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Fort St. Vrain
Unit No. 1
P-86105

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Mr. H. N. Berkow, Director
Standardization and Special
Projects Directorate

Docket No. 50-267

SUBJECT: Inservice Inspection of High Energy Piping, Final Report

REFERENCES:
1. NRC letter, Denton to Walker, dated 2/7/86 (G-86062)
2. PSC letter, Walker to Berkow, dated 12/10/85 (P-85460)
3. NRC Policy Issue SECY 85-370 dated 11/22/85 (G-85488)

Dear Mr. Berkow:

Attached for your information is the final report on the Inservice Inspection program which PSC recently performed on the high energy piping at Fort St. Vrain (FSV). As discussed in the Safety Evaluation of Confirmatory Item 6, Inservice Inspection (Enclosure 6 to Reference 1), this program inspected 35 critical areas of FSV's high energy piping, and verified the integrity of this piping in support of 35 percent power operation.

If you have any questions concerning this inspection, please contact Mr. M. H. Holmes at (303) 480-6960.

Very truly yours,

D. W. Warembourg

D. W. Warembourg, Manager
Nuclear Engineering Division

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FORT ST. VRAIN
LIMITED INSPECTION PLAN
FOR HIGH ENERGY PIPING
AS DEFINED UNDER EQ PROGRAM
CONFIRMATORY ACTION 6

TABLE OF CONTENTS

Section 1: INSPECTION PROGRAM
- Program Definition and Purpose
- Inspection Criteria
- Examination Point Selection Criteria
- Nondestructive Examination Methods
- Evaluation Criteria

Section 2: PROGRAM OBJECTIVES
- Selected Inspection Areas
- Nondestructive Examination Procedures
- Nondestructive Examination Personnel
- Inspection Preparation

Section 3: INSPECTIONS PERFORMED
- Points Examined and Comparison to Areas Selected
- Inspection Personnel
- Repairs
- Results

Section 4: CONCLUSIONS

Attachment 1: NONDESTRUCTIVE EXAMINATION PROCEDURES

Attachment 2: ISOMETRICS

SECTION 1

INSPECTION PROGRAM

Program Definition and Purpose

The purpose of the program was to provide Augmented Inservice Inspection, of Category D (ANSI B31.1, 1967), high energy, secondary cooling systems at FSV. The inspections were designed to determine the present condition of these systems by random sampling and thereby confirm that no inservice induced deterioration has occurred. The original construction code (ANSI B31.1, 1967) which is the basis for system quality was not intended to be an inservice inspection code and did not provide volumetric inspection baseline standards except for field weld radiographs. Therefore, ASME Section XI "Rules for Inservice Inspection of Nuclear Power Plant Components" 1980 Edition up to and including Winter 81 Addenda, was selected as guidance for the formulation of the nondestructive examination methods and procedures, including initial evaluation of inspection results.

The purpose of the inspection was to fulfill the requirements of Confirmatory Action 6 (Reference G-85488, Enclosure 1) in support of the FSV 35 percent power operation during the Environmental Qualification schedule extension period, i.e., verify the current integrity of FSV's high energy piping.

Inspection Criteria

Inspections will be performed in accordance with approved FSV inspection procedures (Attachment 1).

Examination Point Selection Criteria

Examination points are selected to be representative of the various possible combinations of high energy systems, piping fabrication methods, materials of construction, and degradation phenomena as follows:

Systems:
- Main Steam (MS)
- Feedwater (FW)
- Hot Reheat (HRH)
- Cold Reheat (CRH)

Fabrication Methods:
- Seamless
- Hollow Forged
- Welded Plate

Material Composition:
- 2-1/4% Cr - 1% Mo ASTM A335 Gr P22
- 2-1/4% Cr - 1% Mo ASTM A155 (A691)
- 2-1/4% Cr - 1% Mo ASTM A234, WP22
- 2-1/4% Cr - 1% Mo ASTM A182, F22
- Carbon Steel A106, GR A or B
- Carbon Steel, A155
- Carbon Steel, A234, WPB or WPC

Degradation Phenomena:
- Thermal Fatigue
- Mechanical Fatigue
- Corrosion
- Erosion

An example of the process used in the selection of examination points for the main steam system is as follows:

Table 2A indicates that the main steam system piping has two types of fabrication, seamless and hollow forged and one type of material, 2-1/4% Cr - 1% Mo A335. Combining this with the four degradation phenomena results in eight examination points for the main steam system piping. The examination points for the other three systems were selected in this manner except for feedwater where corrosion is not considered to be a contributing factor, since feedwater piping normally remains solid with deoxygenated water during plant shutdown.

All welds uncovered at the examination point were examined which provided a total of 85 examinations.

The following information is presented to demonstrate how the effects of the degradation phenomena are factored into the selection of the examination points.

* Thermal Fatigue - Thermal fatigue is caused by the stresses created by thermal expansion and contraction as the pipe heats up and cools down. The critical areas are assumed to be those that see high stress values during each thermal cycle. These areas were identified using the thermal stress analyses for each system.

* Mechanical Fatigue - The mechanical fatigue suffered by the pipe material is caused primarily by the continuous low amplitude vibration from fluid flow and equipment operation. Since this type of cyclic stress analysis was not required for this vintage plant, the assumption is made that the response of the pipe to small vibrations is similar to the response to large vibrations such as those created by seismic events. Using this basis, the critical areas for mechanical fatigue were selected based on the high stress areas in the Operating Basis Earthquake (OBE) analysis for each system.

* Corrosion - The high purity and low oxygen content of the water in the high energy piping systems result in a very low rate of generalized corrosion. The primary concern was in identifying areas of localized corrosion of critical areas in which water may pocket during shutdown conditions. Pipe low points and potential water pockets were identified as inspection points by reference to the isometric drawings showing the piping arrangement.

* Erosion - Erosion damage to the pipe can be caused by a number of mechanisms. Those of concern were from water velocity and cavitation in the feedwater system, entrained water in the cold reheat system, entrained water downstream of desuperheaters, and solid particles in the main steam and hot reheat systems. Regardless of mechanism, the areas of the pipe subject to erosion are primarily where changes in direction occur. Inspection points were then selected by referring to the isometric for each system.

* Creep Rupture - Note that creep rupture was not considered in the selection of examination points. The reason for this is that creep damage is a function of the time spent at temperature while under stress. The allowable stress levels established by the design codes are intended to limit creep damage to acceptable levels over the total design life of the plant. Variations in material properties and operating conditions have made advisable the examination of piping in older units for creep damage. Since the estimated operating time at temperature for the main steam and hot reheat lines is less than two years, which is a small fraction of the plant design life, creep rupture was not considered a significant concern at this time.

Nondestructive Examination Methods

The three types of examinations used during the implementation of this inspection plan, are defined as visual, surface, or volumetric. The examination method(s) used is specified in (Standards for Examination Category,) "Examination Categories," table, below.

Visual Examination

The visual examination was conducted to determine the condition of the part, component, or surface examined, including such conditions as cracks, wear, corrosion, erosion, or physical damage on the surface of the part or components.

Surface Examination

A surface examination indicates the presence of surface cracks or discontinuities. This method was conducted by either magnetic particle examination in accordance with Article 7 of ASME Section V, or liquid penetrant examination in accordance with Article 6 of ASME Section V.

Volumetric Examination

A volumetric examination indicates the presence of discontinuities throughout the volume of material and was conducted by radiography in accordance with Article 2 of ASME Section V, or by ultrasonic examination, in accordance with Appendix III of ASME Section XI.

Calibration standards employed during ultrasonic examinations comply with the design requirements of Appendix III of ASME Section XI.

Standards for Examination Categories

The high energy piping covered under this inspection program is classified as Piping Design Class "D" in accordance with ANSI B31.1, (1967), Power Piping Code, and associated errata correction. It is therefore, not subject to the conditions of Quality Group A, B, or C as defined by ASME Section III or Section XI, Divisions 1 or 2. However, in order to maintain the equivalent safety margin of the acceptance standards of Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, PSC applied the examination categories under Table IWC-2500-1:

Examination Categories

EXAMINATION CATEGORY C-F, PRESSURE RETAINING WELDS IN PIPING					
ITEM No.	Parts Examined	Examin. Require./ Fig. No.	Examin. Method	Accept. Standard	Extent Of Examination
C5.11	Circumferential Weld	IWC-2500-7	Surface	IWC-3000	100% of each weld requiring examination
C5.12	Longitudinal Weld	IWC-2500-7	Surface	IWC-3000	2.5t - at the intersecting circum. weld
C5.20	Piping Welds >1/2 in. Nominal Wall Thickness				
C5.21	Circumferential Weld	IWC-2500-7	Surface and Volumetric	IWC-3000	100% of each weld requiring examination
C5.22	Longitudinal Weld	IWC-2500-7	Surface and Volumetric	IWC-3000	2.5t - at the intersecting circum. weld
C5.30	Pipe Branch Connections >4 in. Nominal Branch Pipe Size				
C5.31	Circumferential Weld	IWC-2500-9 to -13, inclusive	Surface	IWC-3000	100% of each weld requiring examination
C5.32	Longitudinal Weld	IWC-2500-12 and -13	Surface	IWC-3000	2.5t - at the intersecting circum. weld

The selected components were be examined by the nondestructive method described under Nondestructive Examination Methods section in this program, to the extent as specified by the preceding categories.

Evaluation Criteria

As stated in the "Standards for Examination Categories" Section of this Plan, the high energy piping required for inspection is classified as Piping Design Class "D" in accordance with ANSI B31.1, (1967), Power Piping Code. This piping, therefore, was not subject to the inspection requirements required for Quality Group A, B, or C as defined by ASME Section III or Section XI, Divisions 1 or 2. However, since codes governing the inservice inspection of Class "D" piping do not exist, PSC utilized ASME Section XI as guidance for this augmented Inspection Plan. This transition from Class "D" to the ASME Section XI classification created the need for PSC to revise procedures for these inspections.

Additionally, construction system design did not consider ASME Section XI examination requirements nor provide baseline inspections; therefore, the examinations were performed to the extent practical to comply with the intent of the inservice inspection code (ASME, Section XI). PSC did not perform any surface reconditioning of weld crowns since this would have decreased traceability to the original construction records, i.e., radiography. Evaluation for continuation of service and acceptance of components was in accordance with the original construction code, ANSI B31.1, with consideration given to the applicable ASME Section XI Flaw Indication Standard(s) as guidance.

SECTION 2

PROGRAM OBJECTIVES

Selected Inspection Areas

The inspection areas selected, including selection factors, are listed on Table 2A. Marked up isometric drawings of the inspection areas are contained in Attachment 2. Also included are isometric drawings which identify the hot and cold reheat, welded plate piping by cross-hatching on drawings 11A-154, 11A-155, 11A-156, 11A-161, 11A-162, 11A-163, 11A-164, 14A-87, and 14A-88.

TABLE 2A

INSPECTION AREA	SYSTEM	INSPECTION FOR	CONSTRUCTION TYPE		PIPE CLASS	SIZE	WALL	NUMBER	DRAWING NUMBER	NUMBER
1	FW	Th. F.	Seamless	A106, GR. B	D2A	11.75	1.574	L3188	5-99	20
2	FW	Th. F.	Hollow Forged	A106, GR. B*	D2A	17.5	2.344	L31100	5-103	305
3	FW	M. F.	Seamless	A106, GR. C	D2A	5	Sch XXS	L2203	5-96	415
4	FW	M. F.	Hollow Forged	A106, GR. B*	D2A	13	1.742	L2201	5-95	585
5	FW	Eros.	Hollow Forged	A106, GR. B	D2A	13	1.742	L2202	5-92	452-455
6	FW	Eros.	Hollow Forged	A106, GR. B*	D2A	13	1.742	L2201	5-95	585
7	MS	Th. F.	Hollow Forged	A335, GR. P22	D1	16.25	2.715	L2221	14A-93	330
8	MS	Th. F.	Seamless	A335, GR. P22	D1	8.75	1.462	L2286	14A-90	756
9	MS	M. F.	Seamless	A335, GR. P22	D1	8.75	1.462	L2271	14A-94	186
10	MS	M. F.	Hollow Forged	A335, GR. P22	D1	16.25	2.715	L2278	14A-99	205
11	MS	Corros.	Seamless	A335, GR. P22	D1	8.75	1.462	L2271	14A-94	183-186
12	MS	Corros.	Hollow Forged	A335, GR. P22	D1	20.75	2.996	L5201	2-255	455
13	MS	Eros.	Seamless	A335, GR. P22	D1	8.75	1.462	L2271	14A-94	186
14	MS	Eros.	Hollow Forged	A335, GR. P22	D1	16.25	2.715	L2278	14A-99	205
15	CRH	Th. F.	Seamless	A106, GR. B	D9	12	Sch. 80	L2295	11A-159	335
16	CRH	Th. F.	Welded Plate	A515, GR. 60	D9	32	1.268	L5207	11A-164	990
17	CRH	M. F.	Seamless	A106, GR. B	D9	12	Sch. 80	L2295	11A-159	335
18	CRH	M. F.	Welded Plate	A155, GR. 60	D9	26.5	1.088	L22250	11A-156	635
19	CRH	Eros.	Seamless	A106, GR. B	D9	14	Sch. 80	L2293	11A-159	411-415
20	CRH	Eros.	Welded Plate	A515, GR. 60	D9	32	1.268	L5207	11A-164	990
21	CRH	Corros.	Seamless	A106, GR. B	D9	14	Sch. 80	L2293	11A-159	411-415
22	CRH	Corros.	Welded Plate	A515, GR. 60	D9	32	1.268	L5207	11A-164	990
23	HRH	Th. F.	Seamless	A335, GR. P22	D3	11	0.800	L2248	14A-76	350
24	HRH	Th. F.	Seamless	A335, GR. P22	D3	11	0.800	L2248	14A-76	355
25	HRH	Th. F.	Welded Plate	A155, GR. 2 1/4 CR, CL 1	D6	20	0.896	L52200	14A-87	970
26	HRH	M. F.	Seamless	A335, GR. P22	D6	22	1.004	L5217	14A-87	485
27	HRH	M. F.	Hollow Forged	A335, GR. P22	D3	22.25	1.714	L22112	14A-85	205-211
28	HRH	M. F.	Welded Plate	A155, GR. 2 1/4 CR, CL 1	D6	20	0.896	L52200	14A-87	495
29	HRH	Corros.	Seamless	A335, GR. P22	D3	11	0.800	L22105	14A-84	185
30	HRH	Corros.	Hollow Forged	A335, GR. P22	D3	22.25	1.714	L2252	14A-85	250-986
31	HRH	Corros.	Welded Plate	A155, GR. 2 1/4 CF CL 1	D6	34	1.511	L5216	14A-87	540-550
32	HRH	Eros.	Seamless	A335, GR. P22	D3	11	0.800	L22105	14A-84	185-186
33	HRH	Eros.	Hollow Forged	A335, GR. P22	D3	22.25	1.714	L22112	14A-85	204
34	HRH	Eros.	Welded Plate	A155, GR, 2 1/4 CR, CL 1	D6	34	1.511	L5216	14A-87	540-550
35**	FW	Eros.	Seamless	A106, GR. B	D2B	6	.864	L21224	10A-66	231

* Additional Tolerances Per ASTM A530.

** This area inspected due to historical erosion problems.

Nondestructive Examination Procedures

Copies of approved FSV examination procedures are attached (Attachment 1).

Nondestructive Examination Personnel

Personnel performing the nondestructive examinations shall be certified as Level I, II or III, as appropriate, in accordance with QCIM-4 or NDE-1. These personnel will be PSC employees or contractors.

Inspection Preparation

Insulation will be removed and the surfaces prepared as necessary to perform these inspections. The majority of the insulation is asbestos and as such requires special precautions for handling.

SECTION 3

INSPECTIONS PERFORMED

Points Examined and Comparison to Areas Selected

The insulation was removed and appropriate surface preparation performed for the areas selected for inspection on Table 2A. Two areas (C&G) were included from earlier inspections which were not on Table 2A. Two areas (H&J) were included because the areas were available due to insulation removal for other reasons. One area (36) was added to the list to include a possible erosion area downstream of the main steam desuperheaters. When the insulation was removed from an inspection area, the exposed longitudinal or circumferential welds were inspected. Inspections included magnetic particle, ultrasonic for thickness, and angle beam ultrasonic for defects whenever possible within the restraints imposed by supports attached to the piping. Area 25 at the hot reheat steam chest was radiographed for the first PSC reports and since there is a pipe support interference, additional inspection was not performed. Three areas inspected were identified as potential mechanical fatigue or erosion areas (205-MDPT, IP 10/14; 206-A, IP27; & 204-MDPT, IP33), but either did not have welds at all or did not have accessible welds so only base metal was examined, although they are numbered like and referred to as welds.

The following are summary totals from Table 3A (attached); and piping spool drawings.

I. Number of Welds Inspected by System

a.	Main Steam	23
b.	Feedwater	15
c.	Hot Reheat	31
d.	Cold Reheat	13
	Total	82

II. Number of Welds Inspected by Type

a.	Circumferential	74
b.	Longitudinal	8
	Total	82

III. Number of Welds Inspected by Potential Failure Mechanism

a.	Thermal Fatigue	25	
b.	Mechanical Fatigue	27	
c.	Corrosion	15	
d.	Erosion	15	
e.	Other	7	
	Total	82	(Some Repeat)

IV. Number of Welds Inspected by Pipe Fabrication Type

a.	Seamless	57
b.	Hollow Forged	5
c.	Welded Plate	20
	Total	82

V. Number of Welds Inspected by Material Type

a.	A335, P22	40	
b.	A155, 2-14/% Cr - 1% Mo.	11	
c.	A234, WP22	29	
d.	A182, F22	12	
e.	A106, B or C	18	
f.	A155, Carbon Steel	9	
g.	A234, WPB or WPC	25	
	Total	82	(Some of the welds are for two different materials)

VI. Number of Inspections Performed

a.	Magnetic Particle	79
b.	UT, Thickness	74 + 5 partial
c.	UT, angle beam	73 + 4 partial
d.	RT (other than confirmatory)	3

TABLE 3A

Weld No.	Inspection Point(s)	Examine For	Mag Particle	Thickness	Angle Beam	Remarks
W1/20-A	1 (MF) 11.75" L3188-D2A	Therm. Fat.	TRM-2621	IP-1-T-01	IP-1-45-01	Recordable Indication TRR-2659
W2/20-B	1 (MF) 11.75" L3188-D2A	Therm. Fat.	TRM-2621	IP-1-T-01	IP-1-45-01	50% of weld accessible due to hanger.
W1/305-A	2 (MF) 17.5" L31100-D2A	Therm. Fat.	TRM-2620	IP-2-T-01	IP-2-45-01	45 degrees UT from elbow side only.
W2/305-B	2 (MF) 17.5" L31100-D2A	Therm. Fat.	TRM-2620	IP-2-T-01	IP-2-45-01	
W1/415-B	3 (MF) 5" L2203-D2A	Mech. Fat.	TRM-2619	IP-3-T-01	IP-3-45-01	Rough Weld Surface required offset scan.
W2/415-A	3 (MF) 5" L2203-D2A	Mech. Fat.	TRM-2619	IP-3-T-01	IP-3-45-01	
W1/585-A	4 (MF) 13" L2201-D2A	Mech. Fat.	TRM-2618	IP-4/6-T-01	IP-4/6-45-01	
W2/585-B	4 (MF) 6 (MF) 13" L2201-D2A	Mech. Fat. Erosion	TRM-2618 TRM-2618	IP-4/6-T-01 --	IP-4/6-45-01 --	
W1/455-A	5 (MF) 13" L2202-D2A	Erosion	TRM-2624	IP-5-T-01	IP-5-45-01	
W2/455-B	5 (MF) 13" L2202-D2A	Erosion	TRM-2624	IP-5-T-01	IP-5-45-01	
W3/452-A	5 (MF) 13" L2202-D2A	Erosion	TRM-2624	IP-5-T-01	IP-5-45-01	
W4/450-A	5 (MF) 13" L2202-D2A	Erosion	TRM-2624	IP-5-T-02	IP-5-45-01	
W1/450-B	5 (MF) 10" L22266-D2A	Erosion	TRM-2624 TRM-2638	IP-5-T-03 --	IP-5-45-02 --	Rejectable surface indications. Surface indications buffed out satisfactorily - thickness checked after buffing.
W1/350-A	7 (MS) 8.75" L2216-D1	Therm. Fat.	TRM-2631	IP-7-T-01 (1/16/86)	IP-7-45-01 (1/17/86)	Downstream limitation due to welded attachments.
W2/350-B	7 (MS) 8.75" L2216-D1	Therm. Fat.	TRM-2631	IP-7-T-01 (1/16/86)	IP-7-45-01 (1/17/86)	From elbow side only.
W1/330-A	7 (MS) 16.25" L2221-D1	Therm. Fat.	TRM-2655	IP-7-T-01 (1/19/86)	IP-7-45-01 (1/19/86)	

