Letter to N. C. Moseley from Carolina Power and Light Company dated June 13, 1975.

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Carolina Power & Light Company

June 13, 1975

FILE: NG-3513 (R)

SERIAL: NG-75-885

Mr. Norman C. Moseley, Director
U. S. Nuclear Regulatory Commission
Region II, Suite 818
230 Peachtree Street, N.W.
Atlanta, Georgia 30303

Dear Mr. Moseley:

H. B. ROBINSON UNIT NO. 2
LICENSE NO. DPR-23
INSULATION AND PIPING AFFECTED BY FAILURE OF "C"
REACTOR COOLANT PUMP SEAL, MAY 2, 1975

This report is in response to the request by NRC to provide justification for not replacing wetted insulation that resulted from "C" Reactor Coolant Pump Seal failure on May 2, 1975. The discussion addresses the stainless steel insulated lines outside of "C" Reactor Coolant Pump bay, "C" Pump bay piping, and Reactor Vessel incore detector thimble penetrations.

As a result of the containment flooding, piping near the containment base mat was submerged. The stainless steel piping which was submerged consisted of seal water injection to RCP "A", excess letdown lines, normal letdown lines, residual heat removal line to "A" loop, and safety injection line to "A" loop cold leg. Refer to attached Table 1. This constitutes approximately 650 feet of piping. Portions of this piping were flooded from early Friday morning, May 2, 1975 to about 0400 Sunday morning, May 4, 1975. The chloride concentration of the water was 0.25 ppm as measured on May 2, 1975. Therefore, there was a concern for the saturation of the insulation with chlorides, possible leaching out on piping, and the potential for chloride stress corrosion. Westinghouse was contacted to provide recommendations for corrective action.

The initial Westinghouse reply was received on May 6, 1975. Recommendations were to remove insulation from all submerged stainless steel piping and all wetted piping in the area of the spill, clean the pipe, and reinsulate. It was also suggested to remove insulation from the bottom of the reactor vessel and to rinse the vessel and clean the incore thimble penetrations. The specification which was referenced for use in the evaluation was Westinghouse PS 84351 NL, Revision 2 "Determination of Surface Chlorides and Fluoride Contamination on Stainless Steel Material." This specification allows a maximum chloride concentration of 0.0015 mg/dm^2 for insulated surfaces.

Initial plans were then made to remove all the insulation and proceed as suggested. However, a sampling program was begun on loop piping that was not wetted by the incident, and the chlorides on this piping were found to be higher than the referenced acceptance limits. Refer to Table 3. Based on this as-found condition and a concern for minimizing radiation exposures of workers required to remove insulation and reinsulate the submerged piping Westinghouse was again contacted to provide clarification and/or justification for the proposed acceptance criteria. It was at that time that Westinghouse recommended sampling the piping and piping insulation with respect to the acceptance criteria in Westinghouse PS 83336 KA, "Requirements for Thermal Insulation Used on Austenitic Stainless Steel Reactor Plant Piping and Equipment." To provide data on the worst case, insulation was removed from each pipe at its lowest elevation, and the sample results indicated that the insulation and piping were acceptable. Refer to attached Table 2. Westinghouse was then requested to provide a justification for the applicability of the process specification for insulation to the piping. A report was received on May 21, 1975 justifying the acceptance standards. Refer to Attachment 1. This report concluded that the data falling within the acceptance curve of the subject specification indicated that sufficient amounts of sodium silicate were present in the insulation to prevent chloride stress corrosion. Further there is no concern for the contamination if the surface is covered with sodium silicate inhibited insulating material when it is ascertained that there is sufficient silicate inhibitor to prevent halide stress cracking. This mechanism for inhibition of halide stress corrosion was established by H. P. Karnes in his report, "The Corrosive Potential of Wetted Thermal Insulation," presented at the AICHE 57th National Meeting, September 26-29, 1965. With this final justification it was decided that the wetted piping and insulation were acceptable without replacement.

A plot of the chemical analysis data for each line and its corresponding insulation is enclosed as Graph 1. This acceptance curve is per the subject Westinghouse Specification PS 83336 KA which corresponds to Figure 1 of Regulatory Guide 1.36, "Non-Metallic Thermal Insulation for Austenitic Stainless Steel". This indicates that sufficient leachable sodium and silicate ions are present to assist in minimizing the effects of the chloride and fluoride.

To account for all chlorides present, the plot consists of sodium and silicate ions versus chloride and fluoride ions in the insulation plus chloride and fluoride ions on the pipe. On this basis, even though the lines were in contact with the contaminated water for some time, no adverse chemical effects attributed to halogens and stress corrosion have resulted.

Also, as pointed out in Westinghouse letter CPS-75-078 (Attachment 2) pipe surface contamination on and all pipes that were submerged does not exceed 0.0015 mg/dm^2 which is the specification to be met for cleaning pipe prior to insulation installation. Westinghouse further states that it is believed that chloride contamination observed on the submerged piping is not potentially hazardous with respect to chloride stress corrosion and continued operation is justified without any other immediate action.

So that the sections of pipe that were submerged can be better visualized, Line Diagrams 1 through 7 are provided to show these pipe locations and elevations. The diagrams also show that all of these lines include at least one isolation valve between the reactor coolant loop piping and the section of submerged pipe. Thus, in the event that a problem might inconceivably occur with pipe cracking and leakage, the line can be isolated.

The piping systems within "C" Reactor Coolant Pump Bay experienced significant wetting of the insulation due to spray from the failed pump seal, but none were submerged due to water accumulation on the containment floor. The inlet and outlet "C" loop piping, "C" Reactor Coolant Pump casing, and "C" loop insulation were examined for possible chloride and fluoride ion problems. Also in order that a comparison between dry and wetted main coolant piping insulation could be made, samples were also analyzed from "A" and "B" main coolant loops. These results are given in Table 3 and are plotted on Graph 2. The same basis for acceptance of this insulation as was used above was applied in this case.

Incore thimble penetrations at the base of the Reactor Vessel are not insulated, but they were submerged during the accident. In order to insure that no problem existed, all thimble penetrations on the vessel base were thoroughly cleaned, and three nonadjacent penetrations were sampled for chloride and fluoride contamination. These results are also given in Table 3 and show that there is no indication of chloride and fluoride ions being present.

The following lists the specific recommendations made by Westinghouse in their initial letter of May 6, 1975 and a summary of the corrective action taken:

1. Insure vessel safe ends were not contaminated with chlorides.
   Corrective Action: The vessel safe ends did not get wet due to being at a higher elevation than the water level.

2. Insure all instrumentation tubing at the base of the vessel is clean.
   Corrective Action: All incore thimble penetrations were cleaned and checked for chlorides (Table 3).

