLOSED 22 SECONDS. AFTER FURTHER TESTS THE CLOSURE TIMES WERE WITHIN 3-5 SECONDS. AS THE RESULT OF THE TEST, THE OUTBOARD MSIV, FO-28-D, WAS TESTED WITH A CLOSURE TIME OF 77 SECONDS. THE VALVE WAS CYCLED SEVERAL TIMES WITH STROKE TIMES WITHIN 3-5 SECONDS. ALL OTHER MSIVs WERE TESTED WITH ONLY ONE OTHER VALVE, FO-28-B, CLOSING AT 12 SECONDS AND FURTHER TESTS RESULTED IN CLOSURE TIMES WITHIN 3-5 SECONDS. AFTER THE FIRST TEST ON THE THREE VALVES THE SLOW CLOSURE TIMES COULD NOT BE REPEATED. SUSPECT WATER IN AIR SUPPLY AFFECTING THE PNEUMATIC SOLENOIDS WHERE THE CYCLING FREED THE SOLENOIDS. CONSIDERING SHORTENING THE SURVEILLANCE FREQUENCY FOR FULL CLOSURE TEST WHICH IS NOW 92 DAYS. NOTIFIED RDO(SNELL).

1

Reportable Event number 10516 .

B/70

DAILY REPORT REGION III

DATE: 10-30-87

LICENSEE/FACILITY	NOTIFICATION/SUBJECT
CLEVELAND ELECTRIC ILLUMINATING CO./ PERRY UNIT 1	SRI-PC/ EXCESSIVE MAIN STEAM ISOLATION VALVE (MSIV) STROKE TIMES

EVENT

EVENT NO. 10515

AT 6:37 P.M. ON OCTOBER 29, 1987 WHILE OPERARTING AT 76% POWER, THE LICENSEE PERFORMED A FAST CLOSURE OF THE INBOARD MSIV ON THE "D" STEAMLINE, 1B21-F022D, IN ACCORDANCE WITH STARTUP TEST INSTRUCTION (STI) 1B21-025A, SECTION 8.4, "FULL CLOSURE OF THE FASTEST MSIV AT MAXIMUM PERMISSIBLE POWER." THE VALVE DID NOT BEGIN TO STROKE CLOSED UNTIL APPROXIMATELY 18 SECONDS AFTER IT'S CONTROL SWITCH WAS PLACED IN THE "CLOSED" POSITION. THE VALVE THEN STROKED CLOSED IN LESS THAN 3 SECONDS. THE LICENSEE DECLARED THE VALVE INOPERABLE AND IMMEDIATELY BEGAN TO REDUCE REACTOR POWER TO BELOW 75%. SUBSEQUENTLY, AT APPROXIMATELY 9:03 P.M., THE VALVE WAS RESTROKED TWICE WITH SATISFACTORY STROKE TIMES. BASED UPON THE INITIAL FAILURE, THE LICENSEE PERFORMED FAST CLOSURE TESTING OF THE REMAINING MSIVs. AT 9:44 P.M., MSIV 1B21-F028D WAS STROKED CLOSED WITH AN UNSATISFACTORY STROKE TIME OF 1 MINUTE AND 17 SECONDS AND AT 9:52 P.M. WAS RESTROKED WITH AN ACCEPTEBLE STROKE TIME. AT 10:16 P.M., MSIV 1B21-F028B WAS STROKED CLOSED WITH AN UNSATISFACTORY STROKE TIME OF 11.? SECONDS AND AT 10:18 P.M. WAS RESTROKED WITH AN ACCEPTABLE STROKE TIME. VALVES 1B21-F028D AND 1B21-F028B WERE ALSO DECLARED INOPERABLE PENDING EVALUATION. THE REMAINIG VALVES STROKED ACCEPTABLY. THE EXCESSIVE INITIAL CLOSURE TIMES OF VALVES 1B21F022D AND 2B21F028D (BOTH ON THE "D" STEAMLINE) WERE DETERMINED BY THE LICENSEE TO BE REPORTABLE IN ACCORDANCE WITH 10 CFR 50.72 (b)(2)(iii). DURING ALL MSIV CLOSURES, THE PILOT SOLENOID STATUS LIGHTS WERE OBSERVED TO EXTINGUISH, INDICATING THAT THE MSIV PILOT VALVE SOLENOIDS DEENERGIZED. THE LICENSEE CURRENTLY BELIEVES THAT DURING INITIAL CLOSURE TESTS, MSIV PILOT VALVES ASSOCIATED WITH VALVES 1B21-F022D, 1B21-F028D, AND 1B21-F028B DID NOT FREELY STROKE OPEN UPON PILOT SOLENOID DEENERGIZATION. BASED UPON THE INABILITY TO RECREATE THE FAILURES AND SUBSEQUENT SATISFACTORY MSIV PERFORMANCE, THE LICENSEE DECLARED THE MSIVs OPERABLE AT 10:40 P.M.. THE LICENSEE IS CONTINUING TO EVALUATE THE EXCESSIVE MSIV STROKE TIMES IN CONSULTATION WITH GENERAL ELECTRIC AND IS CONSIDERING INCREASING MSIV SURVEILLANCE TEST FREQUENCY TO PROVIDE ADDITIONAL ASSURANCES OF MSIV OPERABILITY.