TABLE 3A

Weld No.	Inspection Point(s)	Examine for	Mag Particle	Thickness	Angle Beam	Remarks
W1/210-A	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W2/756-A	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W3/756-B	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W4/754-A	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W5/762-A	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	Recordable angle beam indication identified as ID geometry.
W6/762-B	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W7/PV2730-A	8 (MS) 8" L2286-D1	Therm. Fat.	TRM-2625	IP-8-T-01	IP-8-45-01	
W1/268-A	11 (MS) 8.75" L2271-D1	Corrosion	TRM-2650	IP-9/11/13-T-01	IP-9/11/13-45-01	
W2/186-A	9 (MS) 13 (MS) 8.75" L2271-D1	Mech. Fat. Erosion	TRM-2650 --	-- IP-9/11/13-T-01	IP-9/11/13-45-01 --	
W3/186-B	9 (MS) 13 (MS) 8.75" L2271-D1	Mech. Fat. Erosion	TRM-2650 --	-- IP-9/11/13-T-01	IP-9/11/13-45-01 --	
W1/205-MDPT	10 (MS) 14 (MS) 16.25" L2278-D1	Mech. Fat. Erosion	TRM-2644 --	-- IP-10/14-T-01	IP-10/14-45-01 --	Elbow mid-point - not a weld.
W1/455-A	12 (MS) 20.75" L5201-D1	Corrosion	TRM-2623	IP-12-T-01	IP-12-45-01	Scan from pipe side only.
W2/455-B	12 (MS) 15" L5202-D1	Corrosion	TRM-2623	IP-12-T-02	IP-12-45-02	Scan from pipe side only.
W3/455-C	12 (MS) 15" L5202-D1	Corrosion	TRM-2623	IP-12-T-02	IP-12-45-02	Scan to hanger interference on pipe side only.
W1/335-A	15/17 (CRH) 12" L2295-D9	Therm. & Mech. Fatigue	TRM-2629	IP-15/17-T-01	IP-15/17-45-01	
W2/335-B	15/17 (CRH) 12" L2295-D9	Therm. & Mech. Fatigue	TRM-2629	IP-15/17-T-01	IP-15/17-45-01	

TABLE 3A

Weld No.	Inspection Point(s)	Examine For	Mag Particle	Thickness REMARKS	Angle Beam	Remarks
W1/990-B	16 (CRH) 32" L5207-D9	Therm. Fat.	TRM-2617	IP-16/20/22-T-01	IP-16/20/22-45-01	
W2/990-C	16 (CRH) 20/22 (CRH) 32" L5207-D9	Therm. Fat. Erosion/Corrosion	TRM-2617 --	-- IP-16/20/22-T-01	IP-16/20/22-45-02 --	
W3/990-D Longitud-inal	16 (CRH) 32" L5207-D9	Therm. Fat. Long. Weld	TRM-2617	IP-16/20/22-T-01	IP-16/20/22-45-02	
W1/635-A Longitud-inal	18 (CRH) 26.5" L22250-D9	Mech. Fat.	TRM-2641	IP-18-T-01	IP-18-45-01	
W2/635-B	18 (CRH) 26.5" L22250-D9	Mech. Fat.	TRM-2641	IP-18-T-01	IP-18-45-01	
W3/635-C	18 (CRH) 26.5" L22250-D9	Mech. Fat.	TRM-2641	IP-18-T-01	IP-18-45-01	
W4/635-D Longitud-inal	18 (CRH) 26.5" L22250-D9	Mech. Fat.	TRM-2641	IP-18-T-01	IP-18-45-01	
W1/415-B	19/21 (CRH) 14" L2293-D9	Erosion/Corrosion	TRM-2651	IP-19/21-T-01	IP-19/21-45-01 IP-19/21-60-01	
W2/415-A	19/21 (CRH) 14" L2293-D9	Erosion/Corrosion	TRM-2651	IP-19/21-T-01	IP-19/21-45-01 IP-19/21-60-01	Recordable 45 degree angle beam indication identified as ID geometry.
W1/350-B	23 (HRH) 11" L2248-D3	Therm. Fat.	TRM-2635	IP-23/24-T-01	IP-23/24-45-01	
W2/350-A	23 (HRH) 11" L2248-D3	Therm. Fat.	TRM-2635	IP-23/24-T-01	IP-23/24-45-01	
W3/355-A	24 (HRH) 11" L2248-D3	Therm. Fat.	TRM-2635	IP-23/24-T-01	IP-23/24-45-01	From pipe side only.
W1/970-C	25 (HRH) 20" L52200-D6	Therm. Fat.	N/A	N/A	N/A	RT. Only - TRR-2568
W2/970-B Longitud-inal	25 (HRH) 20" L52200-D6	Therm. Fat. Long. Weld	N/A	N/A	N/A	RT. Only - TRR-2568
W3/970-A	25 (HRH) 20" L52200-D6	Therm. Fat.	N/A	N/A	N/A	RT. Only - TRR-2568

TABLE 3A

Weld No.	Inspection Point(s)	Examine for	Mag Particle	Thickness	Angle Beam	Remarks
W1/485-B	26 (HRH) 22" L5217-D6	Mech. Fat.	TRM-2637	IP-26-T-01	IP-26-45-01	Reportable angle beam indication identified as counter bore.
W2/485-A	26 (HRH) 22" L5217-D6	Mech. Fat.	TRM-2637	IP-26-T-01	IP-26-45-01	
W1/206-A	27 (HRH) 22" L22112-D3	Mech. Fat.	TRM-2645	IP-27/33-T-01	IP-27/33-45-01	
W1/213-A	27 (HRH) 22" L22120-D3A	Mech. Fat.	TRM-2640	IP-27-T-02	IP-27-45-03	Scanned pipe side only.
W2/215-A	27 (HRH) 22" L22120-D3A	Mech. Fat.	TRM-2640	IP-27-T-02	IP-27-45-05	
W3/215-B	27 (HRH) 22" L22120-D3A	Mech. Fat.	TRM-2640	IP-27-T-02	IP-27-45-05	
W4/83-A	27 (HRH) 22" L2212[illegible]0-D3A	Mech. Fat.	TRM-2640	IP-27-T-02	IP-27-45-01	Scanned pipe side only - recordable indication identified as ID & OD geometry.
W1/432-A	27 (HRH) 22" L2253-D3A	Mech. Fat.	TRM-2639	IP-27-T-01	IP-27-45-04	Scanned pipe side only - recordable indication identified as ID & OD geometry.
W2/433-B	27 (HRH) 22" L2253-D3A	Mech. Fat.	TRM-2639	IP-27-T-01	IP-27-45-06	
W3/433-A	27 (HRH) 22" L2253-D3A	Mech. Fat.	TRM-2639	IP-27-T-01	IP-27-45-06	Reportable indications identified as ID & OD geometry.
W4/85-A	27 (HRH) 22" L2253-D3A	Mech. Fat.	TRM-2639	IP-27-T-01	IP-27-45-02	Scanned pipe side only.
W1/495-B	28 (HRH) 22" L5217-D6	Mech. Fat.	TRM-2622	IP-28-T-02	IP-28-45-02	
W2/495-A	28 (HRH) 22" L5217-D6	Mech. Fat.	TRM-2622 TRM-2632	IP-28-T-02	IP-28-45-03	Reportable indication identified as ID geometry. Two surface indications buffed out.
W3/495-C	28 (HRH) 20" L52200-D6	Mech. Fat.	TRM-2622	IP-28-T-01	IP-28-45-01	Reportable indication identified as OD geometry.

TABLE 3A

Weld No.	Inspection Point(s)	Examine For	Mag Particle	Thickness	Angle Beam	Remarks
W4/495-D Longitud-inal	28 (HRH) 20" L52200-D6	Mech. Fat.	TRM-2622	IP-28-T-01	IP-28-45-01	
W5/950-A	28 (HRH) 20" L52200-D6	Mech. Fat.	TRM-2622	IP-28-T-01	IP-28-45-01	Reportable indication identified as ID geometry.
W1/185-A	29/32 (HRH) 11" L22105-D3	Corrosion/Erosion	TRM-2647	IP-29/32-T-01	IP-29/32-45-01	
W2/185-B	29/32 (HRH) 11" L22105-D3	Corrosion/Erosion	TRM-2647	IP-29/32-T-01	IP-29/32-45-01	
W1/186-A	30 (HRH) 22" L2252-D3	Corrosion	TRM-2630	IP-30-T-01	--	Not accessible at top due to welded support.
BW1/435-A	31 (HRH) 34" L5216-D6	Corrosion	TRM-2628 TRM-2643	IP-31-T-01	IP-31-45-01	Mag particle indication ground out and repaired NCR-86-030. Could not scan top due to welded support.
BW2/545-B	31 (HRH) 34" L5216-D6	Corrosion	TRM-2628	IP-31-T-01	IP-31-45-01	Could not scan bottom due to welded support.
BW3/545-C	31/34 (HRH) 34" L5216-D6	Corrosion/Erosion	TRM-2628	IP-31-T-01	IP-31-45-01	
LW1/545-A Longitud-inal	31 (HRH) 34" L52 -D6	Corrosion Long. Weld	TRM-2628	IP-31-T-01	IP-31-45-01	
LW2/545-D Longitud-inal	31 (HRH) 34" L5216-D6	Corrosion Long. Weld	TRM-2628	IP-31-T-01	IP-31-45-01	
W1/204-MDPT	33 (HRH) 22" L22112-D3	Erosion	TRM-2645	IP-27/33-T-01	IP-27/33-45-01	
W1/231-A	35 (MF) 10" L21961-D28	Erosion	TRM-2649	IP-35-T-01	IP-35-45-01	
W1/226-A	35 (MF) 6" L21224-D28	Erosion	TRM-2648	IP-35-T-02	IP-35-45-02	
W1/695-A	36 (MS) 16" L5284-D9	Erosion	TRM-2646	IP-36-T-01		
W1/405-A	C (MS) 8.75" L2214-D1	High Stress	TRM-2636	IP-C-T-01	IP-C-45-01	Rejectable mag particle indications repaired.

TABLE 3A

Weld No.	Inspection Point(s)	Examine for	Mag Particle	Thickness	Angle Beam	Remarks
W1/115-B	G (CRH) 26.5" L22251-D9	Intersects Long Weld	TRM-2642	IP-G-T-01	IP-G-45-01 IP-G-60-01	Scan limited due to configuration & welded connection. Recordable indication identified as ID & OD geometry.
W2/115-A Longitud- inal	G (CRH) 26.5" L22251-D9	Long. Weld	TRM-2642	IP-G-T-01	IP-G-45-01 IP-G-60-01	Recordable indication identified as OD geometry.
W1/200-A	H (MS) 8.75" L2271-D1		TRM-2634	IP-H-T-01	IP-H-45-01	
W1/215-A	J (MS) 6" L22287-D1		TRM-2626	IP-J-T-01	IP-J-45-01 IP-J-45-02	Rough surface required offset scan with scewd transducer from pipe side only.
W2/492-A	J (MS) 6" L22287-D1		TRM-2626	IP-J-T-01	IP-J-45-01 IP-J-45-02	Recordable indication identified as ID geometry.
W3/492-B	J (MS) 6" L22287-D1		TRM-2626	IP-J-T-01	IP-J-45-01 IP-J-45-02	Recordable indication identified as ID geometry. Scanned elbow side only.

Inspection Personnel

The personnel who performed the surface, volumetric and or visual examinations were qualified in accordance with FSV procedure QCIM-4 or EBASCO procedure NDE-1. Personnel qualification records are available at FSV for inspection.

Repairs

One surface indication which could not be buffed out was detected by magnetic particle examination (BW1/435-A, IP31). Disposition of NCR-86-030 resulted in grinding the indication out, repair by welding, heat treatment, and satisfactory reexamination.

Results

No indications attributable to inservice induced degradation were noted in any areas examined.

SECTION 4

CONCLUSIONS

Augmented inspection of selected areas in main steam, feedwater, hot reheat, and cold reheat revealed no inservice induced defects. Therefore, the current integrity of FSV's high energy piping has been verified, and the requirements of Confirmatory Action 6 in support of the FSV 35 percent power operation during the Environmental Qualification schedule extension period have been fulfilled.

NONDESTRUCTIVE EXAMINATION PROCEDURES

QCIM-20	Liquid Penetrant Test Procedure	Issue 4
QCIM-23	Dry Magnetic Particle Inspection Procedure	Issue 5
QCIM-24	Fluorescent Magnetic Particle Inspection	Issue 3
QCIM-30	Radiographic Examination Procedure	Issue 5
QCIM-38	Ultrasonic Examination of Class 1 and 2 Piping Welds Joining Similar and Dissimilar Materials	Issue 1

TITLE: LIQUID PENETRANT TEST PROCEDURE

(Solvent-Removable Visible Dye Penetrant)

ISSUANCE AUTHORIZED BY		
PORC REVIEW	PORC 655 JAN 8- 1986	EFFECTIVE DATE 1-8-86

1.0 PURPOSE

This procedure describes a practice employed to detect discontinuities open to the surface in nonporous materials.

2.0 APPLICABILITY

This procedure conforms to the latest edition & addenda of the applicable Codes and applies to all solvent removable visible dye penetrant examinations performed at Fort St. Vrain Station as required.

3.0 GENERAL REQUIREMENTS

3.1 Inspection personnel shall be qualified in accordance with Procedure QCIM-4.

3.2 Penetrant Materials: The penetrant materials shall be of the solvent-removable, visible dye penetrant type, manufactured by the Magna Flux Corporation, Sherwin Incorporated or Uresco Inc.

3.3 Penetrant materials of different manufacture shall not be intermixed when performing a given test.

3.4 The penetrant materials shall have been analyzed for sulfur content and total halogens. The residual amount of total sulfur or halogens shall not exceed 1% by weight. Certification of these tests shall be obtained for each penetrant material used, giving batch numbers and test results.

Caution: The chemicals used for cleaning and liquid penetrant testing are volatile and flammable, their vapors may be toxic; safety precautions shall be taken in accordance with the manufacturer's recommendations.

FORM CI 272 22 3642

3.5 The liquid penetrant examination of intermediate weld layers shall include a minimum of 1/2 inch of the walls of the weld groove where possible. The liquid penetrant examination of the finished weld shall include 1/2 inch of the base metal on each side of the weld, where possible.

3.6 Satisfactory results may be obtained when the surface is in the as-welded, as-cast, or as-forged condition. In some cases, surface preparation by grinding or machining may be necessary to remove irregularities that would otherwise mask the indication or defects. Power wire brushing, gritblasting or sandblasting shall not be performed on any surface which is to receive a visible dye penetrant inspection. The surface shall be free of scale, slag, weld ripples, and crevices which will entrap penetrant. Welds shall be final acceptance tested in the "as welded" surface condition. The weld contour must blend into the base metal without undercutting that would mask the indication of defects.

4.0 PROCEDURE

4.1 Precleaning

4.1.1 The surface to be tested and any adjacent area within at least one inch of the surface to be tested shall be clean and free from oil, grease, dirt or other foreign material which will interfere with the test. Cleaning will be accomplished by vapor degreasing, ultrasonic cleaning or by dipping, spraying, swabbing or brushing with a halogen and sulphur free solvent such as acetone or alcohol. A final precleaning shall be accomplished by dipping, spraying, swabbing or brushing with clear, unused or redistilled acetone, so that the area tested is well soaked. Allow a minimum of five (5) minutes for the last traces to evaporate. Examine visually for cleanliness.

4.2 Application of Penetrant

4.2.1 The dye penetrant shall be applied by brushing, spraying or dipping. The test surface shall be kept wetted for a minimum period of ten (10) minutes. The temperature of the part being penetrant tested and the penetrant materials shall be between 60°F and 125°F. If there should be any complete drying of penetrant during this period, the surface shall be cleaned and retested.

4.3 Removal of Excess Penetrant

4.3.1 The test surface shall be wiped dry as completely as possible with dry, clean absorbent cloth or paper. The remaining excess penetrant shall be removed by wiping with a cloth dampened (not dripping) with the recommended cleaner. Immediately dry with a clean, absorbent cloth or paper. Lint-free cloth or paper shall be used for final cleaning. The time for surface drying after removal of last traces of excess penetrant and prior to application of developer shall be not less than five (5) or more than ten (10) minutes.

4.4 Application of Developer

4.4.1 The developer must be well mixed just prior to application. The developer shall be sprayed on the surface to be examined in a very thin even film. The developer shall be allowed to dry naturally without fanning, compressed air, etc.

4.5 Test Interpretation & Retest

4.5.1 The indications, if any, shall be viewed and evaluated a minimum of seven (7) and no later than thirty (30) minutes after the developer has dried.

4.5.2 One retest may be performed within the thirty (30) minute limit specified in 4.5.1 above by removing the developer utilizing a dry, clean cloth or paper. Use of a cleaner such as acetone is prohibited. Application of developer shall be performed as specified in 4.4 above. Test interpretation following a retest shall be performed a minimum of seven (7) and no later than ten (10) minutes after the developer has dried.

4.6 Evaluation of Indications

4.6.1 Defects which occur as mechanical discontinuities at the surface will be indicated by bleeding out of the penetrant; however, localized surface imperfections such as may occur from machining marks or surface conditions may produce similar indications which are not relevant to the detection of defects.

4.6.2 Any indication which is believed to be nonrelevant shall be regarded as a defect until the indication is either eliminated by surface conditioning or it is demonstrated to be nonrelevant. Nonrelevant indications and broad areas of pigmentation which would mask indications of defects are unacceptable and require retest.

4.6.3 Relevant indications are those which result from mechanical discontinuities. Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications which are circular or elliptical with the length less than three times the width. Only indications with major dimensions greater than 1/16 in. shall be considered relevant.

4.7 Acceptance Standard

4.7.1 Unless otherwise specified, the following relevant indications are unacceptable:

a) Any cracks and linear indications.

b) Rounded indications with dimensions greater than 3/16 inch.

c) Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

d) Ten or more rounded indications in any six square inches of surface whose minor dimension is no less than one inch with these dimensions taken in the most unfavorable location relative to the indications being evaluated.

4.7.2 Acceptance of components examined under ASME Section XI shall be in accordance with Article IWB-3000, and paragraph IWB-3112 as it relates to Table IWB-3410-1, "Acceptance Standards".

4.8 Post Cleaning

4.8.1 With the exception of defective areas requiring repair, the penetrant materials shall be removed by first wiping, then by cleaning with acetone to a degree that no penetrant materials remain when examined with the unaided eye.

4.9 Records

4.9.1 Records shall be maintained on the PSC Liquid Penetrant Test Report form (Attachment QCIM-2B). The test report shall be completed with all necessary information including penetrant materials type and batch numbers, i.e. SKL-S/A12345, SKC-S/B67890, etc.

4.9.2 Test reports shall be completed and administered per the requirements of procedure QCIM-2..

5.0 REFERENCES

5.1 ANSI B31.1 - Power Piping
5.2 ANSI B31.7 - Nuclear Power Piping
5.3 ASME Code Section III - Nuclear Power Plant Components
5.4 ASME Code Section VIII - Pressure Vessels
5.5 ASME SE165 - Liquid Penetrant Inspection
5.6 ASME Code Section V - Nondestructive Examination
5.7 QCIM-4, Nondestructive Examination Personnel Qualification and Certification.
5.8 QCIM-2 Preparation & Control of Nondestructive Examination Test Reports
5.9 ASME Code Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components

6.0 ATTACHMENTS

None

7.0 COMMITMENTS

The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

7.1 None

TITLE: DRY MAGNETIC PARTICLE INSPECTION PROCEDURE

ISSUANCE AUTHORIZED BY			
PORC REVIEW	PORC 85 5 JAN 8- 1986		EFFECTIVE DATE 1-8-86

1.0 PURPOSE

This procedure outlines the requirements for performing magnetic particle examination of surface and slightly sub-surface discontinuities in materials with ferromagnetic properties using the direct or rectified current or AC or DC yoke with dry magnetic particles.

2.0 APPLICABILITY

This procedure conforms to the latest editions and addenda of the applicable Codes and applies to dry magnetic particle examination performed at the Fort St. Vrain Station as required.

3.0 GENERAL REQUIREMENTS

3.1 Inspection personnel who perform the duties specified in this procedure shall be qualified in accordance with the requirements of Procedure QCIM-4.

3.2 The magnetizing equipment shall be capable of inducing a magnetic field of suitable intensity in the part being examined.

3.3 Dry iron powder shall be used as the inspection medium. This material shall be of high permeability and low retentivity, and of suitable sizes and shapes to produce readily magnetic particle indications. The color of the medium should be such that it provides a contrast to the background of the test surface. Test surface shall not exceed 600°F.

3.3.1 Red, gray or white iron powder, Parker Research or equal shall be used.

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3.4 Surface Preparation

3.4.1 Prior to examination, the test surface and any area adjacent to the test surface within one inch minimum, shall be dry and free of any extraneous matter that would interfere with the examination.

3.4.2 Detergents, organic solvents, descaling solution, paint removers, sand or grit blasting, and degreasing are methods that may be used to clean test surface.

3.4.3 As-cast, as-rolled, as-welded, and as-forged surfaces are satisfactory for examination, provided the surface does not interfere with the interpretation of the test.

3.5 When it is necessary to verify the adequacy or direction of the magnetizing field, the Magnetic Particle Field Indicator described in ASME Section V, Article 25 (SA-275), Figure 8, or an equivalent indicator shall be used by positioning the indicator on the surface to be examined.

3.5.1 When using this indicator, a suitable flux or field strength is indicated when a clearly defined line of magnetic particles forms across the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force.

4.0 PROCEDURE

4.1 Prod Examination Method

4.1.1 Magnetization shall be continuous during the examination.

4.1.2 The test area shall be magnetized by using portable prod type electrical contacts pressed against the surface.

4.1.3 Prod spacing shall be at least six (6) inches but not more than eight (8) inches. When the geometric configuration of a part is such that prod spacing of less than six (6) inches is required, prod spacing may be decreased but at no time shall spacing be less than three (3) inches.

4.1.4 Prods must be kept clean and dressed to prevent arcing.

4.1.5 The magnetizing current shall be:

a) Material with thickness less than 3/4" - 90 to 110 amp per inch of prod spacing.

b) Materials with thickness greater than 3/4" - 100 to 125 amp per inch of prod spacing.

4.1.6 On each test area, a minimum of two (2) examinations shall be performed, with prod placed so the lines of flux of one examination are approximately at right angles to the lines of flux to the other.

4.1.7 Examinations shall be conducted with sufficient overlap to assure 100% coverage at the established sensitivity.

4.1.8 The iron powder shall be applied in a light, evenly distributed cloud with a Parker Research (model PB-1) powder blower or equivalent. Excess powder shall be removed by a low pressure air stream.