3. All submerged stainless steel pipe should have the insulation removed, the pipe cleaned, and the insulation restored.
   Corrective Action: A chemical analysis was performed on each pipe and insulation at its lowest elevation (Table 2) and plotted (Graph 1). Acceptance was based on the criteria and justification received in Westinghouse correspondence of May 21, 1975.

4. Insure that no main loop piping was submerged.
   Corrective Action: No main loop piping was submerged.

5. All insulation in "C" Pump Bay that was wetted should be removed, the pipe cleaned, and the insulation replaced.
   Corrective Action: A chemical analysis was made of insulation in "C" Bay and compared with insulation for the other pump bays that had not been wetted (Table 3 and Graph 2). Acceptance was based on the same criteria as referenced in Item 3 above.

6. Inspect and clean bolts on the reactor coolant pumps that were contaminated by the water.
   Corrective Action: The pump was disassembled and inspected and all bolts were cleaned prior to reassembly.

Based on this evaluation and corrective action it was not deemed necessary to remove and replace the wetted insulation. There is sufficient evidence to assure that halogen stress corrosion will not occur and the existing conditions pose no threat to plant safety.

As per Westinghouse recommendation a program shall be established for further piping and insulation sampling at the next scheduled outage. This precautionary step shall be taken to confirm the results of the initial sampling and provide assurance of pipe integrity.

Very truly yours,

E. E. Utley
Vice President
Bulk Power Supply

DBW:cpw

Attachments

CC: Mr. N. B. Bessac
Mr. T. E. Bowman
Mr. P. W. Howe
Mr. R. E. Jones
Mr. J. B. McGirt
Mr. D. B. Waters

ATTACHMENT 1

Westinghouse Electric Corporation Power Systems

PWR Systems Division
Box 355
Pittsburgh Pennsylvania 15230

RECEIVED
MAY 30 '75
CP & L Co.

May 21, 1975
ST-CO-668
CPS-75-071

Mr. J. B. McGirt, Plant Manager
Carolina Power & Light Company
P. O. Box 790
Hartsville, South Carolina 29550

Dear Mr. McGirt:

Surface Chloride Concentrations on CPL Loop Piping

This is in response to your request for an explanation of the rationale employed in writing the Westinghouse Chemistry Specification Number 1.8 for surface chloride and fluoride contamination on stainless steel materials and its relationship to recently determined chloride surface contamination on CPL loop piping. That specification is included in WCAP-7452, Revision 1, "Chemistry Criteria and Specifications for Westinghouse Pressurized Water Reactors". Testing at Westinghouse laboratories has shown that stressed austenitic stainless steel samples exposed to less than the specified 1.5 $\mu g/dm^2$ chloride or fluoride surface contamination did not experience stress cracking. It is recognized that higher values of surface halide contamination can be tolerated without the material being corrosively attacked when the stainless is covered with unjacketed thermal insulation containing low values of leachable halides as well as a concentration of leachable silicates sufficiently great to provide inhibition to external stress corrosion cracking./1 However, in the process of installing insulation on piping and equipment, it is possible that small areas may be left uncovered and thus might not receive the benefits of the silicate inhibitor. It is specified, therefore, that all stainless surfaces be cleaned to the low surface halide level of 1.5 $\mu g/dm^2$ before application of thermal insulation. This specification is intended to be applied immediately prior to the time that surfaces are to have insulation installed either prior to plant startup or during post operational maintenance when it becomes necessary to reinstall sections of insulation.

If unjacketed, asbestos-type insulation containing a given concentration of leachable halides and leachable silicates is removed from a stainless surface and the surface is then smear-sampled for contamination, it is expected that some level of contamination will be determined in excess of the specified limit for surface halides. Such contamination would result from particles of the insulating material remaining on the stainless surface after the bulk of the insulation had been removed. In the situation

/1 H. F. Karnes, The Corrosive Potential of Wetted Thermal Insulation, presented at the AIChE 57th National Meeting, September 26 - 29, 1965; Conf. 650905-2.

described, the contamination would not be of concern if the surface is to be covered with sodium silicate inhibited insulating material when it is ascertained that there is sufficient silicate inhibitor available to prevent halide stress cracking caused by sources of halides leached from the insulation or already present on the stainless surface. In order for a cracking mechanism to be initiated, the halide surface contamination must be wetted such that the halides become ionic in form. For that situation to occur, water must enter the insulation system before it can contact the dry halide contamination which is passive in the dried state. The sodium silicate inhibitor would then be leached by the water from the insulation, along with any leachable halides and then would be deposited on the heated stainless steel surface where the silicates would prevent the halides from causing cracking. This mechanism of inhibition of halide stress corrosion cracking by the presence of sodium silicate inhibitors in thermal insulating materials was established by Karnes in the previously referenced report of testing completed at Knolls Atomic Power Laboratory.

A review of the surface halide data recently collected from CPL loop piping and reactor coolant pump housing, along with data gleaned from analyses of samples of insulation removed from CPL loop piping, supports the contention that sufficient silicate inhibitors are available on the insulated stainless surfaces to preclude halide stress cracking. These data are presented below:

Table 1

Sample Location	Cl- (mg/dm^2)	F- (mg/dm^2)	Cl- ppm	F- ppm	SiO_2 ppm	Na ppm
C Loop Inlet	0.0037	N/D				
C Loop Outlet	0.061	N/D				
C RCP Location #1	0.050	N/D				
C RCP Location #2	0.047	N/D				
A Loop Insulation			3.5	N/D	437	787
B Loop Insulation			3.75	N/D	900	1500
C Loop Insulation			3.25	N/D	375	275

N/D Not Detectable

The acceptability of thermal insulation is judged by establishing the ratio of the leachable sodium + silicate concentrations to the leachable chloride + fluoride concentrations. This ratio of acceptability is easily determined by comparison of the data with a plot provided in the Westinghouse Process Specification 83336 KA, Requirements for Thermal Insulation Used On Austenitic Stainless Steel Reactor Plant Piping and Equipment. The loop insulation data verifies the fact that the insulation is acceptable for use in the subject application and will provide the necessary inhibition to halide stress corrosion cracking.

In conclusion, it may be stated that the chloride contamination observed on CPL loop piping and C-RCP housing is not considered potentially hazardous with respect to chloride stress corrosion cracking since sodium silicate inhibitors are available in the thermal insulation to prevent the occurrence of such a mechanism.