REGIONAL FOLLOWUP: THE RESIDENT INSPECTORS EVALUATE THE LICENSEE'S ROOT CAUSE DETERMINATION AND WILL MONITOR MSIV PERFORMANCE DURING FUTURE MSIV SURVEILLANCE TESTING.

B/71

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Regional Administrator is speaking at the American Nuclear Society meeting in Tampa, Florida.

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PRIORITY ATTENTION REQUIRED MORNING REPORT - REGION III OCTOBER

LICENSEE/FACILITY	NOTIFICATION/SUBJECT
CLEVELAND ELECTRIC ILLUMINATING CO./ PERRY UNIT 1	SRI-PC/ EXCESSIVE MAIN STEAM ISOLATION VALVE (MSIV) STROKE TIMES
EVENT	EVENT NO.

AT 6:37 P.M. ON OCTOBER 29, 1987 WHILE OPERATING AT 76% POWER, THE LICENSEE PERFORMED A FAST CLOSURE OF THE INBOARD MSIV ON THE "D" STEAMLINE, 1B21-F022D, IN ACCORDANCE WITH STARTUP TEST INSTRUCTION (STI) 1B21-025A, SECTION 8.4, "FULL CLOSURE OF THE FASTEST MSIV AT MAXIMUM PERMISSIBLE POWER." THE VALVE DID NOT BEGIN TO STROKE CLOSED UNTIL APPROXIMATELY 18 SECONDS AFTER IT'S CONTROL SWITCH WAS PLACED IN THE "CLOSED" POSITION. THE VALVE THEN STROKED CLOSED IN LESS THAN 3 SECONDS. THE LICENSEE DECLARED THE VALVE INOPERABLE AND IMMEDIATELY BEGAN TO REDUCE REACTOR POWER TO BELOW 75%. SUBSEQUENTLY, AT APPROXIMATELY 9:03 P.M., THE VALVE WAS RESTROKED TWICE WITH SATISFACTORY STROKE TIMES. BASED UPON THE INITIAL FAILURE, THE LICENSEE PERFORMED FAST CLOSURE TESTING OF THE REMAINING MSIVS. AT 9:44 P.M., MSIV 1B21-F028D WAS STROKED CLOSED WITH AN UNSATISFACTORY STROKE TIME OF 1 MINUTE AND 17 SECONDS AND AT 9:52 P.M. WAS RESTROKED WITH AN ACCEPTABLE STROKE TIME. AT 10:16 P.M., MSIV 1B21-F028B WAS STROKED CLOSED WITH AN UNSATISFACTORY STROKE TIME OF 11.9 SECONDS AND AT 10:18 P.M. WAS RESTROKED WITH AN ACCEPTABLE STROKE TIME. VALVES 1B21-F028D AND 1B21-F028B WERE ALSO DECLARED INOPERABLE PENDING EVALUATION. THE REMAINING VALVES STROKED ACCEPTABLY. THE EXCESSIVE INITIAL CLOSURE TIMES OF VALVES 1B21F022D AND 2B21F028D (BOTH ON THE "D" STEAMLINE) WERE DETERMINED BY THE LICENSEE TO BE REPORTABLE IN ACCORDANCE WITH 10 CFR 50.72 (B)(2)(III). DURING ALL MSIV CLOSURES, THE PILOT SOLENOID STATUS LIGHTS WERE OBSERVED TO EXTINGUISH, INDICATING THAT THE MSIV PILOT VALVE SOLENOIDS DEENERGIZED. THE LICENSEE CURRENTLY BELIEVES THAT DURING INITIAL CLOSURE TESTS, MSIV PILOT VALVES ASSOCIATED WITH VALVES 1B21-F022D, 1B21-F028D, AND 1B21-F028B DID NOT FREELY STROKE OPEN UPON PILOT SOLENOID DEENERGIZATION, BASED UPON THE INABILITY TO RECREATE THE FAILURES AND SUBSEQUENT SATISFACTORY MSIV PERFORMANCE, THE LICENSEE DECLARED THE MSIVS OPERABLE AT 10:40 P.M.. THE LICENSEE IS CONTINUING TO EVALUATE THE EXCESSIVE MSIV STROKE TIMES IN CONSULTATION WITH GENERAL ELECTRIC AND IS CONSIDERING INCREASING MSIV SURVEILLANCE TEST FREQUENCY TO PROVIDE ADDITIONAL ASSURANCES OF MSIV OPERABILITY.

REGIONAL FOLLOWUP: THE RESIDENT INSPECTORS EVALUATE THE LICENSEE'S ROOT CAUSE DETERMINATION AND WILL MONITOR MSIV PERFORMANCE DURING FUTURE MSIV SURVEILLANCE TESTING.

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