4.1.9 Demagnetization when required, shall be performed using the AC step down method.

4.2 Coil Method Longitudinal

4.2.1 Magnetization shall be continuous during the examination.

4.2.2 The magnetizing current shall be:

a) For parts with a L/D ratio greater than or equal to 4:

$$\text{Ampere-turns} = \frac{35000}{(L/D) + 2}$$

b) For parts with a L/D ratio less than 4 but equal to or greater that 2:

$$\text{Ampere-turns} = \frac{45000}{L/D}$$

c) Parts with an L/D ratio less than 2 shall not be tested by this method.

4.2.3 When the coil is made of a wound cable around the test part, the coil turns shall be closely spaced.

4.2.4 The effective field extends six (6) inches on either side of the coil.

a) Long parts shall be magnetized in sections.

4.2.5 Particles shall be applied in accordance with Paragraph 4.1.8.

4.2.6 At least two examinations shall be performed on each area. The second examination shall be with lines of magnetic flux perpendicular to the flux direction in the first examination.

4.2.7 A different means of magnetizing may be used for the second examination.

4.3 Direct Contact (Circular)

4.3.1 Magnetization shall be continuous during the examination.

4.3.2 Direct or rectified magnetizing current shall be used. The required current shall be determined using the following guidelines.

a) Parts up to five (5) inches in diameter: 700 to 900 amps per inch.

b) Parts five (5) inches to ten (10) inches in diameter: 500 to 700 amps per inch.

c) Parts ten (10) to fifteen (15) inches in diameter: 300 to 500 amps per inch.

d) Parts over fifteen (15) inches in diameter: 100 to 330 amps per inch.

e) For parts with geometric spaces other than round, the magnetizing amperage may be established using the Magnetic Particle Field Indicator per 3.5.

4.3.3 Particles shall be applied in accordance with Paragraph 4.1.8.

4.3.4 At least two examinations shall be carried out on each area. In the second examination, the lines of magnetic flux shall be perpendicular to those for the first examination. A different means of magnetizing may be used for the second examination.

4.4 Yoke Method

4.4.1 The Yoke Method shall be limited to locating discontinuities open to the surface.

4.4.2 An A.C. Yoke may be used providing the yoke has lifting power of at least ten (10) pounds and D.C. Yokes must have a lifting power of at least forty (40) pounds.

4.4.3 A pole spacing of 3 to 6 inches shall be used.

4.4.4 Particles shall be applied in accordance with Paragraph 4.1.8.

4.4.5 At least two separate examinations shall be performed on each area. The second examinations shall be conducted with the lines of the flux in a direction perpendicular to the first direction. An alternate method of magnetizing may be used for the second examination.

4.4.6 Examinations shall be conducted with a minimum of one (1) inch overlap to assure 100 percent coverage.

5.0 CALIBRATION

5.1 Equipment with ammeters shall be calibrated and shall have units meter accuracy verified by equipment traceable to a National Standard. The units meter shall not deviate by more than plus or minus 10% of full scale, relative to the actual current value as shown by test meter.

5.2 Yokes shall be calibrated by determining their lifting power, per paragraph 4.4.2.

5.3 When equipment with uncalibrated ammeters must be used, all techniques shall be proven using the field indicator described in Section 3.5 prior to use.

6.0 ACCEPTANCE CRITERIA

6.1 Any indications which is believed to be non-relevant, shall be regarded as a defect until the defect is eliminated by surface conditioning or it is re-examined by the same or other nondestructive test method.

6.2 The following relevant indications are unacceptable unless specified otherwise.

6.2.1 Any cracks or linear indication.

6.2.2 Rounded indications with dimensions greater than 3/16 inch.

6.2.3 Four or more rounded indications in a line separated by 1/16 inch or less, edge to edge.

6.2.4 Ten or more rounded indications in any six (6) square inches of surface with the major dimension of this area not to exceed six (6) inches with the area taken in the most unfavorable location relative to the indications being evaluated.

6.3 Acceptance of components examined under ASME Section XI shall be in accordance with Article IWB-3000, and paragraph IWB-3112 as it relates to Table IWB-3410-1, "Acceptance Standards."

7.0 RECORDS

7.1 Results shall be documented on the Public Service Company Magnetic Particle Examination Report form (attachment QCIM-2B). The test report shall be completed with all necessary information, signed and dated by QA/QC personnel.

7.2 Test reports shall be consecutively numbered and administered per the requirements of Procedure QCIM-2.

8.0 REFERENCES

8.1 ANSI B31.1 - Power Piping

8.2 ANSI B 31.7 - Nuclear Power Piping

8.3 ASME Section V - Nondestructive Examination

8.4 ASME Section XI - Rules for Inservice Inspection of Nuclear Power Plant Components

8.5 QCIM-2 - Preparation and Control of Nondestructive Examination Test Reports.

8.6 QCIM-4 - Nondestructive Examination Personnel Qualification and Certification.

9.0 ATTACHMENTS

9.1 None

10.0 COMMITMENTS

The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

7.1 None

TITLE: FLUORESCENT MAGNETIC PARTICLE INSPECTION

ISSUANCE AUTHORIZED BY	J Lenger		
PORC REVIEW	PORC 85 5 JAN 9- 1986		EFFECTIVE DATE 1-9-86

1.0 PURPOSE

This procedure outlines the requirements of a method used in performing magnetic particle examination of surface and slightly subsurface discontinuities in materials with ferromagnetic properties using direct or rectified current or an AC or DC yoke utilizing wet, fluorescent magnetic particles.

2.0 APPLICABILITY

This procedure conforms to the latest editions and addenda of the applicable Codes and applies to all fluorescent magnetic particle inspection performed at PSC facilities as required.

3.0 GENERAL REQUIREMENTS

3.1 All personnel who perform the duties specified in this procedure shall be qualified in accordance with the requirements of procedure QCIM-4.

3.2 The magnetizing equipment shall be capable of inducing a magnetic field of suitable intensity in the part being examined.

3.3 The examination shall be conducted in a darkened area using filtered black light. The black light intensity at the surface under examination shall be measured at least once every 8 hours, and whenever the work location is changed, using a meter which is sensitive to light in the ultraviolet spectrum and centered on 365 nanometers (nm) (3650 A°).

3.4 Two readings shall be taken; the first without a filter and the second with an ultraviolet (365nm) absorbing filter placed over the sensing element of the meter. The second reading shall be subtracted from the first and the difference shall be a minimum of 800u W/cm².

3.5 The black light bulb shall be turned on and allowed to warm up for a minimum of five minutes prior to use.

3.6 The test surface shall not exceed 135°F.

3.7 Surface Preparation

3.7.1 Satisfactory results are usually obtained when the surfaces are in the as-welded, as-rolled, as-cast or as-forged condition. However, surface preparation by grinding or machining may be necessary where surface irregularities could mask indications due to discontinuities.

3.7.2 Prior to examination, the surface to be examined and all adjacent areas within at least one inch shall be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil or other extraneous matter that could interfere with the examination.

3.7.3 Cleaning may be accomplished using detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand or grit blasting, or ultrasonic cleaning methods.

3.8 When it is necessary to verify the adequacy or direction of the magnetizing field, the Magnetic Particle Field Indicator described in ASME Section V, Article 25 (SA 275), Figure 8, or an equivalent indicator shall be used by positioning the indicator on the surface to be examined.

3.8.1 When using this indicator, a suitable flux or field strength is indicated when a clearly defined line of magnetic particles forms across the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force. If a clearly defined line is not formed, or is not formed in the desired direction, the magnetizing technique shall be changed or adjusted.

3.9 Bath Concentration

3.9.1 The initial bath concentration of suspended magnetic particles should be in accordance with manufacturers recommendations and should be checked by getting volume measurements and maintained at the specified concentration on a daily basis.

3.9.2 The recommended setting volume is from 0.1 ml to 0.5 ml in a 100 ml bath sample, unless otherwise specified by the manufacturer.

3.9.3 Bath concentration shall be determined by measuring its setting volume through the use of an ASTM pear-shaped centrifuge tube with a 1 ml stem (0.05 ml divisions). Before sampling, shake the suspension well to assure a thorough mixing of all particles. Take a 100 ml portion of the suspension and allow it to settle for approximately 30 minutes. The volume settling out at the bottom of the tube is indicative of the particle concentration in the bath. If the bath concentration is low particle content, add a sufficient amount of particle materials to obtain the desired concentration. If the suspension is high in particle content, add sufficient vehicle to obtain the desired concentration.

3.9.4 If the particles appear to be loose agglomerates rather that a solid layer, take a second sample. If still agglomerated, the particles may have become magnetized and the solution should be replaced.

3.10 Suspension Vehicles

3.10.1 Suspension Vehicles shall be Chevron Base Oil 'C' or equivalent.

4.0 PROCEDURE

4.1 Prod Examination method.

4.1.1 Magnetization shall be continuous during the examination.

4.1.2 The test area shall be magnetized by using portable prod type electrical contacts pressed against the surface.

4.1.3 Prod spacing shall be at least six (6) inches but not more than (8) inches. When the geometric configuration of a part is such that prod spacing of less than six (6) inches is required, prod spacing may be decreased but at no time shall spacing be less than three (3) inches.

4.1.4 Prods must be kept clean and dressed to prevent arcing.

4.1.5 The magnetizing current shall be:

a) Material with thickness less than 3/4" - 90 to 110 amp per inch of prod spacing.

b) Materials with thickness greater than 3/4" - 100 to 125 amp per inch of prod spacing.

4.1.6. On each test area, a minimum of two (2) examinations shall be performed, with prod placed so the lines of flux of one examination are approximately at right angles to the lines of flux to the other.

4.1.7 Examinations shall be conducted with sufficient overlap to assure 100% coverage at the established sensitivity.

4.1.8 The wet fluorescent particles shall be applied in a light, evenly distributed cloud.

4.1.9 Demagnetization, when required, shall be performed using the AC stepdown method.

4.2 Coil Method (Longitudinal)

4.2.1 Magnetization shall be continuous during the examination.

4.2.2 For this technique, magnetization shall be accomplished by passing current through a multi-turn fixed coil or cable that is wrapped around the part or section of the part to be examined.

4.2.3 Direct or rectified current shall be used. The required field strength shall be calculated based on the length (L) and the diameter (D) of the part in accordance with 4.2.4. a, b, and c below. Long parts shall be examined in Sections not to exceed 18 inches and 18 inches shall be used for the part (L) in calculating the required field strength. For noncylindrical parts, (D) shall be the maximum cross-sectional diagonal.

4.2.4 The magnetizing current shall be (± 10%):

a) For parts with L/D ration greater than or equal to 4:

$$\text{Ampere-turns} = \frac{35000}{(L/D) - 2}$$

b) For parts with a L/D ratio less than 4 but equal to or greater than 2:

$$\text{Ampere-turns} = \frac{45000}{(L/D)}$$

c) Parts with an LD ratio less than two shall not be tested by this method.

4.2.5 When the coil is made of a cable wound around the test part, the coil turns shall be closely spaced.

4.2.6 Particles shall be applied in accordance with Paragraph 4.1.8.

4.2.7 At least two examinations shall be performed on each area. The second examination shall be with lines of magnetic flux perpendicular to the flux direction in the first examination.

4.2.8 A different means of magnetizing may be used for the second examination.

4.2.9 Demagnetization, when required, shall be performed using the AC Stepdown method.

4.3 Direct Contact Method (Circular)

4.3.1 Magnetization shall be continuous during the examination.

4.3.2 For this technique, magnetization shall be accomplished by passing current through the part to be examined.

4.3.3 Direct or rectified magnetizing current shall be used. The required current shall be determined using the following guidelines.

a) Parts up to five (5) inches in outer diameter: 700 to 900 amps per inch.

b) Parts five (5) inches to (10) inches in outer diameter: 500 to 700 amps per inch.

c) Parts ten (10) to fifteen (15) inches in outer diameter: 300 to 500 amps er inch.

d) Parts over fifteen (15) inches in outer diameter: 100 to 330 amps per inch.

e) For parts with geometric shapes other than round, the greatest cross-sectional diagonal in a plane at right angles to the current flow shall determine the inches to be used in the above competitions.

f) As an alternate, for non-cylindrical parts only, the magnetizing amperage may be established by using the Magnetic Particle Field Indicator as specified in Section 3.8.

4.3.4 Particles shall be applied in accordance with paragraph 4.1.8.

4.3.5 At least two examinations shall be performed on each area. The second examination shall be with lines of flux perpendicular to the flux direction of the first examination.

4.3.6 A different means of magnetization may be used for the second examination.

4.3.7 Demagnetization, when required shall be performed using the AC step-down method.

4.4 Central Conductor Method

4.4.1 Magnetization shall be continuous during the examination.

4.4.2 For this technique a central conductor shall be used to examine the internal surfaces of ring or cylindrically shaped parts. This technique may also be used for examining the outside surfaces of those shapes.

4.4.3 Where large diameter cylinders are to be examined, the conductor shall be positioned close to the internal surface of the cylinder. When the conductor is not centered, the circumference of the cylinder shall be examined in increments. A Magnetic Particle Field Indicator, applied in accordance with Section 3.8, shall be used to establish the extent of the arc that may be examined for each conductor position.

4.4.4 Bars or cables may be used as central conductors.

4.4.5 The field strength required shall be equal to that determined in Section 4.3 for a Single turn central conductor. The magnetic field shall be increased in proportion to the number of times the central conductor cable passes through a hollow part.

4.4.6 Particles shall be applied in accordance with paragraph 4.1.8.

4.4.7 At least two examinations shall be carried out on each area. In the second examination, the lines of magnetic flux shall be perpendicular to those for the first examination. A different means of magnetizing may be used for the second examination.

4.4.8 Demagnetization when required shall be performed using the AC step-down method.

4.5 Yoke Method

4.5.1 The Yoke Method shall be limited to locating discontinuities open to the surface.

4.5.2 An A.C. Yoke may be used providing the yoke has lifting power of at least ten (10) pounds and D. C. Yokes must have a lifting power of at least forty (40) pounds.

4.5.3 A pole spacing of 3 to 6 inches shall be used.

4.5.4 Particles shall be applied in accordance with Paragraph 4.1.8.

4.5.5 At least two separate examinations shall be performed on each area. The second examinations shall be conducted with the lines of the flux in a direction perpendicular to the first direction. An alternate method of magnetizing may be used for the second examination.

4.5.6 Examinations shall be conducted with a minimum of one inch overlap to assure 100% coverage.

4.5.7 Demagnetization, when required shall be performed using the AC step-down method.

5.0 CALIBRATION

5.1 Magnetic Particle equipment shall be calibrated, as a minimum, at least once a year, or whenever the equipment has been repaired, overhauled or damaged.

5.2 Equipment with ammeters shall have units meter accuracy verified by equipment traceable to a National Standard. The units meter shall not deviate by more than plus or minus 10% of full scale, relative to the actual current value as shown by test meter.

5.3 Yokes shall be calibrated by determining their lifting power, as per paragraph 4.5.2.

5.4 When equipment with uncalibrated ammeters must be used, all techniques shall be proven using the field indicator described in Section 3.8 prior to use.

6.0 ACCEPTANCE CRITERIA

6.1 Any indication which is believed to be non-relevant shall be regarded as a defect until the defect is eliminated by surface conditioning or it is re-examined by the same or other nondestructive test method.

6.2 The following relevant indications are unacceptable unless specified otherwise.

6.2.1 Any cracks or linear indication.

6.2.2 Rounded indications with dimensions greater than 3/16 inch.

6.2.3 Four or more rounded indications in a line separated by 1/16 inch or less, edge to edge.

6.2.4 Ten or more rounded indications in any six (6) square inches of surface with the major dimension of this area not to exceed six (6) inches with the area taken in the most unfavorable location relative to the indications being evaluated.

6.3 Acceptance of components examined under ASME Section XI shall be in accordance with Article IWB-3000, and paragraph IWB-3112 as it relates to Table IWB-3410-1, "Acceptance Standards."

7.0 POST CLEANING

7.1 With the exception of defective areas requiring repair, the fluorescent magnetic particles shall be removed first by wiping, then by cleaning with acetone to a degree that no particles remain when examined with the unaided eye.

8.0 RECORDS

8.1 Results shall be documented on the PSC Magnetic Particle Examination Report Form (Attach. QCIM-2B). The test report shall be completed with all necessary information, signed and dated by QA/QC personnel.

8.2 Records and reports generated as a result of this procedure shall be completed and administered per the requirements of procedure QCIM-2.

9.0 REFERENCES

9.1 ASME Section V - Nondestructive Examination

9.2 ANSI B31.1 - Power Piping

9.3 ANSI B31.7 - Nuclear Power Piping

9.4 QCIM-2 - Preparation and Control of NDE Test Reports

9.5 QCIM-4 - Nondestructive Examination Personnel Qualification and Certification

| 9.6 ASME Section XI, 1980 Edition up to and including Winter '81 Addenda

10.0 ATTACHMENTS

None

| 11.0 COMMITMENTS

| The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

| 11.1 None

TITLE: RADIOGRAPHIC EXAMINATION PROCEDURE

ISSUANCE AUTHORIZED BY			
PORC REVIEW	PORC 85 6 AUG 29 1985		EFFECTIVE DATE 9-6-85

1.0 PURPOSE

This procedure describes the requirements of and the method used for radiographic examination at Fort St. Vrain Station.

2.0 APPLICABILITY

This procedure conforms to the latest editions and addenda of the applicable codes and applies to Radiographic Inspections performed, as required, at Fort St. Vrain Station.

3.0 GENERAL REQUIREMENTS

3.1 All personnel performing and/or evaluating radiographic examinations shall be qualified in accordance with procedure QCIM-4 and the "Public Service Company of Colorado Incorporated Manual of Operating and Emergency Procedures for Radiography".

3.2 Drawings, contracts or Process/Inspection Record Checklists shall specify the extent of radiographic examination, as required for each item. Radiographic locations shall be marked on the drawings as applicable.

3.3 Part Configuration: Consideration shall be given to the design parts, components and welds to permit interpretable radiographic examination.

3.3.1 Backing Rings or Strips: A backing ring or strip, if it is to be left in place, should be of such size and configuration that its image will not interfere with the interpretation of the radiograph.

3.4 Surface Finish of Materials: Surfaces shall satisfy the requirements of the applicable materials specifications, with additional surface conditioning if necessary, by any suitable process to a degree that surface irregularities cannot mask or be confused with discontinuities.

3.5 Surface Finish of the Welds: The weld ripples or weld surface irregularities on both the inside (where accessible) and outside, shall be removed by any suitable mechanical process to such a degree that the resulting radiographic contrast due to any irregularities cannot mask or be confused with the image of any objectionable defect. The weld surface shall merge smoothly into the base material. The finished surface at the reinforcement of all butt-welded joints may be flush with the adjacent base material, or may have a reasonably uniform crown, not to exceed the limits noted in the referencing Code section or Specification.

3.6 Radiographic Sources

3.6.1 Radiation sources may be either X-ray equipment or radioactive isotopes. Recommended X-ray machine voltage setting and radio-isotope sources to be used for radiography are in accordance with Attachments QCIM-30 A, B, or C.

3.6.2 Except as provided in 3.6.3, the recommended minimum thickness for which radioactive isotopes may be used is as follows:

MATERIAL	IRIDIUM 192	COBALT 60
Steel	0.75 in.	1.50
Copper or High Nickel	0.65 in.	1.30 in.
Aluminum	2.50 in.	———

3.6.3 When it is not practical to perform radiography within the limitations of 3.6.1 or 3.6.2 or when other radioactive isotopes other than Iridium 192 or Cobalt 60 are used, the procedure shall be proven satisfactory by actual demonstration of penetrameter resolutions on the minimum thickness of the material radiographed.

3.7 Radiographic Films, Screens & Radiographs

3.7.1 Radiographs shall be made using film Type I or Type II, Table 2, of ASTM SE 94.

3.7.2 Intensifying screens when used, shall be Lead or Lead Alloys.

3.7.3 All film shall be processed & viewed in accordance with recommended practice ASTM SE-94, Part III.

3.7.4 All radiographs shall be free from mechanical, chemical, or other blemishes to the extent that they cannot mask or be confused with the image of any discontinuity in the object being radiographed. Such blemishes include, but are not limited to:

a) Fogging

b) Processing defects such as streaks, water marks, or chemical stains.

c) Scratches, finger marks, crimps, dirtiness, static marks, smudges, or tears.

d) Loss of detail due to poor screen-to-film contact.

e) False indications due to defective screens or internal faults.

3.7.5 Scattered radiation may be reduced by suitable filtration. As a check on back-scattered radiation, a lead symbol "B" with minimum dimensions of 1/2" in height and 1/16" in thickness, shall be attached to the back of the film holder. If a light image of the "B" appears on the radiograph, protection from the back-scatter is insufficient and the radiograph is considered unacceptable.

3.7.6 The transmitted film density through the radiographic image of the body of the appropriate penetrameter and the area of interest shall be 1.8 minimum for single film viewing for radiographs made with an X-ray source and 2.0 minimum for radiographs made with a gamma ray source. For composite viewing of multiple film exposures, each film of the composite set shall have a minimum density of 1.3. The maximum density shall be 4.0 for either single or composite viewing. A tolerance of 0.05 in density is allowed for variations between densitometer readings.

3.7.7 Either a densitometer or step wedge comparison film shall be used for judging film density requirements. The density of step wedge comparison shall be verified with a calibrated step wedge film traceable to a National Standard. Calibration shall be per QCIM-1.

3.7.8 A system of radiograph identification shall be used to produce permanent identification on the radiograph traceable to the job number, component, weld or weld seam, or part numbers, as appropriate. This identification system does not necessarily require that the information appear as radiographic images. In any case, this information shall not obscure the area of interest.

3.7.9 Location markers, which are to appear as radiographic images on the film, shall be placed on the part - not on the cassette - and their locations shall be marked on the surface of the part being radiographed or on a map in a manner permitting the area of interest on a radiograph to be accurately located on the part, and providing evidence on the radiograph that the required coverage of the region being examined has been obtained.