If other questions arise concerning this subject, I would be pleased to discuss them further.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

J. W. Kormuth, Engineer
Systems Chemistry Operations
PWRSD Systems Technology

APPROVED: T. E. Bowman, Lead Engineer
Field Operations - Southern Region

JWK:TEB:als

cc: N. B. Bessac
J. F. Halifax
B. J. Furr

Westinghouse Electric Corporation Power Systems

Nuclear Service Division
Box 355
Pittsburgh Pennsylvania 15230

RECEIVED
JUN 5 - '75
C P & L Co.

June 3, 1975

CPS-75-078

Ref: (1) CPS-75-054 of May 6, 1975

(2) CPS-75-071 of May 21, 1975

Mr. N. B. Bessac, Manager
Nuclear Generation
Carolina Power and Light Company
P. O. Box 1551
Raleigh, North Carolina 27602

Dear Mr. Bessac:

Subject: Analysis of Submerged Stainless Piping and Potential for Halide Stress Corrosion Cracking at H. B. Robinson Unit No. 2

On Tuesday, May 27, 1975 in a telephone conversation, we discussed the potential problems that might occur because the H. B. Robinson Unit No. 2 had been started up on May 26, 1975 without having removed the insulation from that stainless steel piping which had been submerged and wetted during the incident of May 1, 1975. This latter action had been recommended in paragraph 2a. of reference (1). At that time you requested that Westinghouse investigate the situation to determine what would be the best action to take under the present circumstances.

Since that time we have considered the matter at length and have reported periodically by telephone to you on the matter. Information was provided by telephone from the plant on May 25, 1975. This information is displayed in Table I. Consultation with PWR Systems Division-Systems Operations, Chemistry Operations and Nuclear Safety results in the following recommendations, which are based upon Table I data being representative and accurate.

Reference (2) discussed in detail the relationships between the surface level halide contamination of stainless steel piping, and the sodium silicate inhibitors present in the insulation material. A review of the data in Table II for the submerged piping continues to support the contention, as outlined in reference (2), that sufficient silicate inhibitors are available in the insulated stainless piping to preclude halide stress cracking. Please note that all points associated with the insulation display an acceptable ratio of the leachable sodium plus silicate concentration to the leachable chloride plus fluoride concentration if plotted on Figure 2 of PS 83336 KA of 5/12/71 (Requirements for Thermal Insulation Used in Austenitic Stainless Steel Reactor Plant Piping and Equipment).

Furthermore, it should be noted that no surface halide contamination exceeded 0.0015 mg/dm^2, which is the specification to be met when cleaning stainless piping prior to installation of insulations. PS 84351, Rev. 2 of 12/12/72 (Determination of Surface Chloride and Fluoride Contamination on Stainless Steel).

In conclusion therefore, Westinghouse believes that chloride contamination observed on the submerged piping is not considered potentially hazardous with respect to chloride stress corrosion cracking since insulation inhibitors are still available in sufficient quantities to prevent the occurrence of the mechanism. Continued operation of the plant is therefore, in our opinion, justified without any other immediate action.

We recommend that at the first available opportunity a piping and insulation sampling programs be initiated for the effected piping to confirm the representative nature of the samples displayed in Table I.

Please contact me if you have any further questions on this subject.

Very truly yours,

T.E. Bowman III

T. E. Bowman, Lead Engineer
Operating Plants Services

1

cc: J. B. McGirt
J. F. Halifax

TABLE I

PLANT SUPPLIED DATA

PIPE IDENTIFICATION	LENGTH WETTED (APPROX.)	PIPING SWIPE RESULTS (ppm)[1]				INSULATION SAMPLE RESULTS (ppm)[2]				
		Cl	Fl	Na	SiO_2	Cl	Fl	Na	SiO_2	pH
a. 3/4 - CH - 11B	6 ft.	0.010	ND	1.0	0.50	0.085	ND	150	13.50	9.0
b. 3/4 - CH - HC	6 ft.	0.30	ND	2.0	0.90	0.060	ND	65	26.25	9.4
c. 8 - SI - 37	50 ft.	0.06	ND	9.0	0.95	0.110	ND	500	41.25	10.1
d. 2 - SI - 63	50 ft.	0.10	ND	2.5	2.70	0.110	ND	98	45.00	9.4
e. 3/4 - CH - 11A	170 ft.	0.035	ND	0.5	0.03	0.110	0.010	400	90.00	10.3
f. 2 - CH - 20	85 ft.	0.035	ND	1.5	0.02	0.075	ND	75	33.00	9.4
g. 2 - CH - 8C	50 ft.	0.06	ND	8.5	0.02	0.090	0.015	1500	120.00	10.3
h. 2 - CH - 17	220 ft.	0.02	ND	3.0	0.06	0.035	ND	100	33.00	9.6

NOTES: (1) Swipe results ppm refer to ppm of sample liquid (mg material/l solution)

(2) Insulation sample ppm refer to ppm of sample liquid (mg material/l solution)

(3) ND = Not Detectable

TABLE II

CONVERTED PLANT DATA

PIPE IDENTIFICATION	PIPING SWIPE RESULTS (mg/dm^2) [1]				INSULATION SAMPLE RESULTS (ppm) [2] of INSULATION			
	Cl	Fl	Na	SiO_2	Cl	Fl	Na	SiO_2
a. 3/4 - CH - 11B	0.0003	ND	0.0250	0.0125	2.13	ND	3750	338
b. 3/4 - CH - 11C	0.0008	ND	0.0500	0.0225	1.50	ND	1625	656
c. 8 - SI - 37	0.0015	ND	0.2250	0.0238	2.75	ND	12,500	1031
d. 2 - SI - 63	0.0003	ND	0.0625	0.0675	2.75	ND	2450	1125
e. 3/4 - CH - 11A	0.0009	ND	0.0125	0.0008	2.75	0.25	10,000	2250
f. 2 - CH - 20	0.0009	ND	0.0375	0.0005	1.88	ND	1875	825
g. 2 - CH - 8C	0.0015	ND	0.2125	0.0005	2.25	0.38	12,500	3000
h. 2 - CH - 17	0.0005	ND	0.0750	0.0015	0.88	ND	2500	825

NOTES: (1) Based upon PS84351 Rev. 1 conversion; 500 ml sample solution and 20 dm^2 area:

$$\frac{VT}{A} = \frac{0.5\ l}{20\ dm^2} = 0.025\ \frac{l}{dm^2}$$ (multiplication factor)

(2) Based upon PS83336 KA Conversion; 500 ml sample solution and 20 g. insulation sample:

$$\frac{0.5\ l}{.02\ kg} = \frac{25\ l}{kg}$$ (multiplication factor)

TABLE 1

Line Number	Description
2-CH-8C	Seal water injection to "A" pump
3/4-CH-11A	Inlet to excess letdown heat exchanger
3/4-CH-11B	Outlet from excess letdown heat exchanger
3/4-CH-11C	Outlet from excess letdown heat exchanger
2-CH-17	Normal letdown to regenerative heat exchanger
2-CH-20	Normal letdown from regenerative heat exchanger
8-SI-37	RHR loop to "A" loop cold leg
2-SI-63	Boron injection to loop 1 cold leg

TABLE 2

Chemical Analysis (PPM)

Pipe				
Line Number	Chloride	Fluoride	Silica	Sodium
2-CH-8C	0.060	ND	0.02	8.5
3/4-CH-11A	0.035	ND	0.03	0.5
3/4-CH-11B	0.010	ND	0.50	1.0
3/4-CH-11C	0.030	ND	0.90	2.0
2-CH-17	0.020	ND	0.06	3.0
2-CH-20	0.035	ND	0.02	1.5
8-SI-37	0.060	ND	0.95	9.0
2-SI-63	0.010	ND	2.7	2.5

Insulation					
Line Number	Chloride	Fluoride	Silica	Sodium	pH
2-CH-8C	0.90	0.015	120.00	1500	10.3
3/4-CH-11A	0.11	0.01	90.00	400	10.3
3/4-CH-11B	0.085	ND	13.5	150	9.0
3/4-CH-11C	0.06	ND	26.25	65	9.4
2-CH-17	0.035	ND	33.0	100	9.6
2-CH-20	0.075	ND	33.0	75	9.4
8-SI-37	0.11	ND	41.25	500	10.1
2-SI-63	0.11	ND	45.00	98	9.4

ND - Not detectable

Multiplication factors noted in Table II of Attachment 2 are not included in this data.

TABLE 3

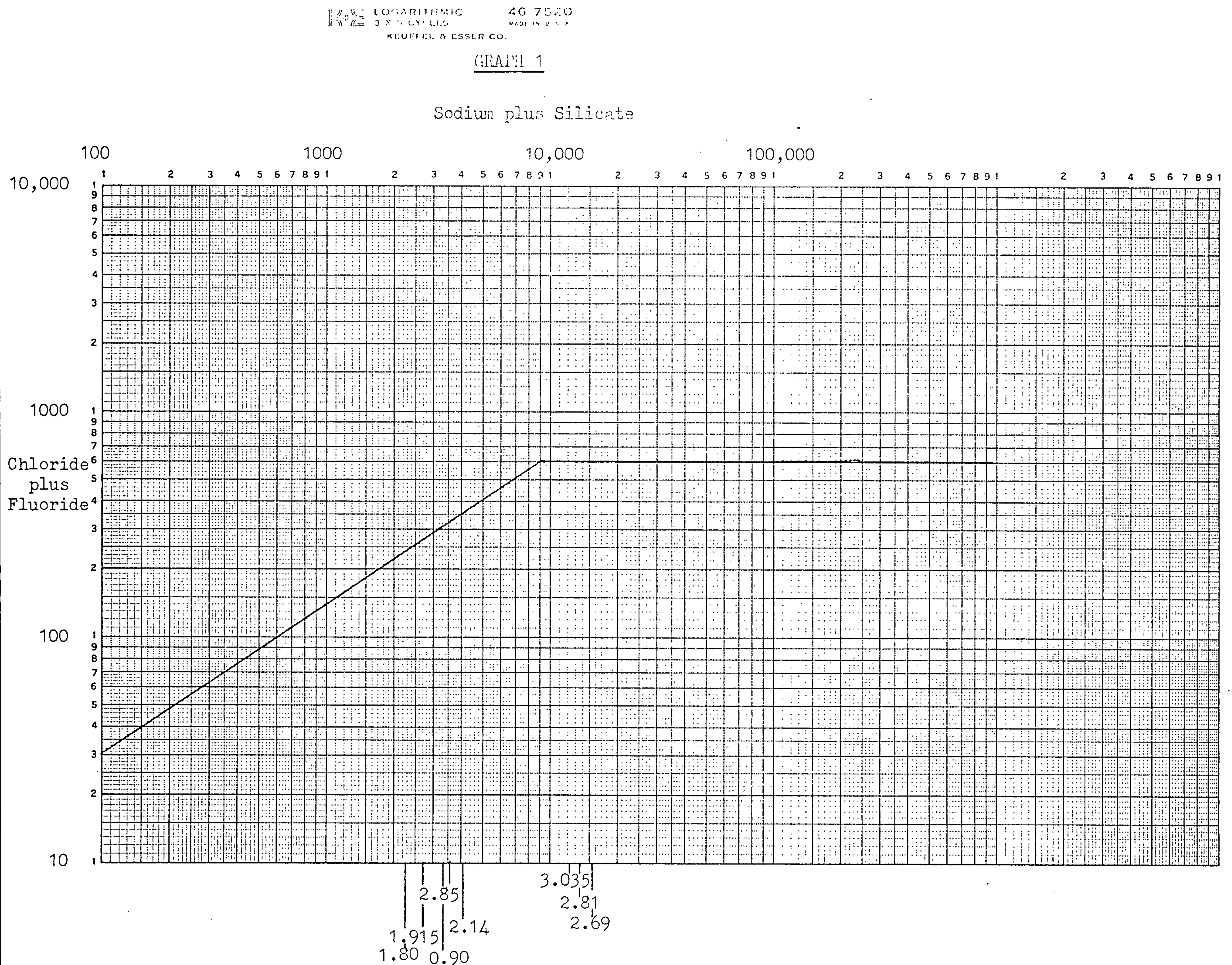
Chemical Analysis (PPM)

Description	Chloride	Fluoride	Silica	Sodium
A loop insulation	3.5	ND	437	787
B loop insulation	3.75	ND	900	1500
C loop insulation	3.25	ND	375	275
Reactor Vessel Incore Thimble Penetrations				
1	ND	ND	0.125	ND
2	ND	ND	ND	0.04
3	ND	ND	0.1	0.01

Sample Location	Chloride (ug/dm^2)	Fluoride (ug/dm^2)
C Loop Inlet	3.7	ND
C Loop Outlet	61	ND
C RCP Location #1	50	ND
C RCP Location #2	47	ND