4.0 SHARPNESS OF RADIOGRAPHIC IMAGE

4.1 The following table is to be used as a guide but not for the rejection of radiographs unless the geometrical unsharpness exceeds 0.070 in..

Material Thickness, in.	Ug Maximum, in.
Under 2	0.020
2 through 2	0.030
Over 3 through 4	0.040
Greater than 4	0.070

NOTE: Material thickness is the thickness on which the penetrameter is based.

4.2 Geometric unsharpness of the radiograph shall be determined in accordance with:

Ug = Fd/D

where:

Ug = geometrical unsharpness

F = Source Size. A manufacturer's written statement documenting the actual or maximum Source Size or focal spot shall be acceptable as Source Size verification.

d = Distance, in., from Source Side of Weld or object being radiographed to the film.

D = distance, in., from Source of radiation to weld or object being radiographed.

5.0 IMAGE QUALITY INDICATORS

5.1 Radiography shall be performed with a technique of sufficient sensitivity to display the penetrameter image and the specified hole, which are essential indications of the quality image of the radiograph. The radiographs shall also display the identifying numbers & letters.

5.2 The penetrameters shall be manufactured and identified in accordance with the requirements or alternates allowed in ASTM SE-142 and Appendices of Section V of the ASME Code. ASME standard penetrameters shall consist of those specified in Attach. QCIM-300, Table 2.

5.3 Penetrameters of thicknesses specified in Attach. QCIM-300 Table 1 shall be used. For any material thickness range, a thinner penetrameter than listed for that range may be used, provided all other requirements for radiography are met. For welds, the thickness on which the penetrameter is based is the single wall thickness plus maximum reinforcement permitted. Backing rings or strips are not to be considered as part of the weld or reinforcement thickness in penetrameter selection.

5.4 Penetrameters shall be placed adjacent to the weld seam except in instances where the weld metal is not radiographically similar to the base material or where the geometric configuration makes it impractical, in which case the penetrameter shall be placed over the weld metal. Where inaccessibility prevents the penetrameter being placed on the source side, a film side penetrameter shall be placed on the film side of the joint, and a lead letter "F" at least as high as the identification numbers shall be placed adjacent to the penetrameter. When configuration or size prevents placing the penetrameter on the object being radiographed, it may be placed on a separate block of radiographically similar material of a thickness equivalent to that of the part or welding being radiographically examined.

5.5 Except as provided in 5.5.1 and 5.5.2, one penetrameter shall be used for each radiograph. Each penetrameter shall represent an area of essentially uniform radiographic density as judged by a densitometer. If the density of the radiograph through the area of interest varies by more than minus 15 or plus 30 percent from the density through the area adjacent to the penetrameter, then an additional penetrameter is required for the exceptional area or areas, except as provided in 5.5.3.b.

5.5.1 If one penetrameter appears in the lightest area of a radiograph and another in the darkest, the area around each penetrameter and the intervening densities on the radiograph are acceptable, provided the minimum density requirements of 3.7.6 are met. These additional penetrameters need not be normal to the radiation source at these locations. When calculating the allowable variation in density, the calculation may be rounded to the nearest 0.1 within the range specified in 3.7.6.

5.5.2 Where more than one film is used for an exposure, a penetrameter image shall appear on each radiograph, except when the source is placed on the axis of the object and a complete circumference radiographed with a single exposure is taken, in which case at least three equally spaced penetrameters are to be used. Where portions of longitudinal welds adjoining the circumferential weld are being examined simultaneously with the circumferential weld, additional penetrameters shall be placed on the longitudinal welds at the end of the sections of those welds being radiographed. When an array of objects is radiographed, at least one penetrameter shall show on each object imaged.

5.5.3 If the penetrameter image does not show on one radiograph in double film technique but does show in composite viewing, interpretation is permitted only by composite film viewing.

a) If the weld reinforcement and/or backing strip are not removed, a shim of material radiographically similar to the weld metal shall be placed under the penetrameter. The shim thickness shall be selected so the total thickness being radiographed under the penetrameter is essentially the same as the total weld thickness plus backing strip, if used and not removed, and other thickness variations such as in nozzle geometries.

b) When thicker shims than required are used, the plus 30% density restriction may be exceeded, provided the required penetrameter sensitivity is displayed and density limitations are not exceeded.

6.0 RADIOGRAPHIC TECHNIQUE

6.1 Single Wall Technique

6.1.1 Radiography shall be done using a single wall radiographic technique whenever practicable. Penetrameter Size and placement shall be per Section 5.0.

6.1.2 For complete radiographic coverage of cylindrical girth welds, a minimum of four exposures 90° apart is required when the Source is placed outside and the film inside the object.

6.1.3 Attachment QCIM-30E contains suggested single wall radiographic techniques. Other exposure arrangements may be made provided they comply with the requirements of this procedure.

6.2 Double - Wall Techniques

6.2.1 Double-Wall Viewing. Unless otherwise specified, for materials and for welds in pipe tubes, 3 1/2 in. (89 mm) or less in nominal outside diameter a technique may be used in which the radiation passes through two walls and the weld (material) in both walls is viewed for acceptance on the same film. For welds, the radiation beam may be offset from the plane of the weld at an angle sufficient to separate the images of the source side and film side portions of the weld so there is no overlap of the areas to be interpreted, in which case a minimum of two exposures taken at 90° to each other shall be made for each joint. As an alternate, the weld may be radiographed with the radiation beam positioned so the images of both walls are superimposed, in which case at least three exposures shall be made at 60° to each other. For double-wall viewing a source side penetrameter shall be used and placement shall be as indicated in Section 5.4.

6.2.2 Single-Wall Viewing

a) For materials and for welds in pipe and tubes with nominal outside diameter greater than 3 1/2" (89 mm), radiographic examination shall be performed for single-wall viewing only. An adequate number of exposures shall be taken to ensure complete coverage.

b) For welds in pipe or tubes with a nominal outside diameter 3 1/2" (89 mm) or less, single-wall viewing may be used provided the source is offset from the plane of the weld centerline as outlined in 6.2.1. As a minimum, three exposures 120° apart shall be required. A film side penetrameter shall be used and placement shall be as indicated in Section 5.4.

6.3 Techniques for Section IX Qualifications

6.3.1 Single wall technique with source side penetrameters shall be used, except for circumferential butt welds joining pipe and tubes of nominal outside diameter of 3 1/2" or less, which shall be examined with the double-wall technique with single wall viewing using a film side penetrameter.

7.0 TECHNIQUE REQUIREMENTS

7.1 Radiographic examination shall be performed in accordance with a written and qualified technique. A copy of the technique shall be available to the inspector for ready reference during film evaluation. Each technique shall include at least the following information:

7.1.1 Number of films

7.1.2 Location of each film on the radiographed item

7.1.3 Orientation of location markers

7.1.4 Location of radiation source, including source-to-film distance and angle of beam

7.1.5 The kilovoltage (milliamperes or rads) and focal spot size (for x-ray machines)

7.1.6 The isotope type, intensity (in curies), and physical dimensions

7.1.7 Film brand and type

7.1.8 Type and thickness of screens

7.1.9 Masking, if used

7.1.10 Single or double-viewing

8.0 ACCEPTANCE STANDARD

8.1 Production or fabrications welds that are shown by radiography to have any of the following types of discontinuities are unacceptable.

8.1.1 Any type of crack or zone of incomplete fusion or penetration.

8.1.2 Any other elongated indication which has a length greater than:

a) 1/4" for T up to 3/4" inclusive.

b) 1/3 T for T from 3/4" to 2 1/4" inclusive.

c) 3/4" for T over 2 1/4".

where T is the thickness of the thinner portion of the weld.

8.1.3 Any group of slag inclusions in line that have an aggregate length greater than T in length of 12 T except where the distance between the successive indications exceeds 6L where L is longest indication in the group.

8.1.4 The maximum rounded indication dimension shall be 20% of T or 1/8", whichever is smaller, except that an isolated pore separated from an adjacent rounded indication by 1" or more may be 30% of T or 1/4", whichever is less.

8.1.5 The total area of rounded indications as determined from the film shall not exceed 0.060 T square inch in any 6" length of weld. If the weld is less than 6" long, the total permissable area of rounded indications shall be reduced in proportion.

8.1.6 In any 1" length of weld or 2 T, whichever is smaller, rounded indications may be clustered in total area to a concentration 4 times that permitted by 0.060 T (0.060 X T X 4). Such clustered rounded indications shall be included in the total area of permissible indications in any 6" length of weld which includes the cluster.

8.1.7 Aligned rounded indications shall be acceptable providing the summation of the diameters of the rounded indications is no more than T in a length 12 T or 6", whichever is less, providing each rounded indication is separated by a distance of at least six times the diameter of the largest adjacent rounded indication. Aligned rounded indications shall be included in the total area of permissible indications in any 6" length of weld.

8.2 Qualification or performance test welds that are shown by radiography to have any of the following types of discontinuities are unacceptable.

8.2.1 Any type of crack or zone of incomplete fusion or penetration.

8.2.2 Any elongated slag inclusion which has a length greater than:

a) 1/8" for t up to 3/8 inch, inclusive

b) 1/3 t for t over 3/8 to 2 1/4 inch, inclusive

c) 3/4 inch for t over 2 1/4 inch

8.2.3 Any group of slag inclusions in line that have an aggregate length greater than t in a length of 12 T, except when the distance between the successive inperfections exceeds 6L where L is the length of the longest inperfection in the group.

8.2.4 The maximum permissible dimension for the rounded indications shall be 20% of t of 1/8", whichever is smaller.

8.2.5 For welds in material less than 1/8 inch in thickness, the maximum number of acceptable rounded indications shall not exceed 12 in a 6" length of weld. A proportionately fewer number of rounded indications shall be permitted in welds less than 6" in lenth.

8.2.6 For welds in material 1/8" or greater in thickness, the charts in Appendix I of ASME Section IX represent the maximum acceptable types of rounded indications illustrated in typically clustered, assorted, and randomly dispersed configurations. Rounded indications less than 1/32" in maximum diameter shall not be considered in the radiographic acceptance tests of welders and welding operators, in these ranges of material thicknesses.

9.0 RADIOGRAPHIC REPORT FORM

The results of the radiograph test shall be noted on the Radiographic Examination Report Sheet (Attachment QCIM-2D)

10.0 RECORDS

Records and Radiographs generated as a result of this procedure shall be transmitted to the Record Center per the requirements in Procedures Q-17 and QCIM-2.

11.0 REFERENCE

11.1 ANSI B31.1, "Power Piping"

11.2 ANSI B31.7, "Nuclear Power Piping"

11.3 ASME Section I, "Power Boilers"

11.4 ASME Section III, "Nuclear Power Plant Components"

11.5 ASME Section V, "Nondestructive Examination"

11.6 ASME Section VIII, "Pressure Vessels"

11.7 ASME Section IX, "Welding and Brazing Qualifications"

11.8 QCIM-2, "Preparation and Control of NDE Test Reports"

11.9 QCIM-4, "Nondestructive Examination Personnel Qualification and Certification"

11.10 RPM-1, "PSC Incorporated Manual of Operating and Emergency Procedures for Radiography"

12.0 ATTACHMENTS

12.1 QCIM-20A, Maximum Voltage for Steel

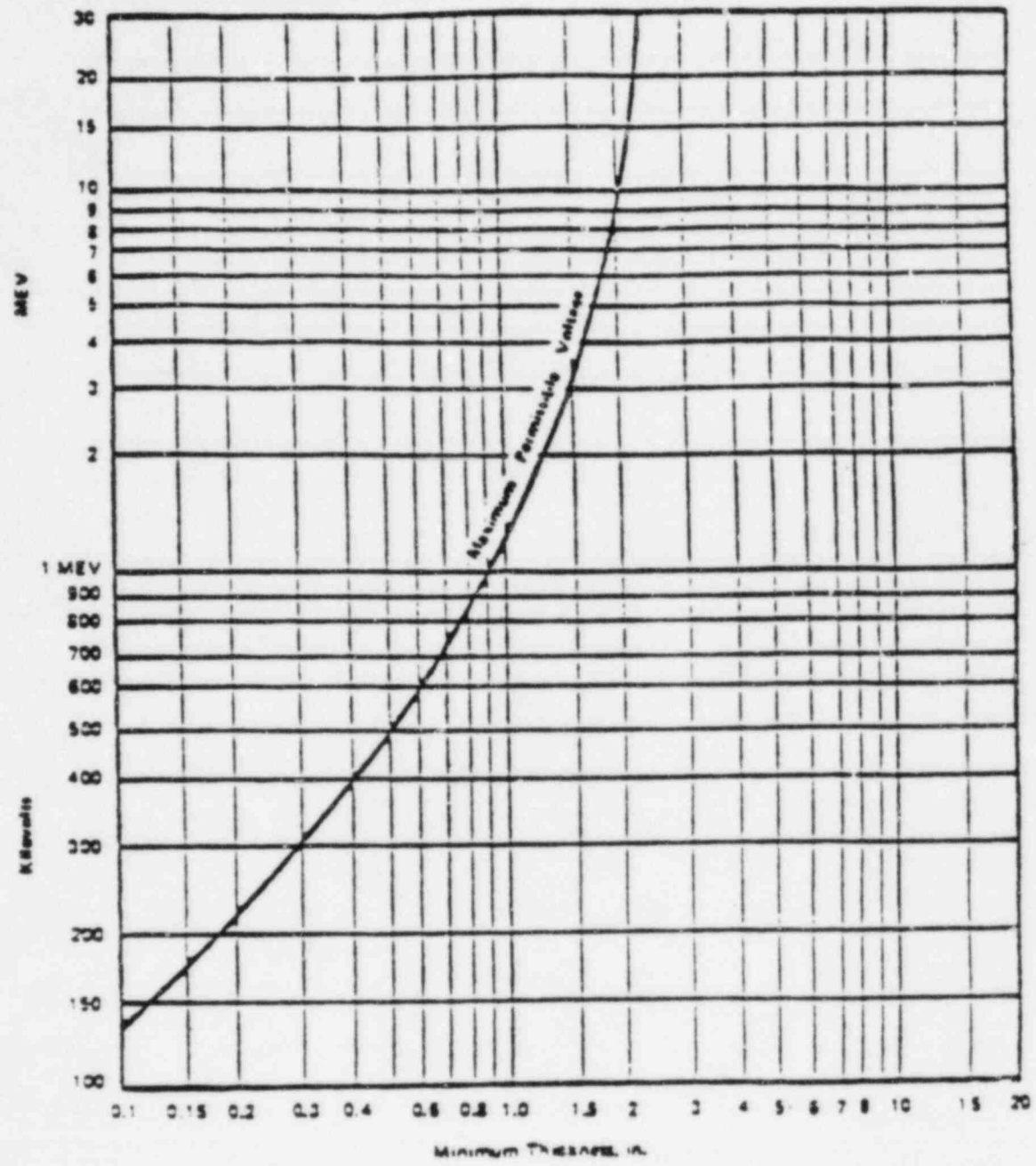
12.2 QCIM-20B, Maximum Voltage for Alloys of Copper and/or High Nickel

12.3 QCIM-20C, Maximum Voltage for Aluminum and Aluminum Alloys

12.4 QCIM-20D, Penetrameters

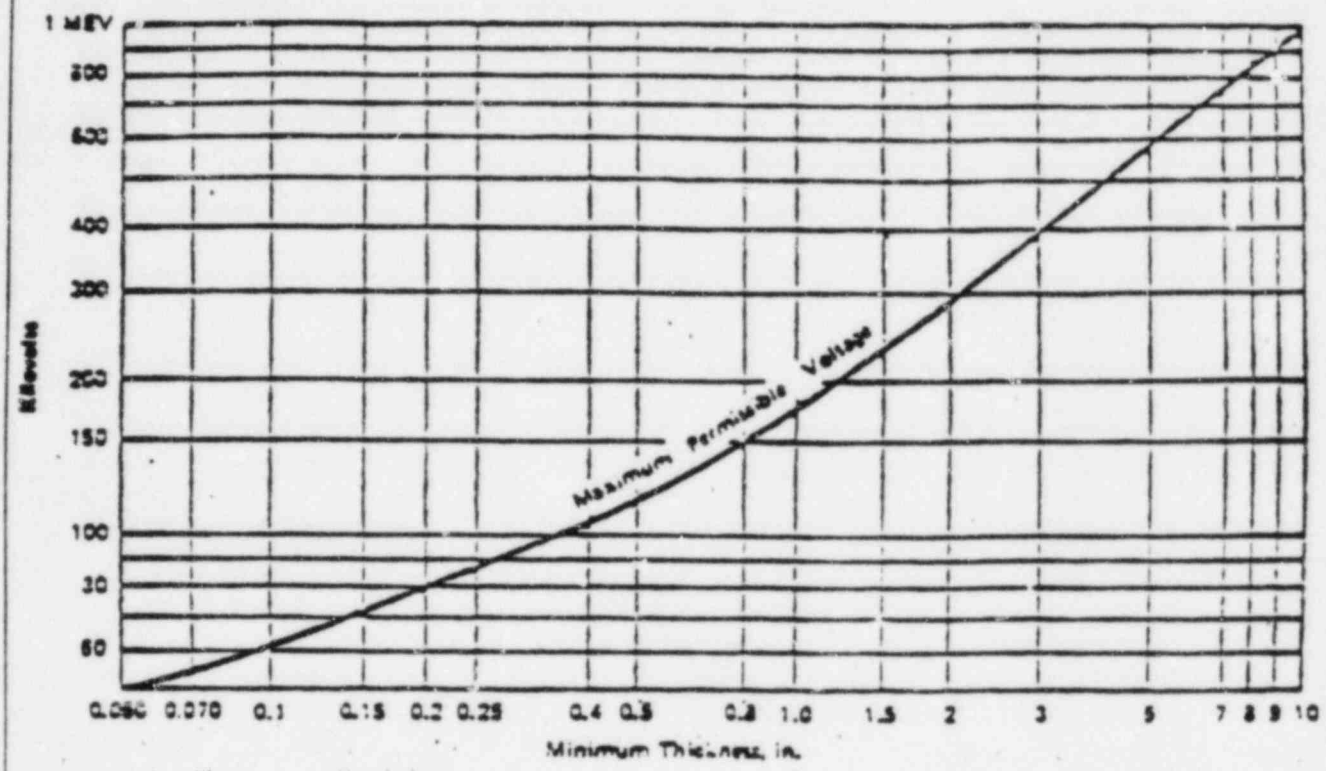
12.5 QCIM-20E, Single Wall Radiographic Techniques

12.6 QCIM-20F, Double Wall Radiographic Techniques



MAXIMUM VOLTAGE FOR ALLOYS OF COPPER AND/OR HIGH NICKEL

FORM (C) 372 - 22 - 3843



MAXIMUM VOLTAGE PERMITTED FOR ALUMINUM AND ALUMINUM ALLOYS

FORM (C) 372 - 22 - 3843

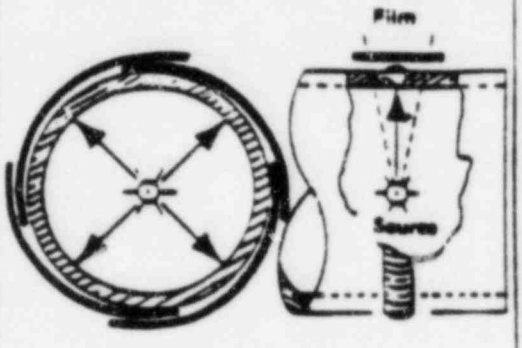
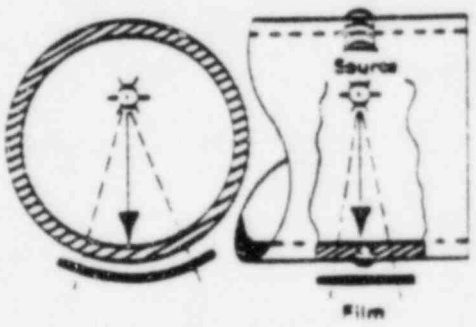
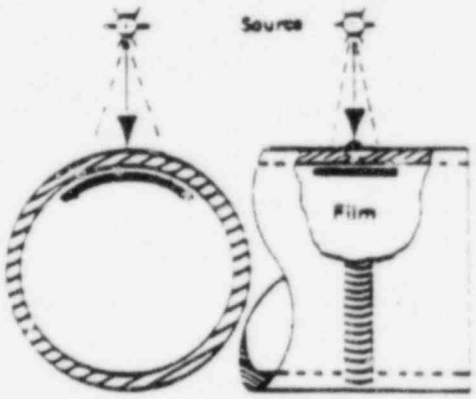
MATERIAL THICKNESS, PENETRAMETER DESIGNATIONS, AND ESSENTIAL HOLES FOR ALL RADIOGRAPHIC TECHNIQUES

Nominal Single-Wall Material Thickness Range, in.	Penetrameter			
	Source Side		Film Side	
	Designation	Essential Hole	Designation	Essential Hole
Up to 0.25 incl.	10	4 T	7	4 T
Over 0.25 thru 0.375	12	4 T	10	4 T
Over 0.375 thru 0.50	15	4 T	12	4 T
Over 0.50 thru 0.625	15	4 T	12	4 T
Over 0.625 thru 0.75	17	4 T	15	4 T
Over 0.75 thru 0.875	20	4 T	17	4 T
Over 0.875 thru 1.00	20	4 T	17	4 T
Over 1.00 thru 1.25	25	4 T	20	4 T
Over 1.25 thru 1.50	30	2 T	25	2 T
Over 1.50 thru 2.00	35	2 T	30	2 T
Over 2.00 thru 2.50	40	2 T	35	2 T
Over 2.50 thru 3.00	45	2 T	40	2 T
Over 3.00 thru 4.00	50	2 T	45	2 T
Over 4.00 thru 6.00	60	2 T	50	2 T
Over 6.00 thru 8.00	80	2 T	60	2 T
Over 8.00 thru 10.00	100	2 T	80	2 T
Over 10.00 thru 12.00	120	2 T	100	2 T
Over 12.00 thru 16.00	160	2 T	120	2 T
Over 16.00 thru 20.00	200	2 T	160	2 T

PENETRAMETER DESIGNATION, THICKNESS, AND HOLE DIAMETERS

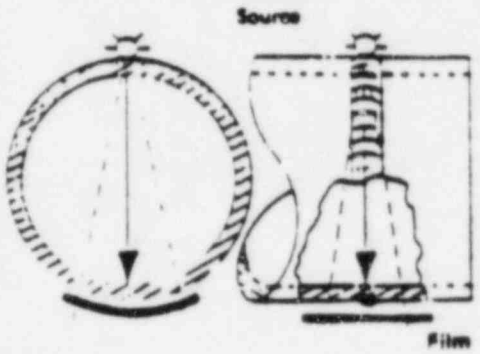
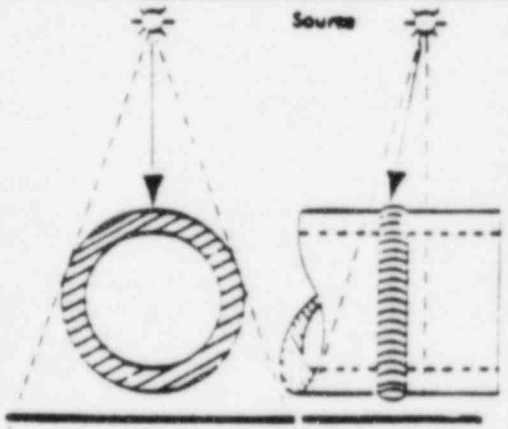
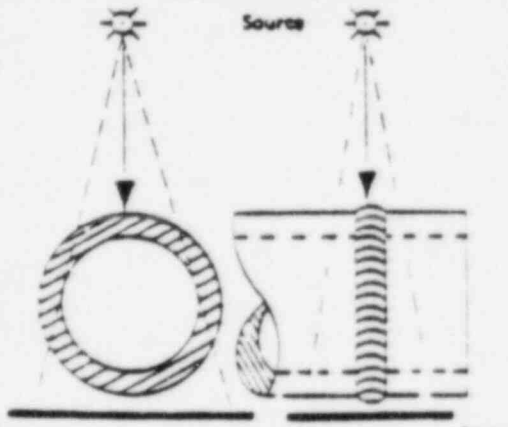
Penetrameter Designation	Penetrameter Thickness	1T Hole Diameter	2T Hole Diameter	4T Hole Diameter
5	0.005	0.010	0.020	0.040
7	0.007	0.010	0.020	0.040
10	0.010	0.010	0.020	0.040
12	0.012	0.012	0.025	0.050
15	0.015	0.015	0.030	0.060
17	0.017	0.017	0.035	0.070
20	0.020	0.020	0.040	0.080
25	0.025	0.025	0.050	0.100
30	0.030	0.030	0.060	0.120
35	0.035	0.035	0.070	0.140
40	0.040	0.040	0.080	0.160
45	0.045	0.045	0.090	0.180
50	0.050	0.050	0.100	0.200
60	0.060	0.060	0.120	0.240
80	0.080	0.080	0.160	0.320
100	0.100	0.100	0.200	0.400
120	0.120	0.120	0.240	0.480
160	0.160	0.160	0.320	0.640
200	0.200	0.200	0.400	

SINGLE-WALL RADIOGRAPHIC TECHNIQUES*

Pipe O.D.	Exposure Technique	Radiogram Viewing	Source-Weld-Film Arrangement		IQI Penetrameter		Location Marker Placement
			End View	Side View	Selection	Placement	
Greater Than 3½ in.	Single-Wall	Single-Wall	 Exposure Arrangement — A			Source Side Film Side	Either Side
Greater Than 3½ in.	Single-Wall	Single-Wall	 Exposure Arrangement — B			Source Side Film Side	Film Side
Greater Than 3½ in.	Single-Wall at least 4 Exposures at 90 deg. to Each Other	Single-Wall	 Exposure Arrangement — C			Source Side Film Side	Source Side

FORM (C) 372 - 22 - 3843

DOUBLE-WALL RADIOGRAPHIC TECHNIQUES'

Pipe O.D.	Exposure Technique	Radiograph Viewing	Source-Weld-Film Arrangement		IQI Penetrameter		Location Marker Placement
			End View	Side View	Selection	Placement	
Greater Than 3½ in.	Double-Wall: at Least 3 Exposures 120 deg. to Each Other	Single-Wall	 Exposure Arrangement — D		Attach. QCIM-300	Source Side Film Side	Film Side
3½ in. or Less	Double-Wall: at Least 2 Exposures at 90 deg. to Each Other	Single or Double Wall	 Exposure Arrangement — E		Attach. QCIM-300	Source Side	Either Side
3½ in. or Less	Double-Wall: at Least 3 Exposures at 60 deg. to Each Other	Double-Wall: Read Superimposed Source Side and Film Side Images	 Exposure Arrangement — F		Attach. QCIM-300	Source Side	Either Side

FORM (C) 372 - 22 - 3840

Public Service™ FORT ST. VRAIN NUCLEAR GENERATING STATION
PUBLIC SERVICE COMPANY OF COLORADO

TITLE: ULTRASONIC EXAMINATION OF CLASS 1 AND 2 PIPING WELDS JOINING SIMILAR AND DISSIMILAR MATERIALS

ISSUANCE AUTHORIZED BY			
PORC REVIEW	PORC 855 JAN 8- 1986		EFFECTIVE DATE 1-8-86

1.0 PURPOSE

1.1 This procedure describes the manual ultrasonic angle beam examination of full penetration piping welds ranging in thickness from 0.2 to 6 inches. This procedure is in accordance with the requirements of ASME Boiler and Pressure Vessel Code Section XI, 1980 up to and including Winter 81 Addenda.

2.0 APPLICABILITY

2.1 The principle objective of examination is the detection, location and evaluation of discontinuities within the weld and adjacent base metal. The weld shall be examined by the angle beam technique from the outside surface of the piping system.

3.0 GENERAL REQUIREMENTS

3.1 Personnel

3.1.1 All personnel performing nondestructive examination shall be certified in accordance with the nondestructive examination personnel qualification and certification which reflects the guidelines set forth by the scope of SNT-TC-1A.

3.2 Instrument

3.2.1 A pulse-echo ultrasonic flaw detection instrument shall be employed. It shall generate, receive, and present on a cathode-ray tube (CRT) screen, pulses in a frequency range from one to five MHz.

3.2.2 The instrument shall be equipped with a stepped gain control calibrated in units of 2 dB or less.

3.2.3 The system performance characteristics of the instrument shall be verified at least once a year.

3.3 Search Unit

3.3.1 Search units may contain either single or dual transducer elements.

3.3.2 The search units shall consist of a transducer and an angle beam wedge. The unit may be comprised of two separate parts or it may be an integral unit.

3.3.3 For general use, the search unit's transducer shall have an active area of not less than 0.04 sq inch nor more than 1.0 sq inch. Under certain circumstances, such as evaluation of indications, other sizes may be employed.

3.3.4 A nominal beam angle of 45 degrees in the material shall be employed. Other angles may be employed for evaluation of an indication, or where wall thickness, geometric configurations or metallurgical condition impedes effective use of 45 degrees angle beam for examination.

3.3.5 Nominal frequency of 2.25 MHz shall be employed. Other frequencies may be employed if variables, such as production material grain structure, necessitate the use of other frequencies in order to assure penetration or improve resolution.

3.3.6 In general, shear mode of wave propagation shall be used. Refracted longitudinal mode of wave propagation may be used if grain structure or other condition impedes the use of shear wave.

3.3.7 The angle beam wedges shall be within ± 3° of nominal value. This shall be checked on a standard reference block such as IIW or Rompas whenever any doubt arises about the tolerances.

3.4 Couplant

3.4.1 An approved couplant, capable of conducting ultrasonic vibrations from the transducer to the examination surface, shall be used.

3.4.2 The couplant identification and batch number shall be recorded on the calibration data sheet.

3.5 Examination Coverage

3.5.1 Scanning shall be done with an overlapping of each scan at least by 10 percent of the transducer dimension measured perpendicular to the scan path.

3.6 Search Unit Movement

3.6.1 The rate of search unit movement shall not exceed 6 inches/second unless calibration has been verified at the higher scanning speed.

3.7 Scanning Sensitivity

3.7.1 Scanning shall be done at twice (+6 dB) the primary reference level as a minimum but recording of ultrasonic reflectors shall be done at the primary reference level.

3.8 Surface Preparation

3.8.1 The examination surface shall be free of irregularities, loose material, or coatings which may interfere with ultrasonic wave transmission.

3.9 Identification of Examination Areas

3.9.1 NED shall provide the proper identification system.

4.0 INSTRUMENT CALIBRATION

4.1 A check of the ultrasonic instruments screen height linearity shall be performed as described in Section 4.0, QCIM 36.

4.2 A check of the ultrasonic instruments amplitude control linearity shall be performed as described in Section 5.0 of QCIM 36.

4.3 The instrument calibration may be performed on any calibration block, including an IIW or Rompas block, and need not be performed with the same search unit used in the next examination.

4.4 The instrument calibration for screen height and amplitude control linearity shall be performed at the beginning of each period of extended use or every three months, whichever is less. This shall also be performed whenever any doubt arises about the instrument's functions.

5.0 BASIC CALIBRATION STANDARDS

5.1 The finish on the surfaces of the standard shall be representative of the surface finishes of the piping to be examined.

5.2 The calibration standard shall conform to ASME Section XI, 1980 up to and including Winter 1981 Addenda.

6.0 SYSTEM CALIBRATION

6.1 General

6.1.1 Complete ultrasonic examination system calibration establishing the DAC curve, shall be performed prior to each examination, or series of similar examination.

6.1.2 Calibration shall include the complete ultrasonic examination system. Any change in search units, shoes, couplants, cables, ultrasonic instruments, recording devices, or any other parts of the examination system shall be the cause of calibration check. The original calibration shall be performed on the basic calibration standard and calibration checks shall be performed as per Article 6.3 of this procedure.

6.1.3 The maximum calibration indications shall be obtained with the sound beam oriented essentially perpendicular to the axis of the calibration reflector. The centerline of the search unit shall be at least 3/4 inch from the nearest side of the standard.

6.1.4 The temperature difference between the examination and calibration standard surfaces shall not exceed 25°F (14°C).

6.1.5 Calibration shall be performed from the outside surface of the calibration standard.

6.2 Calibration

6.2.1 The examination for reflectors parallel to the weld shall, in general, be performed by a one-half V path from two sides of the weld. If variables, such as those referenced in Section 7.1 of this procedure, prevent the use of one-half V examination, the beam path shall be increased a minimum of one-half V until complete examination volume is covered. The examination for reflectors transverse to the weld shall be performed by one-half V path in two directions along the weld. It may also be necessary, particularly in thin wall piping, to increase the examination beam angle.

6.2.2 One-half V Path Technique

To establish the sweep range, obtain the maximum response from the circumferentially oriented I.D. notch, position this response at 0 on the sweep. Next, obtain the maximum response from the O.D. notch, position this response at 8 on the sweep. Continue positioning these responses until no further adjustment is necessary. Again obtain the maximum response from the I.D. notch and using the delay control only, shift this response to 8 on the sweep. Lock the range and delay controls as the sweep is now established. Now obtain the maximum response from the axially oriented I.D. notch and mark its location on the screen. The slope and shape of the DAC curve shall be established using the 1/4T and 3/4T holes drilled parallel to the long axis of the calibration standard. Adjust the peak amplitude of the hole giving the higher response to 80 percent FSH. Mark the amplitude and location on the screen. Without adjusting the instrument controls, maximize response from the remaining hole and mark its amplitude and location on the screen. Connect the amplitude points with a smooth curve and extrapolate this curve an additional 1/4T to cover full examination range. Next establish reference sensitivity by setting the maximum response from the I.D. notch, at the DAC curve level. This curve (DAC) is the primary reference level and recording of ultrasonic reflectors shall be performed at this sensitivity.

As an alternate, a calibration using sound path may be used. The horizontal base line calibration, in inches, may be established using an IIW Block, Rompas Block or Miniature Angle Beam Block. The range selected shall be such that at least 60 percent of the base line will represent the examination area. After the sweep range is calibrated the slope and shape of the DAC curve and reference sensitivity shall be established by the technique described above.

6.2.3 Greater Than One-half V Path Technique

Using the required V paths, ie full V, one and one-half V etc., establish the sweep range calibration by positioning responses from the appropriate ID and OD notches at convenient intervals along the sweep and mark notch locations on the screen. The DAC shall be established by setting the maximum response from the one-half V path ID notch to 80 percent (FSH) and mark the location on the screen. Without adjusting the instrument controls, obtain the maximum response from the remaining notch echo(es) in the test region and mark the location(s) on the screen. Connect the maximum amplitude points with a smooth curve to form the DAC. This curve is the primary reference level and recording of ultrasonic reflectors shall be performed at this sensitivity.

6.2.4 Recording of Calibration Data

Particulars of system calibration shall be recorded on the Calibration Data sheet.

6.3 Calibration Check

6.3.1 A system calibration check, which is the verification of the instrument sensitivity and sweep range calibration, shall be performed at the start and finish of each examination or series of similar examination, with any change in examination personnel, and at least every 4 hours during an examination. Calibration checks may be performed on either the standard used for initial calibration, or a simulator.

6.4 Corrective Action

6.4.1 If any point on the DAC curve has decreased 20 percent or 2 dB of its amplitude, all data sheets since the last calibration shall be marked void. A new calibration shall be made and recorded and the voided examination area shall be reexamined.

6.4.2 If any point on the DAC curve has increased more than 20% or 2 dB of its amplitude, recorded indications taken since the last valid calibration or calibration check shall be reexamined.

6.4.3 If any point on the DAC curve has moved on the sweep line more than 10 percent of the sweep division reading, correct the sweep range calibration and note the correction on the examination record. If recordable reflectors are noted on the data sheets, those data sheets shall be voided, a new calibration shall be recorded, and the voided examination areas shall be reexamined.

7.0 EXAMINATION

7.1 Reflectors Parallel to the Weld Seam

The angle beam examination for reflectors parallel to the weld shall, in general, be performed by a one-half V path from two sides of the weld.

If variables such as access, weld conffguration or wall thickness preclude half V examination, the examination shall be performed by at least a full V path from one side of the weld.

7.2 Reflectors Transverse to the Weld Seam

The angle beam examination for reflectors transverse to the weld shall be performed on the weld crown on a single scan path to examine the weld root by one-half V path in two directions along the weld in a single beam path.

If variables such as weld surface conditions preclude circumferential scans on the weld crown. The examination shall be performed on the base material adjacent to the weld's toe employing the one-half V path 60° share wave technique. Scanning approximately 15° towards the weld centerline on a single scan path, in two directions, on both sides of the weld crown, when accessible.

Calibration of the circumferential scan employing 15° skew angle shall be performed in conformance with 6.2.2, and by setting the sensitivity from the I.D. notch at approximately 15° from perpendicular.

7.3 Directions and Extent of Scanning

Ultrasonic energy shall pass in all the required directions and the extent of scanning shall be such that the ultrasonic beam passes through the entire examination volume as indicated in Attachment QCIM-38A of this procedure.

8.0 DATA RECORDING AND EVALUATION

8.1 Each indication that exceeds 20% DAC, shall be investigated to determine maximum percent of DAC.

8.2 For each indication that exceeds 50% of reference level (DAC) but does not equal 100% DAC, the following information shall be on the Indication Data Sheet.

8.2.1 Search unit location at peak amplitude and scan direction.

8.2.2 Peak amplitude as either Db from reference level, or as a percent of DAC.

8.3 For each indication that equals or exceeds 100% DAC, the search unit location, orientation and the following information, shall be recorded on the indication data sheet.

8.3.1 Peak amplitude as either dB from the reference level (100% DAC), or as a percent of the DAC curve, sweep reading to reflector, search unit position (distance from weld centerline) and sound beam direction.

8.3.2 Minimum sweep reading to reflector and position of search unit at reference level.

8.3.3 Maximum sweep reading to reflector and position of search unit at reference level.

8.3.4 Search unit positions or locations parallel to the reflector at the end points where the reflector amplitude equals the reference level. (length of reflector).

8.4 Indications that can be determined to be of a geometric or metallurgical origin (ie weld geometry, weld-to-base metal interface) need not be recorded on an indication data sheet. However, the amplitude and location from reference shall be recorded in the comments section of the calibration data sheet.

8.5 The presence of a reflector of geometric origin shall be confirmed by one of the following.

8.5.1 Review of the fabrication drawings of the pipe weld edge preparation.

8.5.2 Review of the records from previous non-destructive examinations.

8.5.3 Perform supplemental non-destructive examinations.

9.0 RECORDS

9.1 A detailed ultrasonic examination report shall be prepared using the applicable report forms provided at the end of this procedure and any additional sketches or photographs as may be applicable. If no reportable indications are detected it shall be so noted on the appropriate report form.

9.2 Data shall be entered, as required for each item in the blank space provided on the calibration data sheet, and if used, on the indication data sheet. Where data is not germane for the specific item the blank space shall be marked N/A to indicate that data is not applicable.

9.3 Prompt (24 hours) notification of reportable indications shall be made to the representative designated by NED.

10.0 REFERENCES

10.1 ASME Section XI, 1980 Edition up to and including Winter '81 Addenda.

10.2 QCIM-4 - Nondestructive Examination Personnel Qualification and Certification.

10.3 QCIM-36 - Calibration of Ultrasonic Flaw Detectors.

11.0 ATTACHMENTS

11.1 QCIM-38A - Examination Volume

11.2 QCIM-38B - Inservice Inspection Calibration Data

11.3 QCIM-38C - Inservice Inspection Indication Data

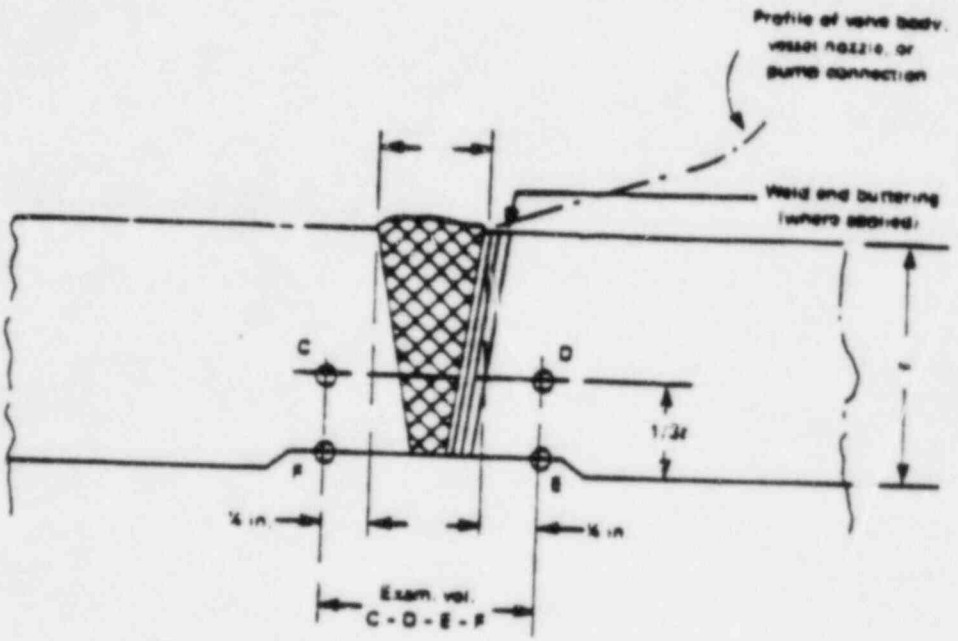
11.4 QCIM-38D - Inservice Inspection Sketch Sheet

12.0 COMMITMENTS

The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

7.1 None

EXAMINATION VOLUME



FORM (C) 372 - 22 - 3643

INSERVICE INSPECTION

CALIBRATION DATA

PROJECT _____

DATA SHEET NO. _____ DATE _____

PROCEDURE (Mat'l. _____ REV _____

COMPONENT OR SYSTEM _____ PIPE ID (IF APPLICABLE) _____

ITEM IDENTIFICATION NO(S). LISTED ON REVERSE SIDE - COMPONENT TEMP _____ EXAM SURFACE _____

CALIBRATION BLOCK NO. _____ THICKNESS _____ TEMP _____

SCAN COVERAGE

☐ % WELD ☐ % BASE MATERIAL ☐ AXIAL ☐ CIRCUMFERENTIAL

EQUIPMENT DATA

SEARCH UNIT

Manufacturer _____

Style _____

Serial No. _____

Size _____ Frequency _____

Angle _____ Mode _____

Couplant _____ Batch No. _____

INSTRUMENT

Manufacturer _____ Model _____

Serial No. _____ Cable _____ Cable Length _____

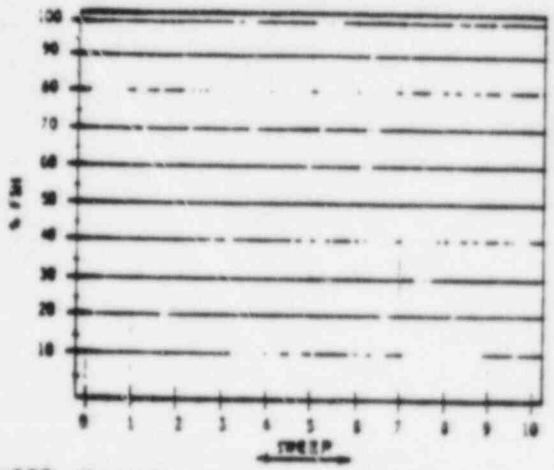
Frequency _____ Reject _____

Rep. Rate _____ _____ Damping _____

dB Gain - Coarse _____ Fine _____

Primary Reference Response
Amplitude % Full Screen Height _____

DAC PLOT - TIME _____ AM. PM.