ND - Not detectable

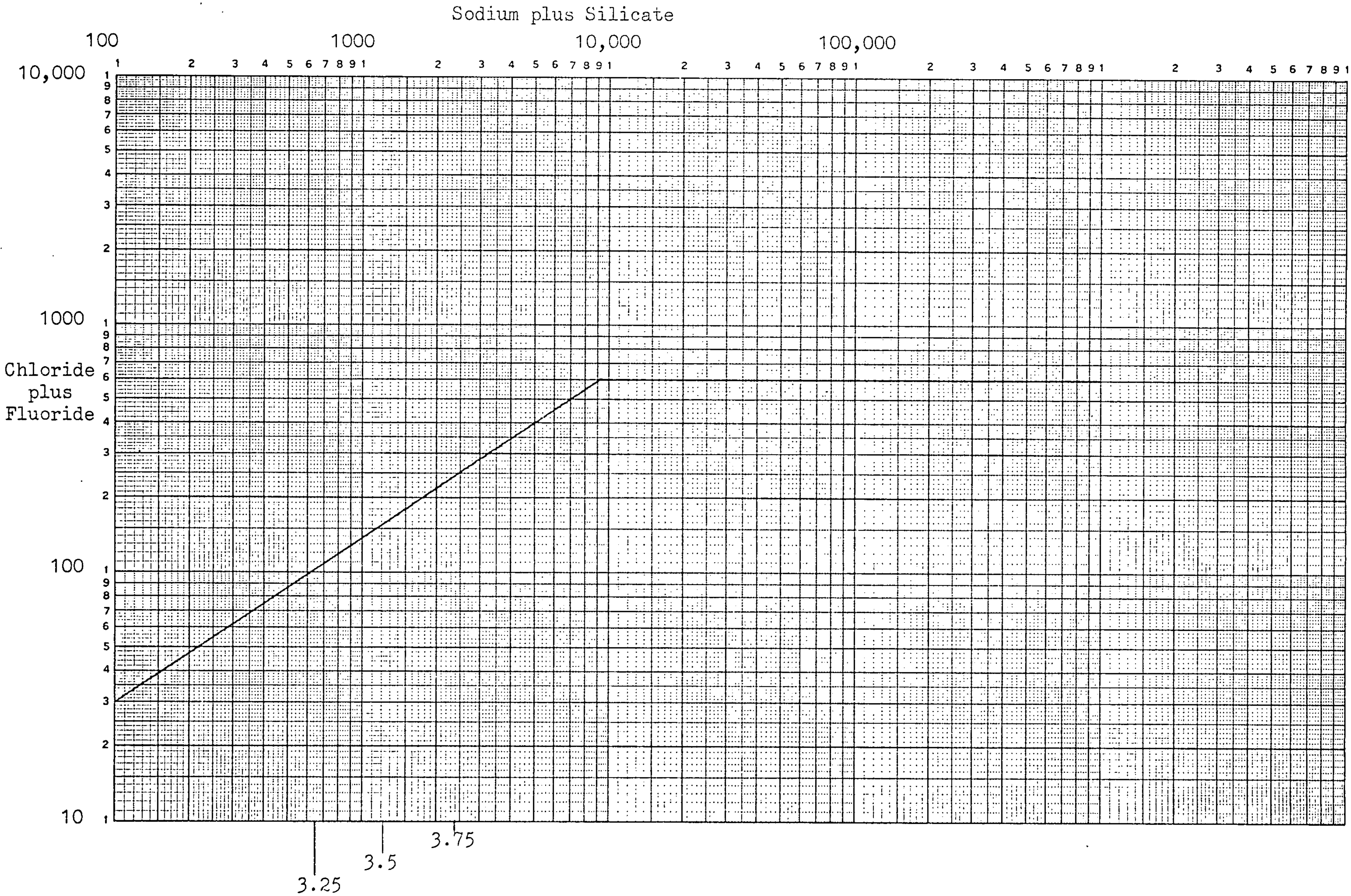
GRAPH 1



LOGARITHMIC 46 7520
3 X 5 CYCLES
KEUFFEL & ESSER CO.
Sodium plus Silicate
100
1000
10,000
100,000
10,000
1000
Chloride plus Fluoride
100
10
2.85
1.915
1.80
0.90
2.14
3.035
2.81
2.69

K+E LOGARITHMIC 3 X 5 CYCLES 46 7520 MADE IN U.S.A.
KEUFFEL & ESSER CO.

GRAPH 2

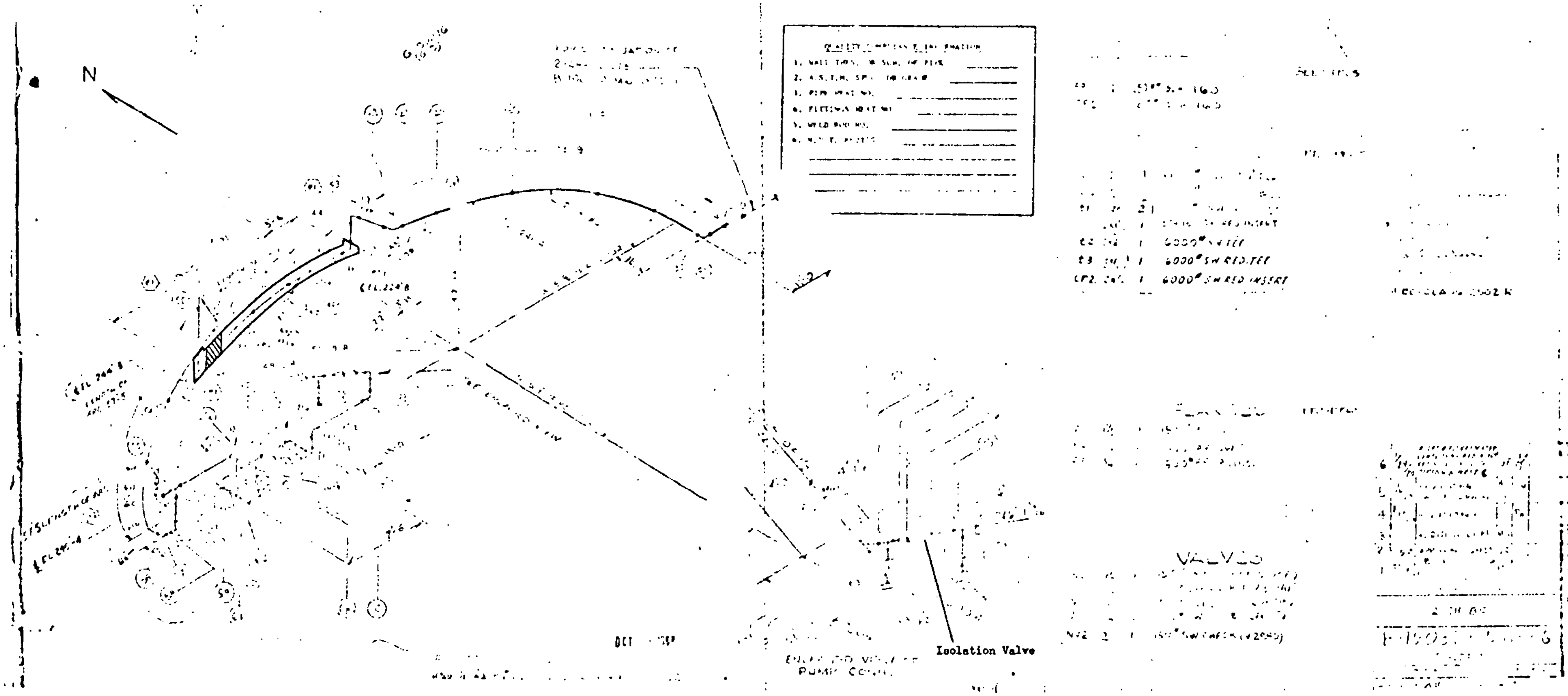


LINE DIAGRAM 1

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

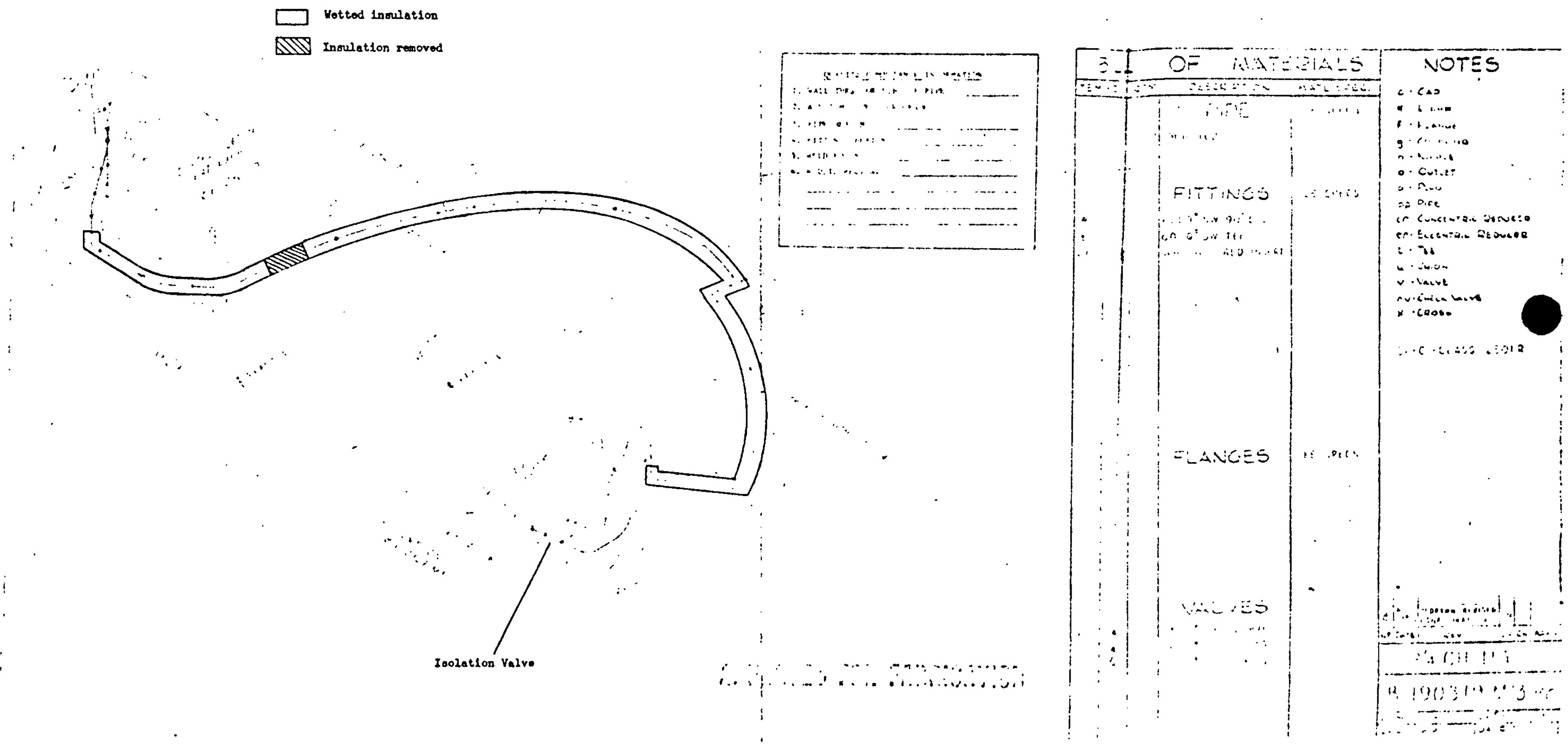
☐ Wetted insulation

▨ Insulation removed



LINE DIAGRAM 2

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

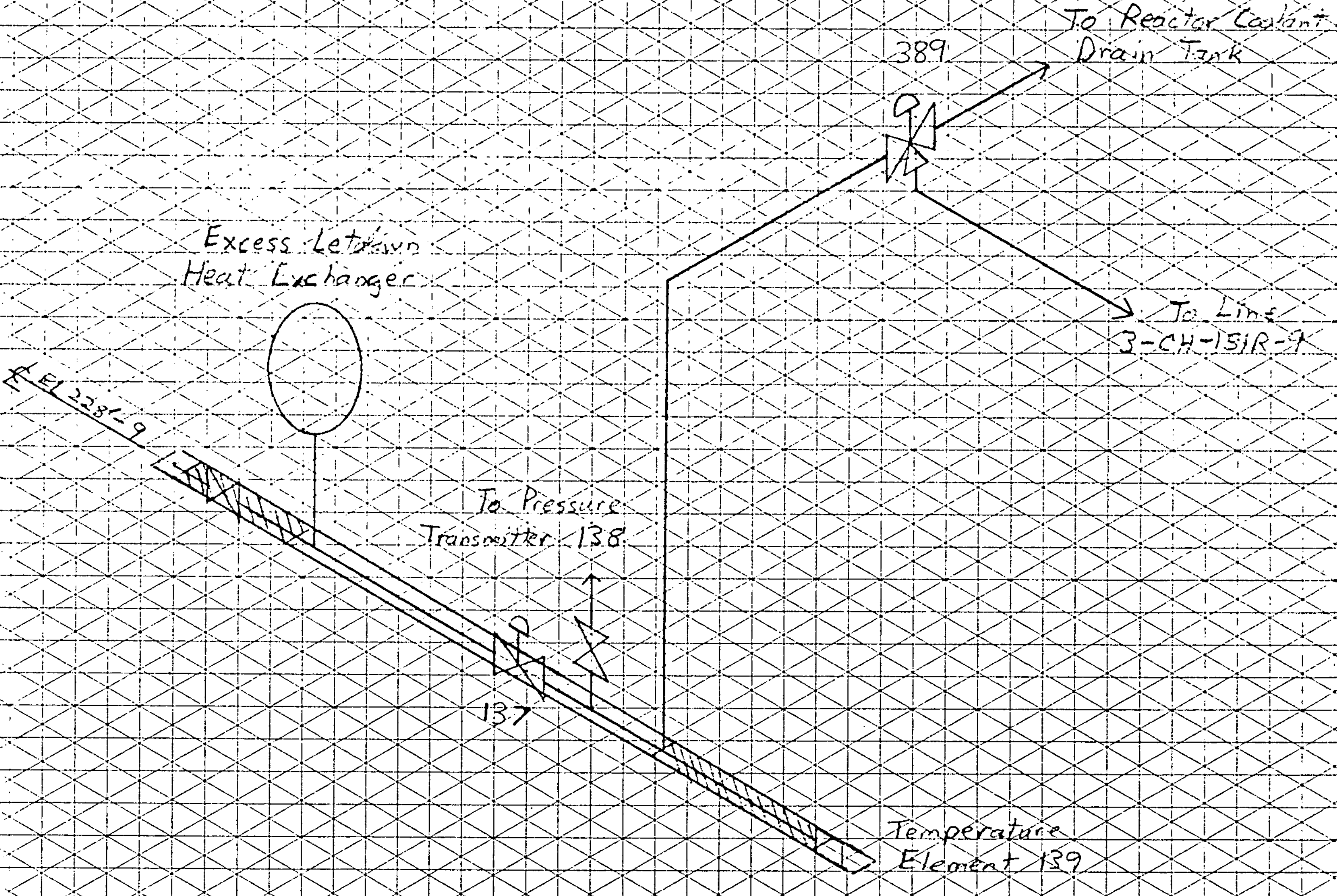