NOTE: When performing examinations where no DAC is required, indicate reference reflector location and amplitude used.

CALIBRATION CHECKS

	AMPL ± 20% (2dB) OF INITIAL AMPL		SWEEP ± 5% OF INITIAL LOCATION	
	YES	NO	YES	NO

NOTE: If response above is "NO" refer to Corrective Action section of procedure.

EXAMINER(S)

1. _____ TOTAL LEVEL _____

2. _____ TOTAL LEVEL _____

REVIEWED BY _____ DATE _____

FORM (C) 372 - 22 - 3643

SHEET ____ OF ____

INSERVICE INSPECTION
INDICATION DATA

ITEM IDENTIFICATION ____

CALIBRATION DATA SHEET NO. ____

DATA TABULATION

SCAN DIRECTION: ST BEAM	SCAN DIRECTION: CIR. COMPRESSIONAL	SCAN DIRECTION: AXIAL	INDICATION NO.	EXAM. ON ____ (ID) WELD SIDE OF WELD	MAX % DAC	SWEEP READING	SEARCH UNIT EXIT POINT LOCATION: CIRCUMFERENTIAL (DISTANCE CW OR CCW FROM REFERENCE LINE)	SEARCH UNIT EXIT POINT LOCATION: AXIAL (DISTANCE FROM WELD ℄)	50° DAC OR HALF MAXIMUM AMPLITUDE: MINIMUM: SWEEP READING	50° DAC OR HALF MAXIMUM AMPLITUDE: MINIMUM: S.U. POSITION	50° DAC OR HALF MAXIMUM AMPLITUDE: MAXIMUM: SWEEP READING	50° DAC OR HALF MAXIMUM AMPLITUDE: MAXIMUM: S.U. POSITION	STRAIGHT BEAM (CAL ON BACK REFLECTION): INDICATION AMPLITUDE (% FSH)	STRAIGHT BEAM (CAL ON BACK REFLECTION): BACK REFLECTION AMPLITUDE (% FSH)

RESULTS: INDICATION NO.	LOCATION OF INDICATION: CIRC	LOCATION OF INDICATION: AXIAL	LENGTH	% T: DEPTH (IF PLANAR)	% T: DISTANCE FROM SURFACE	WIDTH (IF LAMINAR)	COMMENTS

CONTINUATION ATTACHED - ☐ Yes ☐ No

EXAMINERS:

1. ____ ____ TC-1A LEVEL ____

2. ____ ____ TC-1A ℄ ____

REVIEWED BY ____ ____ DATE ____

FORM QCSP 22 3643

INSERVICE INSPECTION

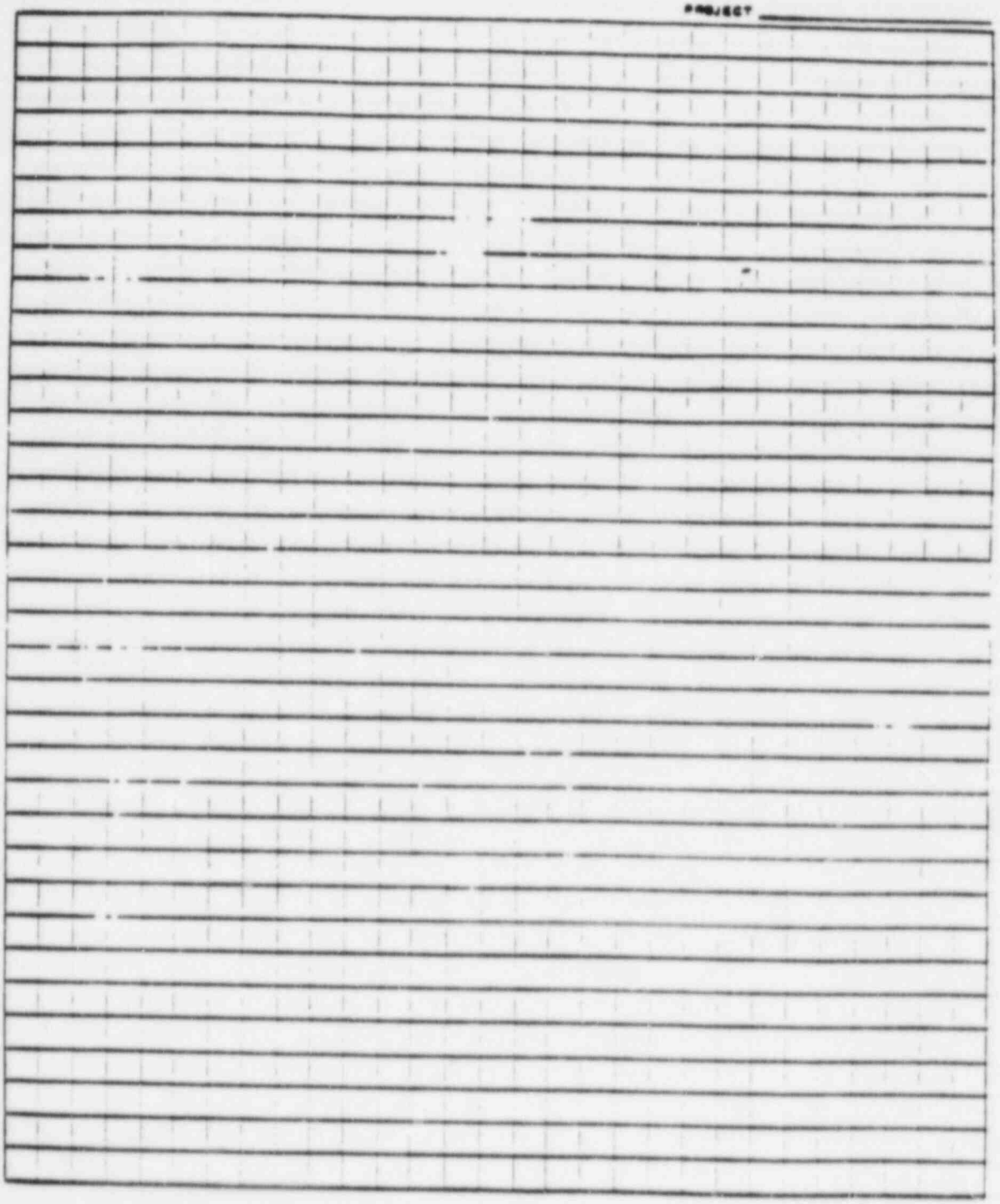
SKETCH SHEET

LINE AND WELD(S) _____

DATE _____

EXAMINER _____

PROJECT _____



FORM (C) 372 - 22 - 3643

Public Service

FORT ST. VRAIN NUCLEAR GENERATING STATION
PUBLIC SERVICE COMPANY OF COLORADO

| TITLE: CALIBRATION OF ULTRASONIC FLAW DETECTORS

ISSUANCE AUTHORIZED BY	K Heuer 8-7-85		
PORC REVIEW	PORC # 87 SEP 6 : 1985		EFFECTIVE DATE 9-13-85

1.0 PURPOSE

This procedure describes the requirements of and the methods used in measuring the screen height linearity and the amplitude control linearity of pulse echo type ultrasonic flaw detectors.

2.0 SCOPE

This procedure conforms to the latest editions and addenda of the applicable codes and applies to all pulse echo type ultrasonic flaw detectors used by Public Service Company.

3.0 GENERAL REQUIREMENTS

3.1 Personnel performing these calibrations/measurements shall be qualified in accordance with Procedure QCIM-4.

3.2 The instruments shall be the pulse echo type which can generate, receive and present on a cathode ray tube, (CRT), high frequency sound energy impulses.

3.3 Both the screen height linearity and the amplitude control linearity shall be measured at the beginning of each period of extended use or every three months, whichever is less.

3.4 The search unit shall be of a frequency and angle so as to obtain the maximum response from the reference holes and notches when the sound beam is oriented perpendicular to the axes of these reflectors. (See Attachment QCIM-36A)

3.5 Transducers may be fitted with shoes to maintain adequate sound penetration or the proper sound beam angle in the test material.

3.6 Couplant shall be any material having good wetting characteristics that will provide for the transmission of ultrasound from the search unit to the test material.

3.7 Calibration blocks shall consist of IIW Reference Block (See Attachment QCIM-36A Fig. 2) or any calibration block which will provide amplitude differences and contains other convenient reflectors.

3.8 Settings and readings must be estimated to the nearest 1% of full screen.

4.0 MEASUREMENT OF SCREEN HEIGHT LINEARITY

4.1 The ultrasonic instrument must provide linear vertical presentation within ±5% of the full screen height for at least 80% of the full screen height (baseline to maximum calibrated screen point). To verify this, perform the following:

4.1.1 Position an angle beam search unit as shown in Attachment QCIM-36A, Fig. 1 or a straight beam search unit as shown in Attachment QCIM-36A, Fig. 2 so that indications can be observed from two reference points as shown in Attachment QCIM-36A, Fig. 3.

4.1.2 Adjust the search unit position to give a 2:1 ratio of amplitudes between the two indications with the larger set at 80% of full screen height.

4.1.3 Without moving the search unit, adjust ansitivity (gain) to successively get the larger indication from 100% to 20% of full screen height, in 10% increments and read the smaller indication at each setting. The reading must be 50% of the larger indication, within 5% of full screen height.

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5.0 MEASUREMENT OF AMPLITUDE CONTROL LINEARITY

5.1 The ultrasonic instrument must utilize an amplitude control, accurate over it's useful range to ±20% of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. To verify this, perform the following:

5.1.1 Position an angle beam or straight beam search unit so the indication from a reference hole in a reference block is peaked on the screen.

5.1.2 With the increases and decreases in attentuation shown in 5.1.3, the indication must fall within the specified limits.

5.1.3

Indication Set at % of Full Screen	dB Control Change	Indication Limits % of Full Screen
80%	-6 dB	32 to 48%
80%	-12 dB	16 to 24%
40%	+6 dB	64 to 96%
20%	+12 dB	64 to 96%

6.0 RECORDS

6.1 Results of this calibration shall be documented on the ultrasonic test report form, Attachment QCIM-2C, and shall be administered and transmitted in accordance with procedure QCIM-1.

7.0 REFERENCES

7.1 ASME Section V - Nondestructive Examination

7.2 QCIM-1 - Equipment and Tool Calibration

7.3 QCIM-2, Preparation and Control of NDE Test Reports

7.4 QCIM-3, Nondestructive Examination Personnel Qualification and Certification

8.0 ATTACHMENT

8.1 Attachment QCIM-36A, Linearity

FORM (C) 372 - 22 - 3643

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PUBLIC SERVICE COMPANY OF COLORADO

9.0 COMMITMENTS

The step(s) and section(s) listed below may not be deleted without issuance of comparable controls. The procedure itself, if initiated as a result of commitment corrective action, may not be deleted without issuance of comparable controls.

9.1 None

FORM (C) 372 - 22 - 3643

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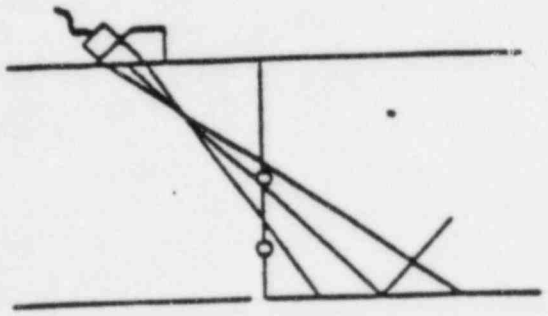