LINE DIAGRAM 3

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

Wetted insulation

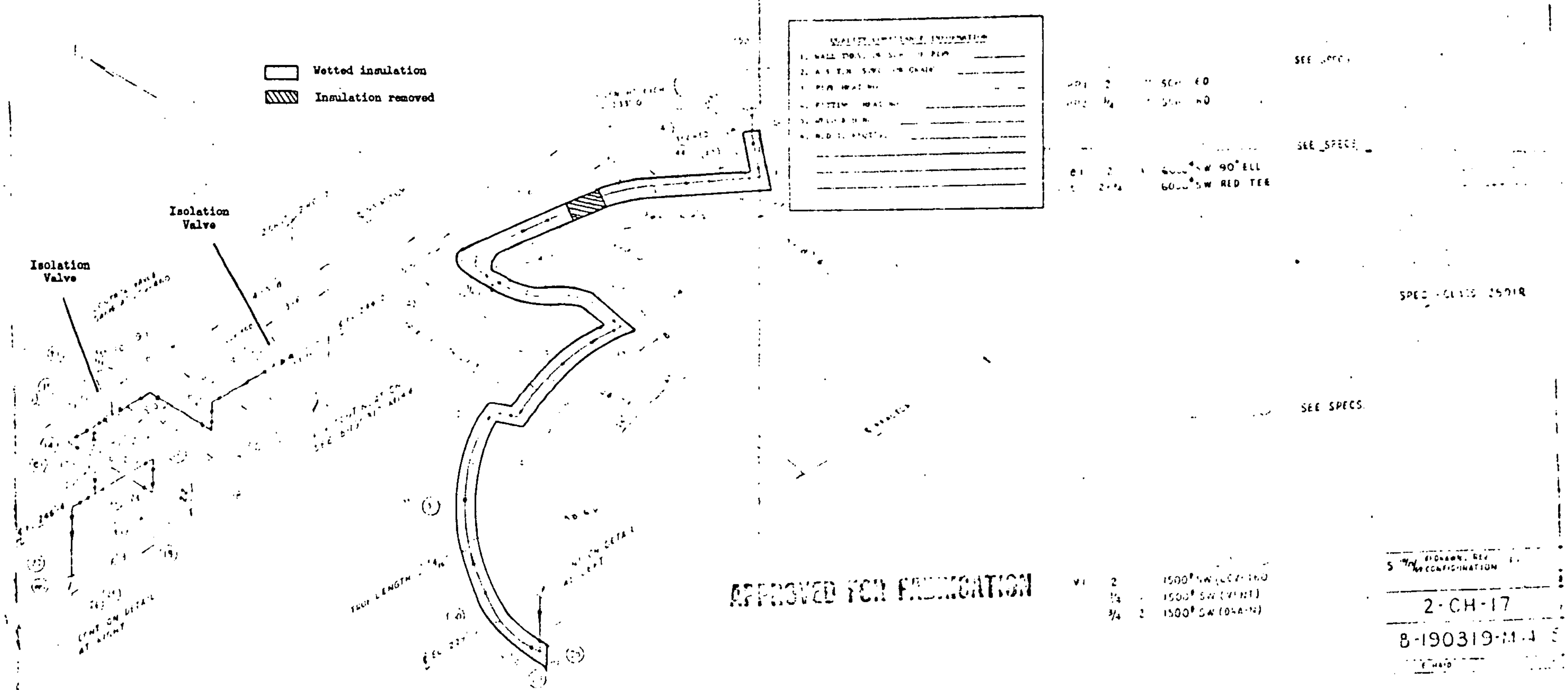
Insulation removed



3/4-CH-11B & 3/4-CH-11C

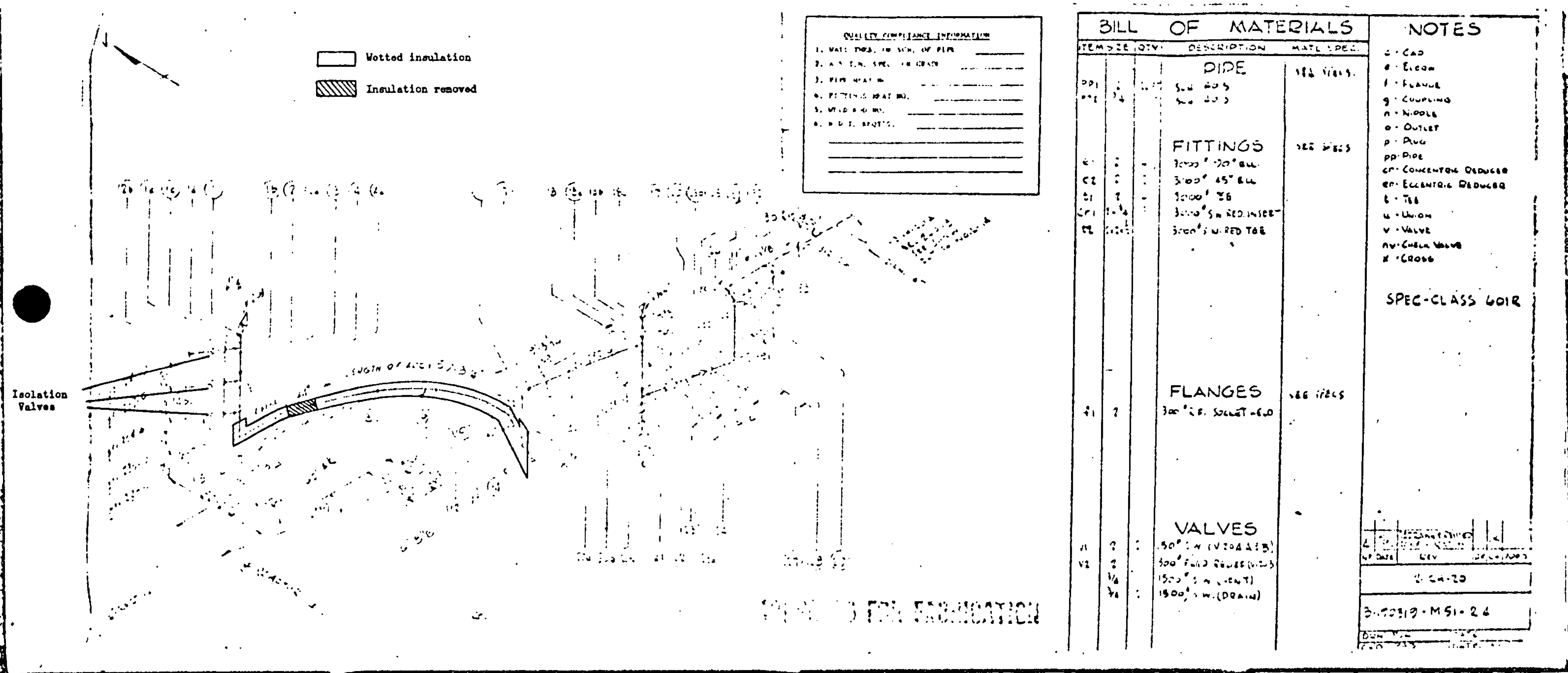
LINE DIAGRAM 4

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet



LINE DIAGRAM 5