FIG. .1 LINEARITY

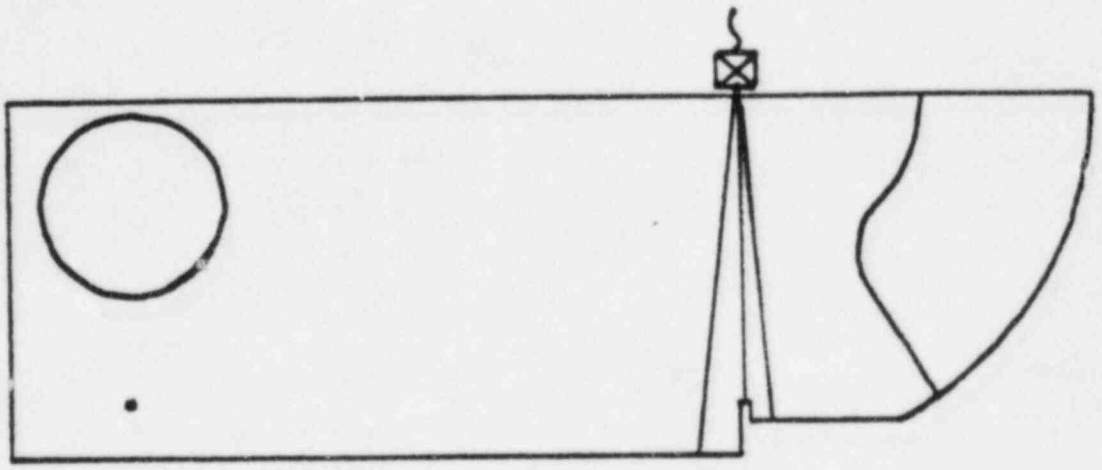


FIG. 2 LINEARITY

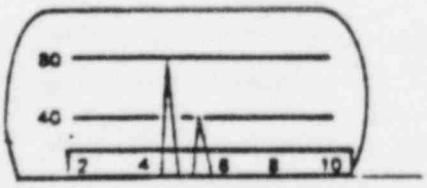


FIG. 3 LINEARITY

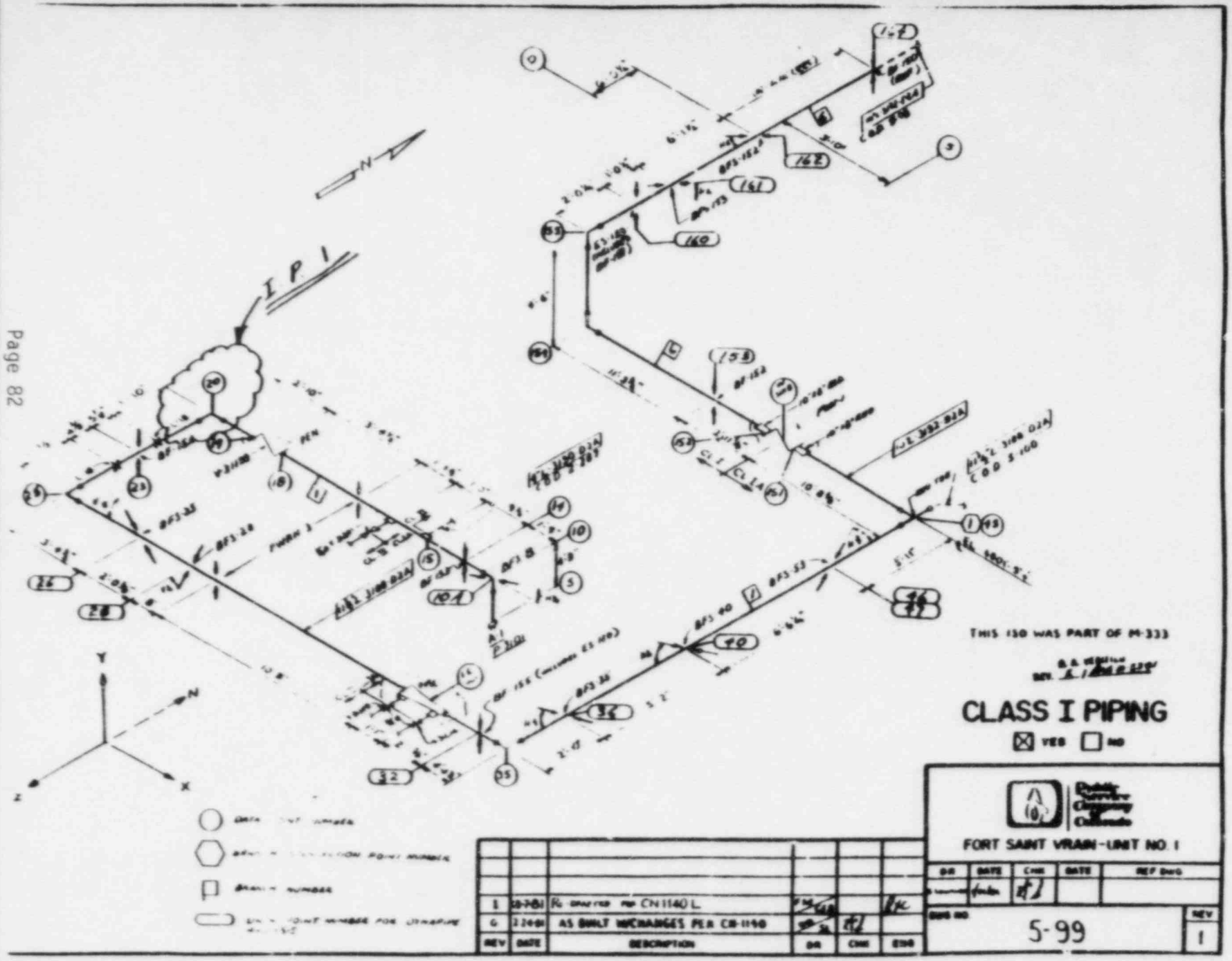
FORM (C) 372 - 22 - 3643

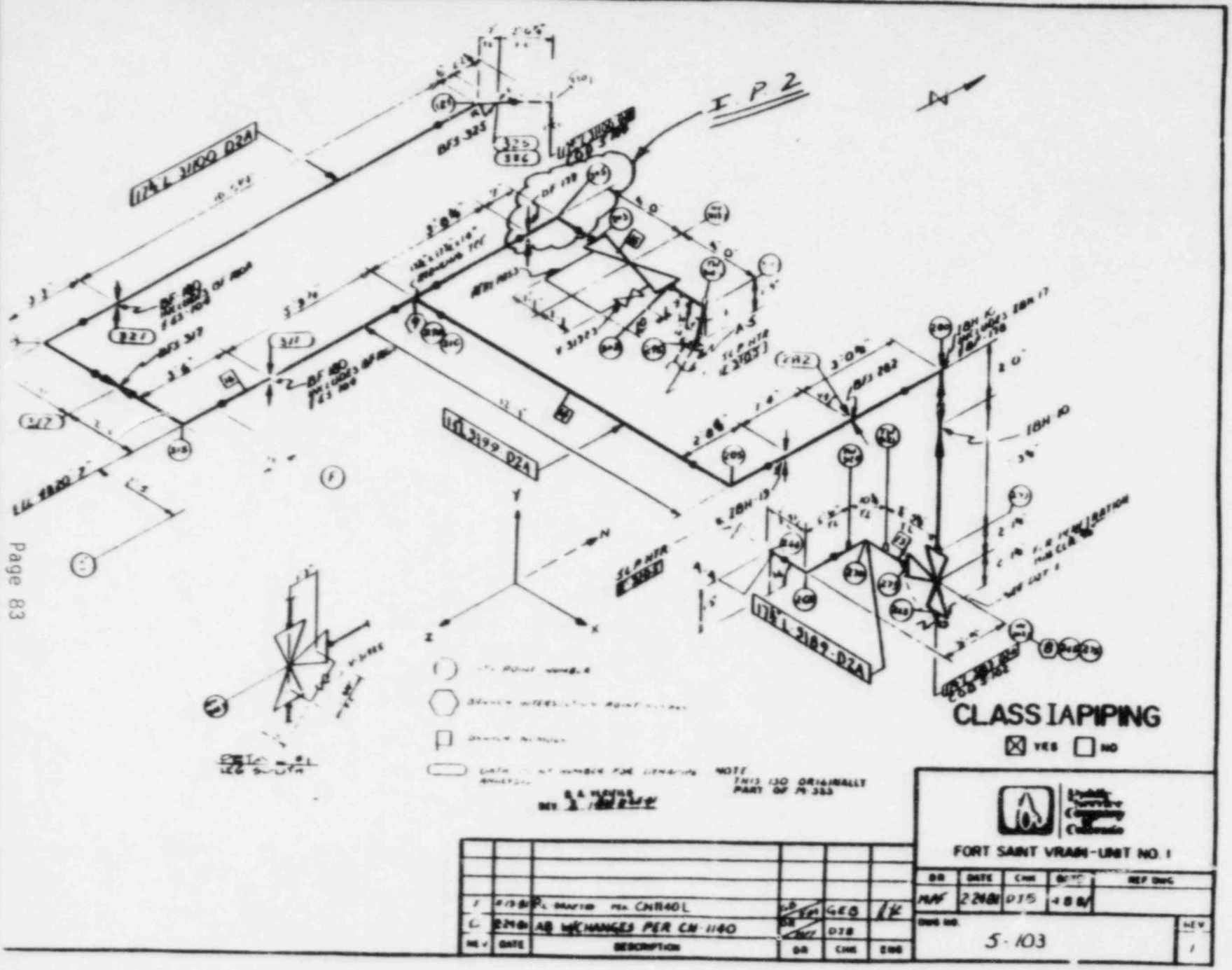
Attachment 2

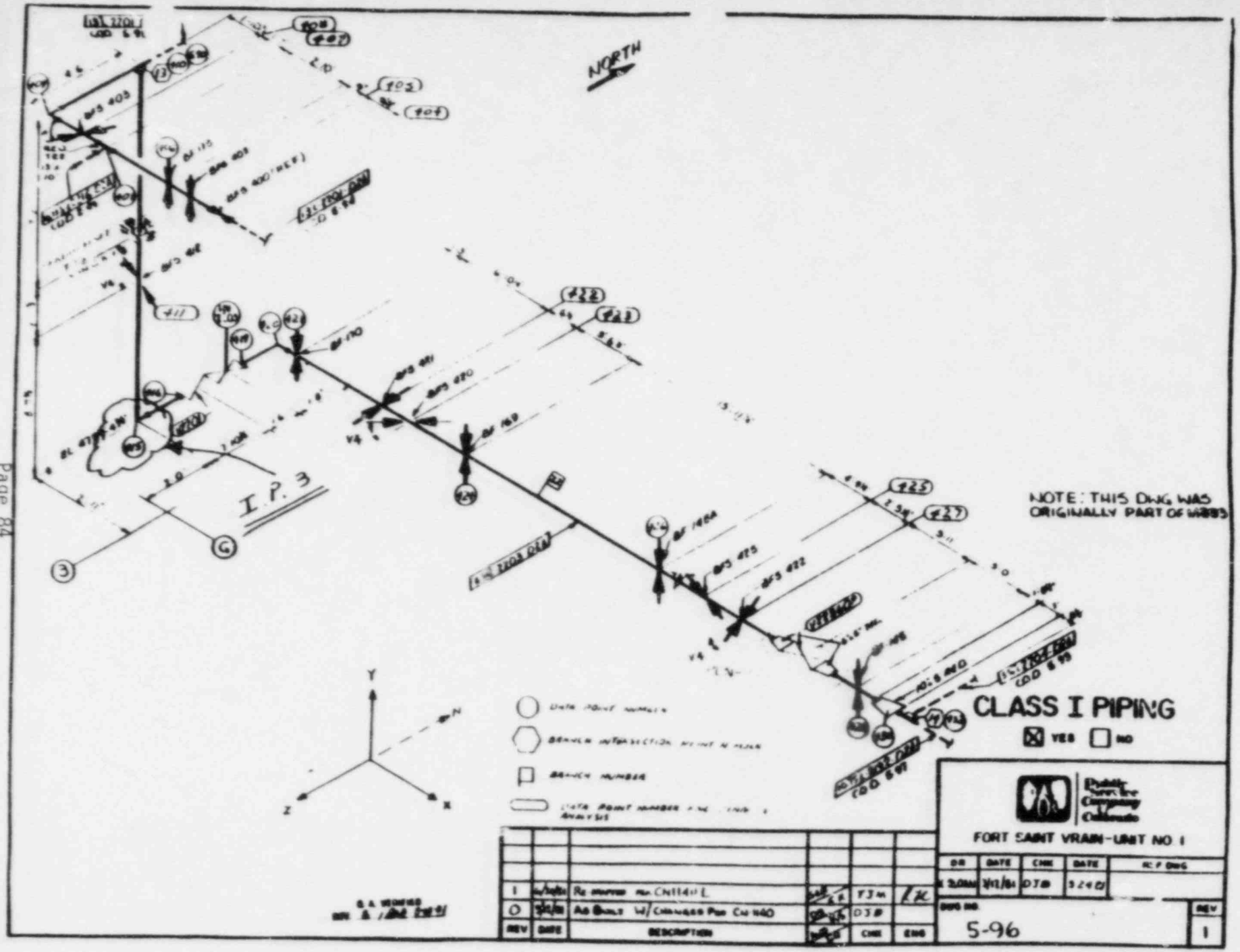
ISOMETRICS

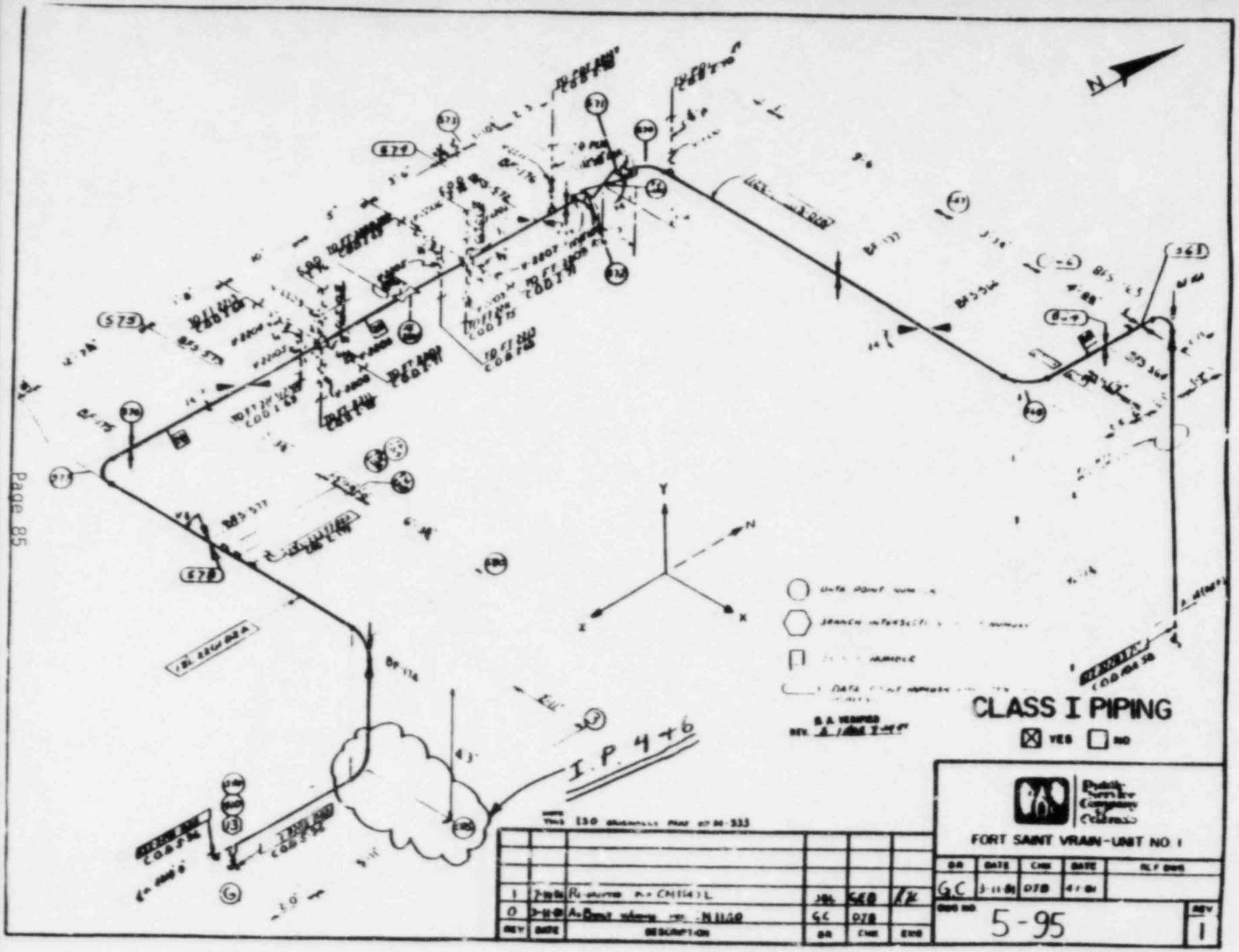
1. Inspection Areas

2. Welded Plate Pipe

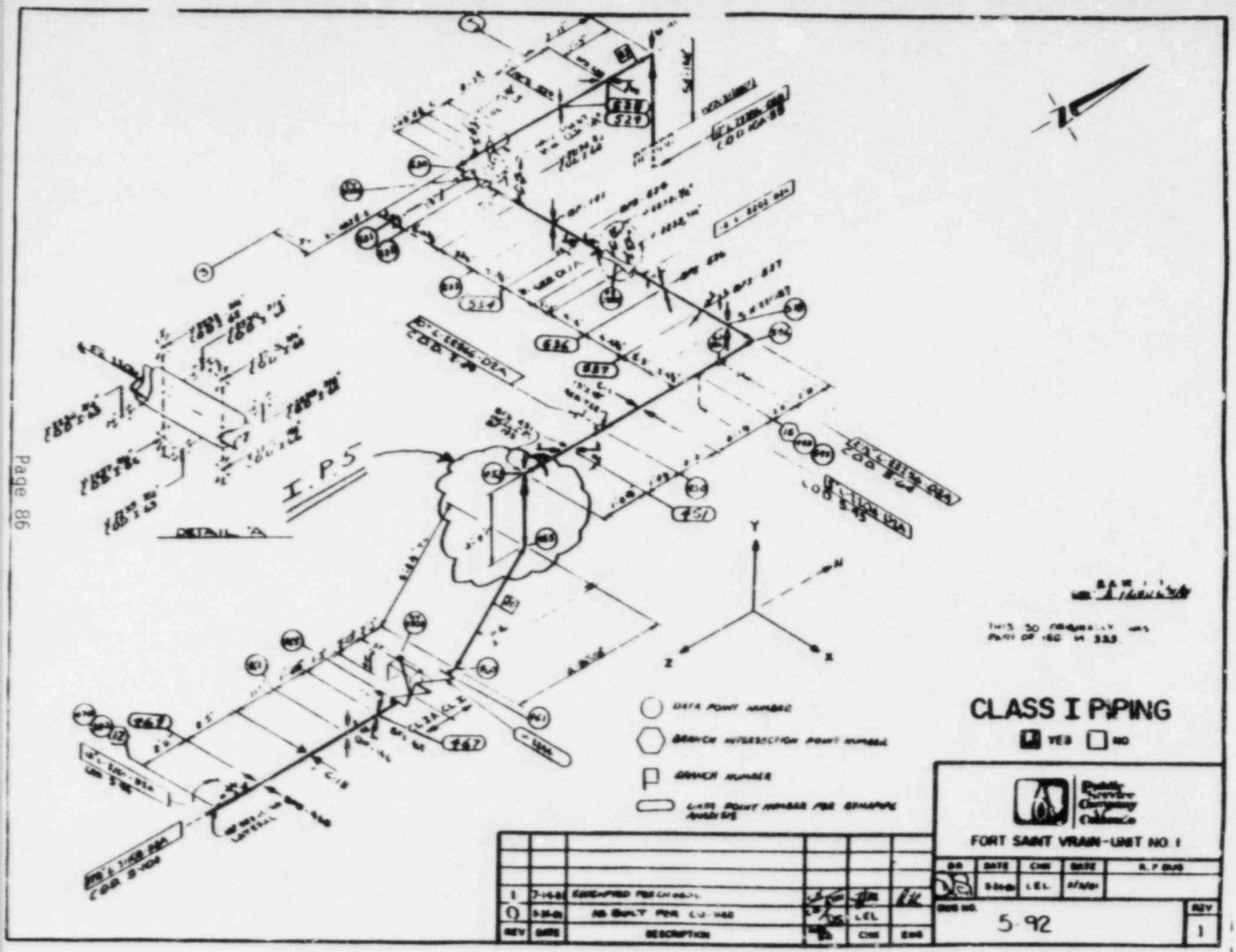


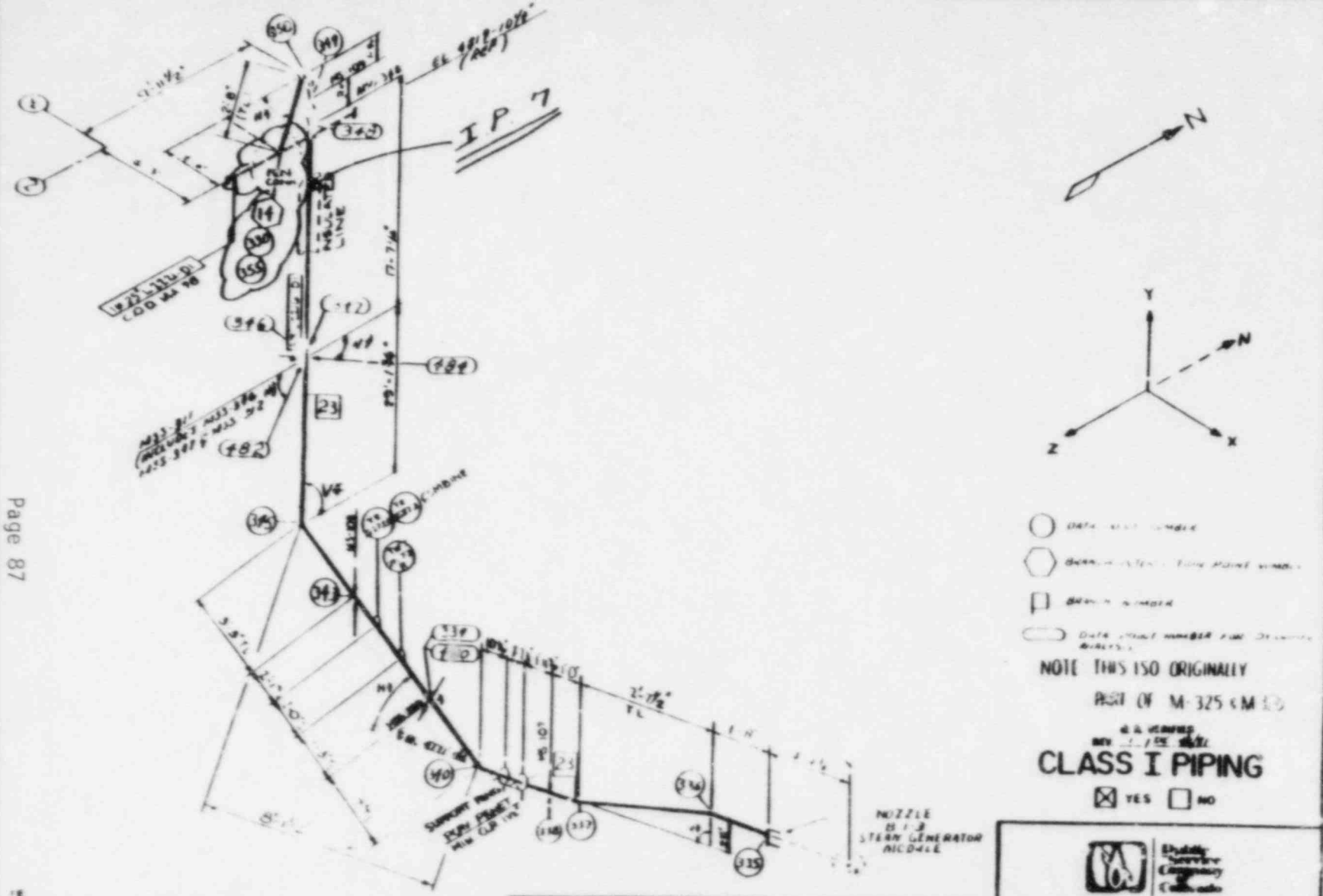

I.P.2
CLASS IA PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO. 1
5-103
FT. ST. VRAIN
NON CONTROLLED COPY
VERIFY ISSUE STATUS WITH DOCUMENT CENTER PRIOR TO USE

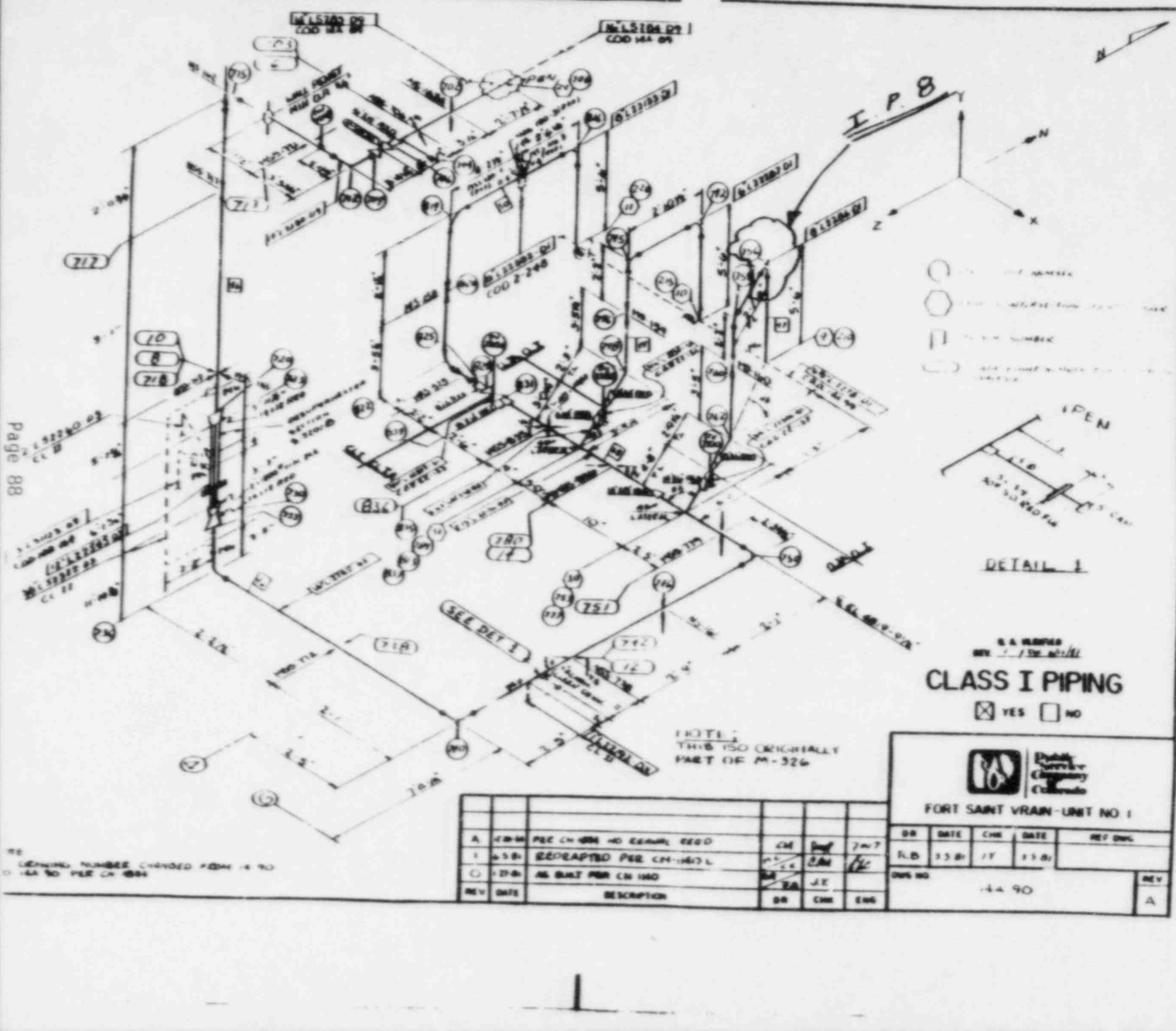

NORTH
I.P. 3
NOTE: THIS DWG. WAS ORIGINALLY PART OF M885
CLASS I PIPING
YES
NO
Public Service Company of Colorado
FORT SAINT VRAIN-UNIT NO 1
5-96
REV
1
DESCRIPTION
DATE
CHK
ENG

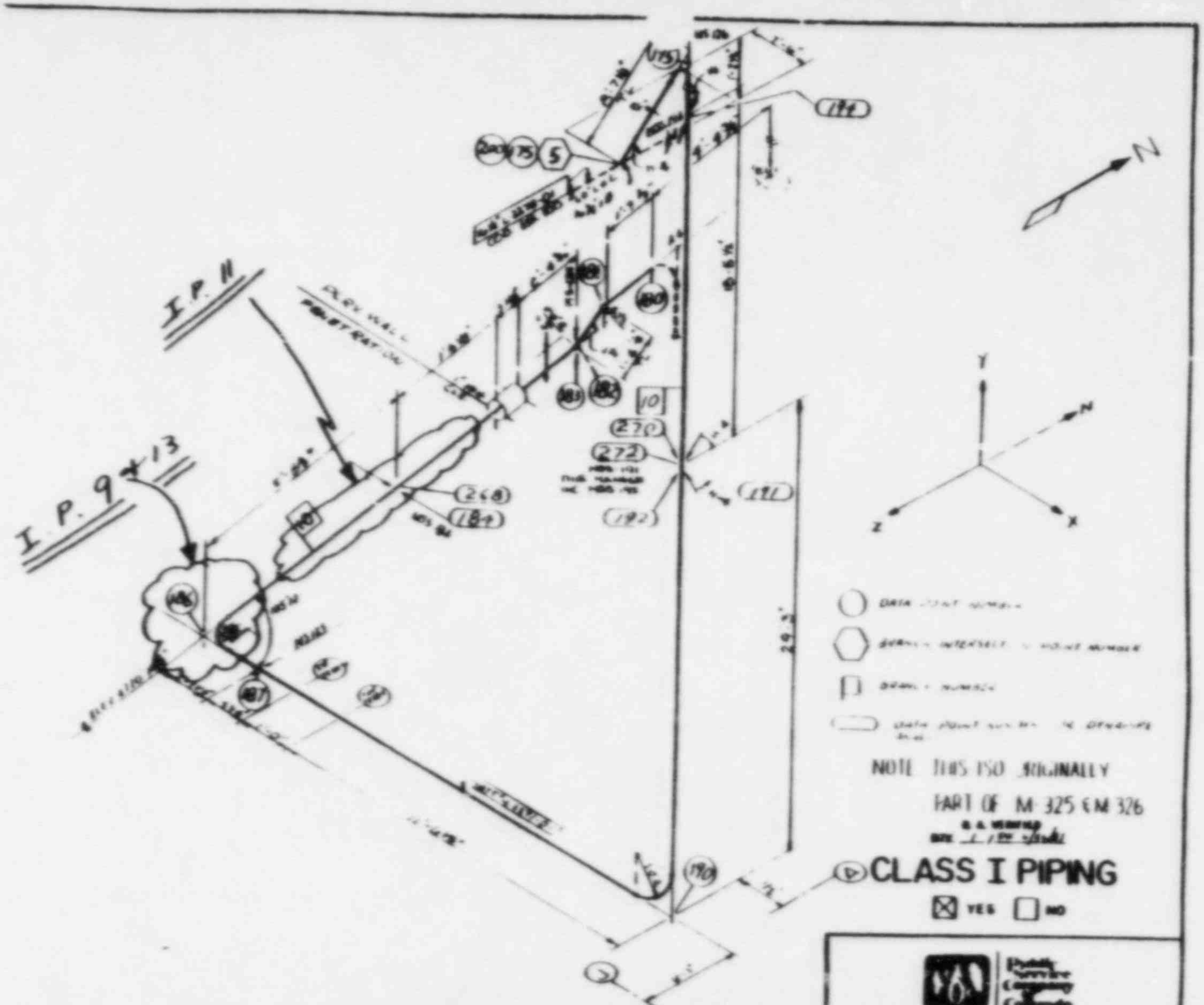


FT ST VRAIN
NON-CONTROLLED
COPY


I.P.5
DETAIL 'A'
Y
N
Z
X
DATA POINT NUMBER
BRANCH INTERSECTION POINT NUMBER
BRANCH NUMBER
DATA POINT NUMBER FOR SEPARATE ANALYSIS
CLASS I PIPING
YES
NO
Public Service Company of Colorado
FORT SAINT VRAIN-UNIT NO 1
DWG NO.
5.92
REV
1
DR
DATE
CHK
DATE
A/E DWG
L.E.L.
REV
DATE
DESCRIPTION
CHK
ENG
AS BUILT PER
LEL