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

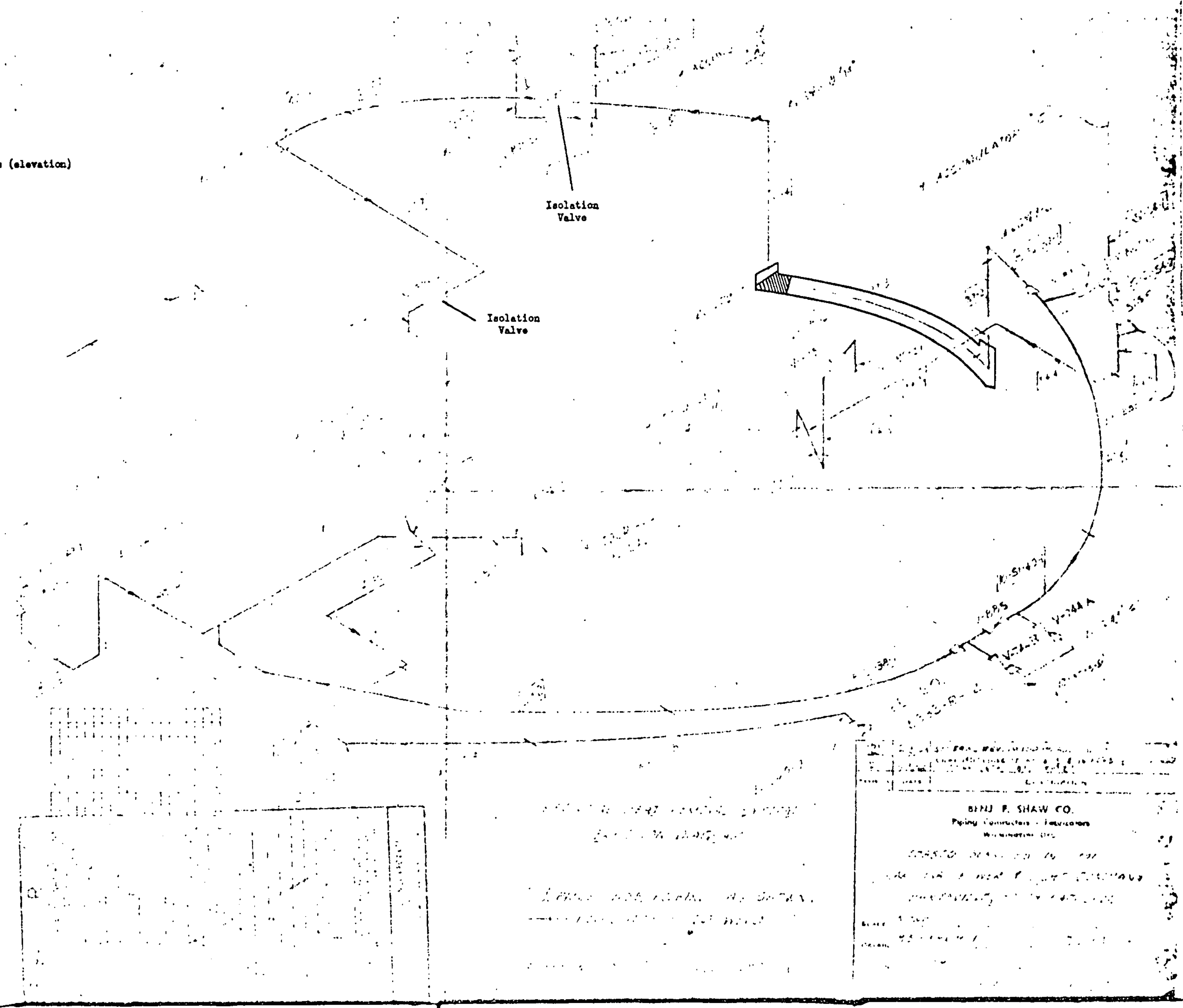


LINE DIAGRAM 6

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

Wetted insulation

Insulation removed



LINE DIAGRAM 7

MAXIMUM WATER LEVEL: 229 feet 3/4 inches (elevation)
FLOOR ELEVATION: 228 feet

☐	Wetted insulation
▨	Insulation removed