IP 7
N
Y
N
Z
X
NOTE THIS ISO ORIGINALLY
CLASS I PIPING
YES
NO
NOZZLE
STEAM GENERATOR
FORT SAINT VRAIN - UNIT NO 1
DRAWING NUMBER CHANGED FROM
TO
PIPE CH-
RECRAFTED PIPE CH-
AS BUILT W/ CHANGES PER CHRGD
DESCRIPTION
DR
CHK
ENG
DATE
REF DWG
DWG NO
REV


I. P. 8
DETAIL 1
SEE DET 1
OPEN
NOTE:
THIS ISO ORIGINALLY
PART OF M-326
CLASS I PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO. 1
DESCRIPTION
REV
DATE
DR
CHK
ENG
REF DWG
DWG NO
14A 90
A
REDRAFTED PER CN-1402 L
AS BUILT PER CN 1160
DRAWING NUMBER CHANGED FROM 14 90
TO 14A 90 PER CN 1894



A		PER CN 1836 NO REANAL REQ'D	CM		
1		REDRAFTED PER CN-1180L			
0		AS BUILT W/ CHANGES PER		LEL	
REV	DATE	DESCRIPTION	DR	CHK	ENG

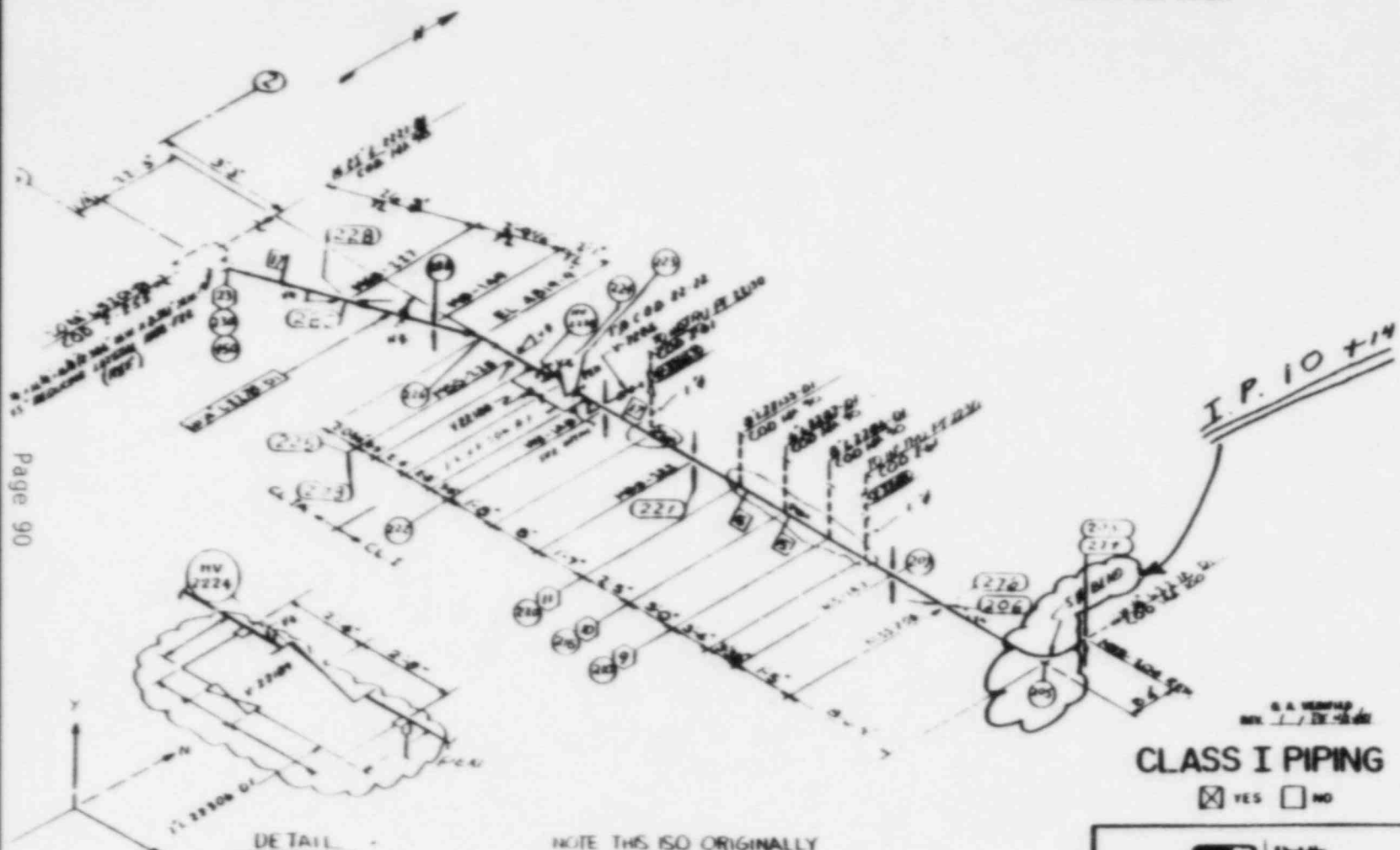
Public Service Company of Colorado

FORT SAINT VRAIN - UNIT NO 1

DR	DATE	CHK	DATE	REF DWG
		LEL		

DWG NO: 14A-94 | REV: A

NOTE
DRAWING NUMBER CHANGED FROM A-99 TO A4 99 PER CN 1834



CLASS I PIPING

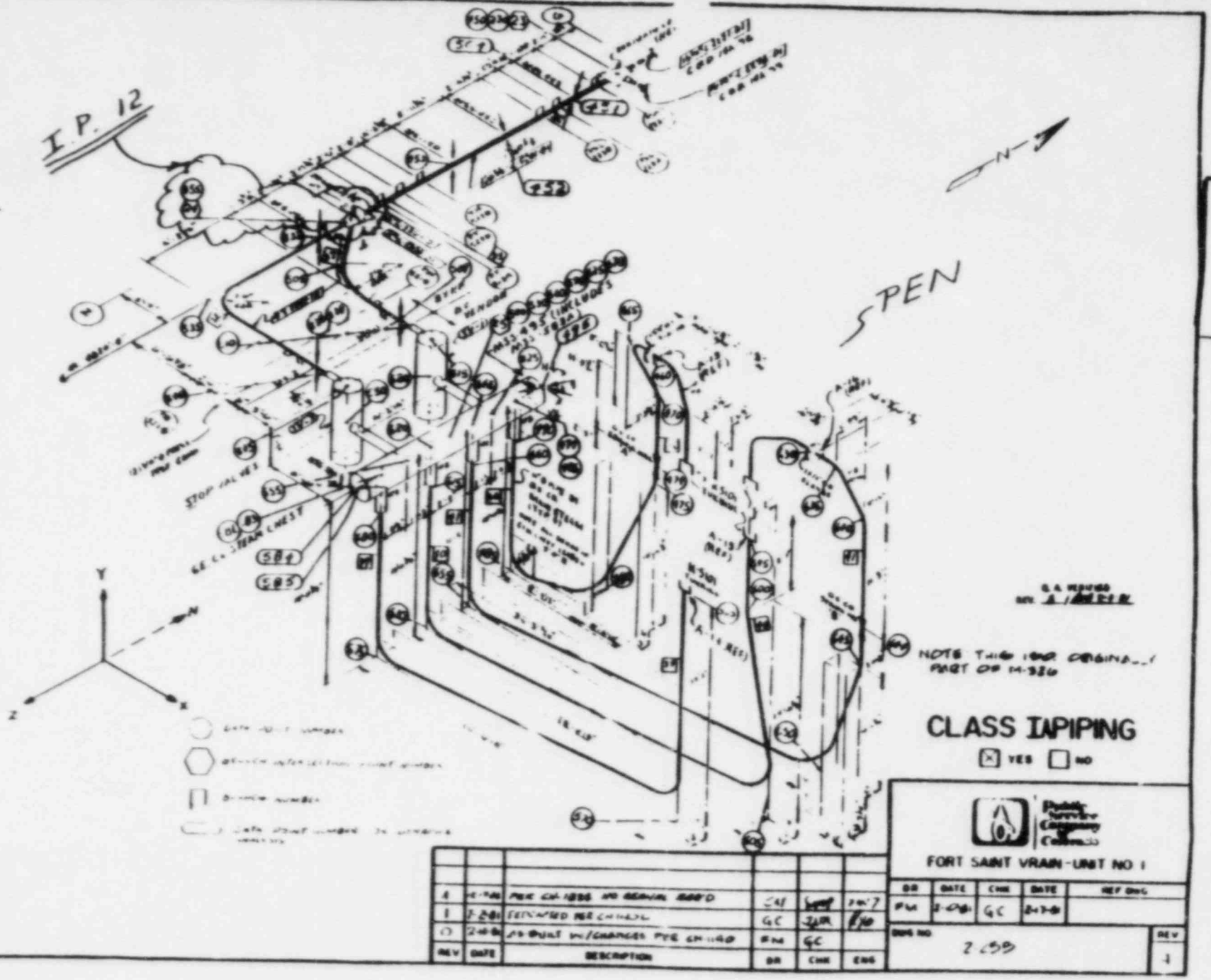
☒ YES ☐ NO

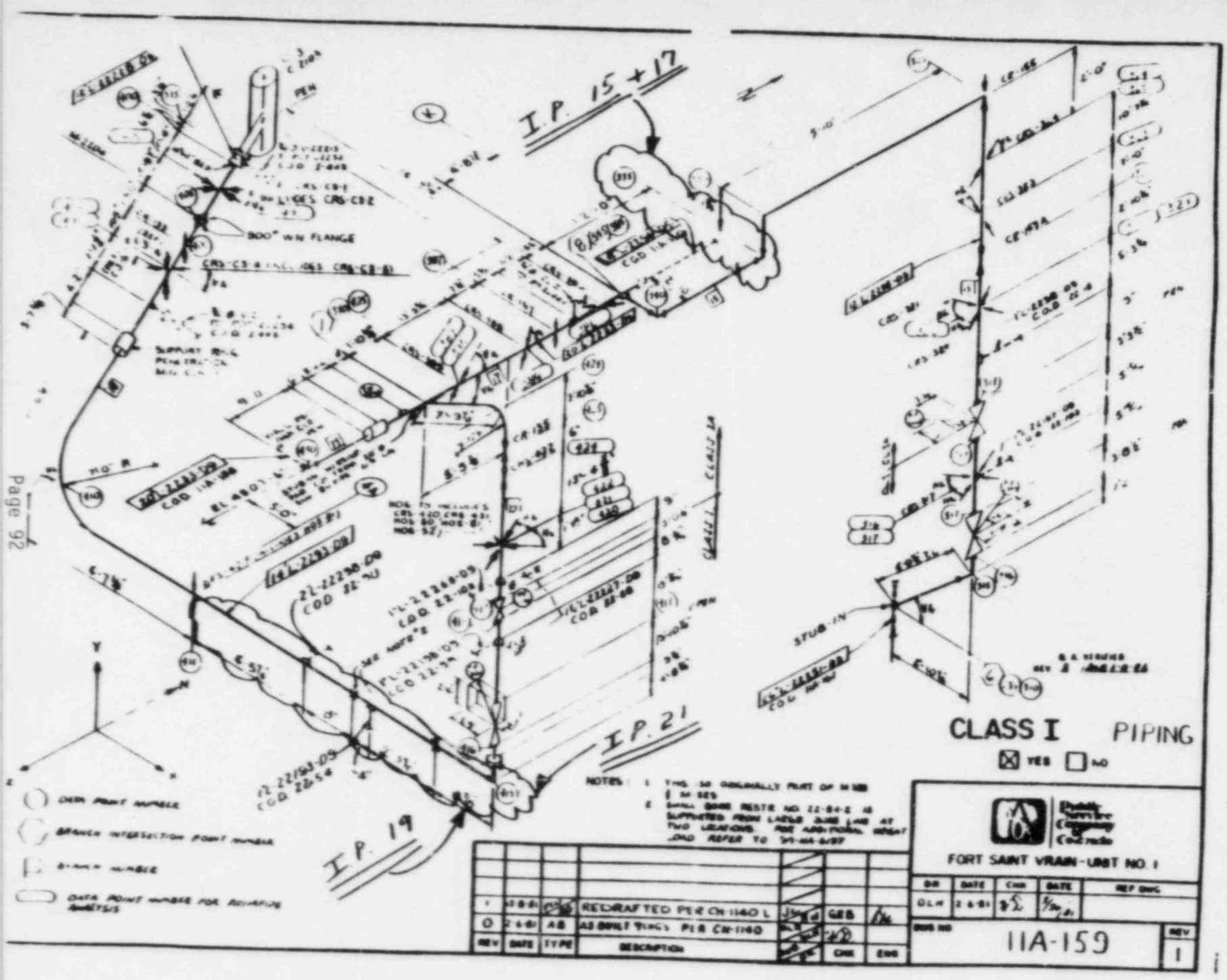
FORT SAINT VRAIN - UNIT NO 1

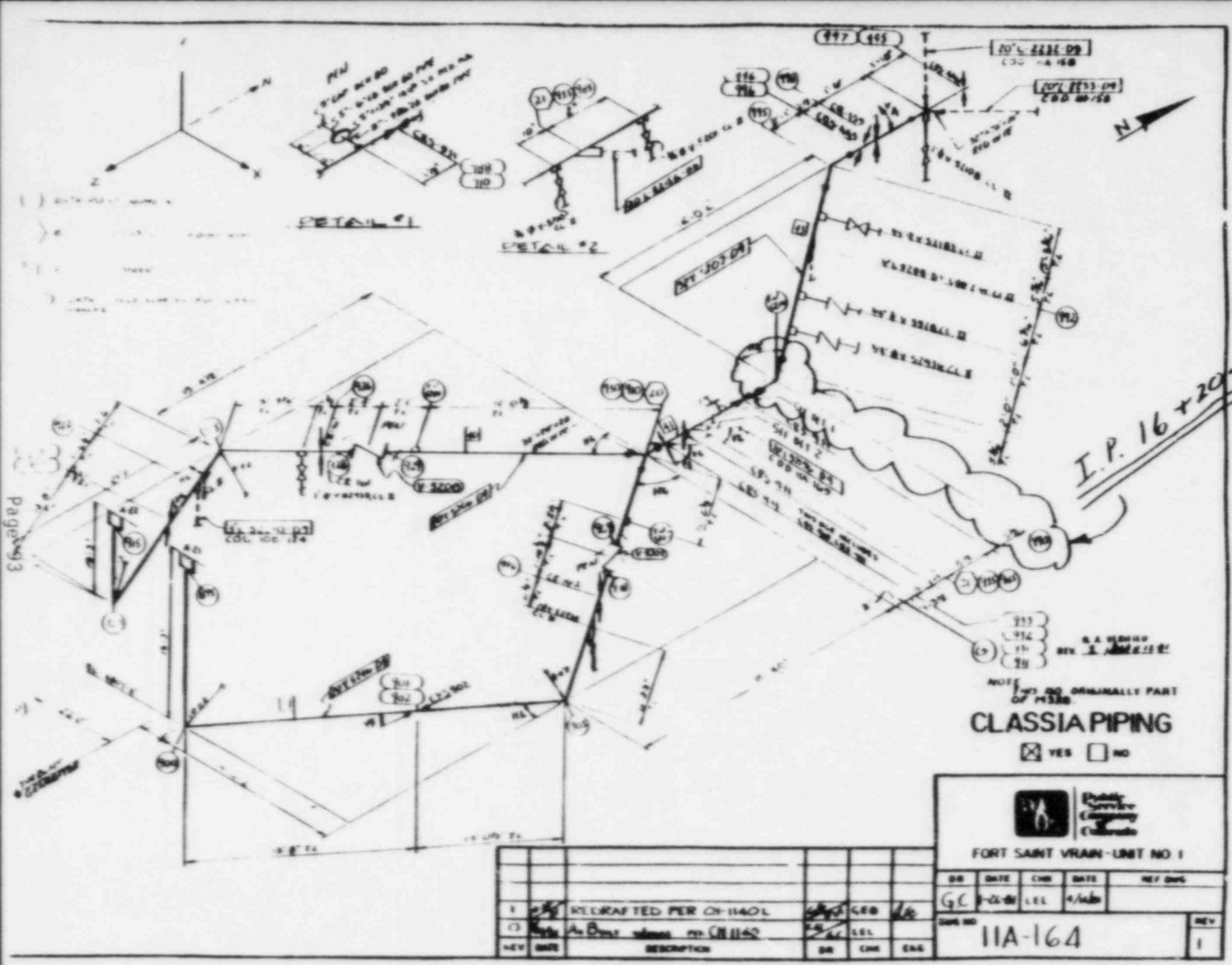
REV	DATE	DESCRIPTION	DR	CHK	ENG
A		PER CN 1834 NO CHANGE ISSUED	CH		TWT
1		REDRAFTED PER CN-1160 L			EK
0		AS BUILT PER CN 1160			

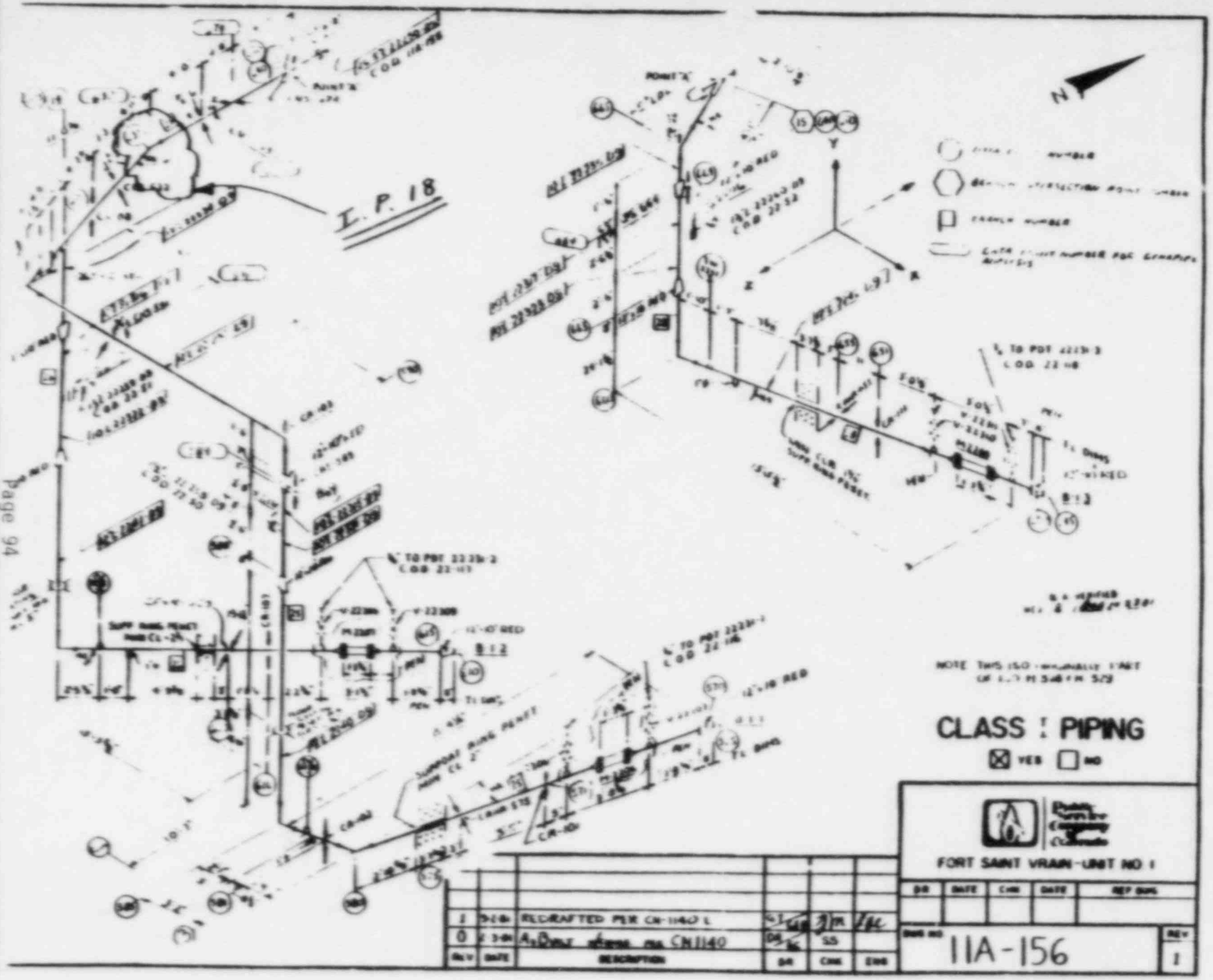
DR	DATE	CHK	DATE	REF DWG

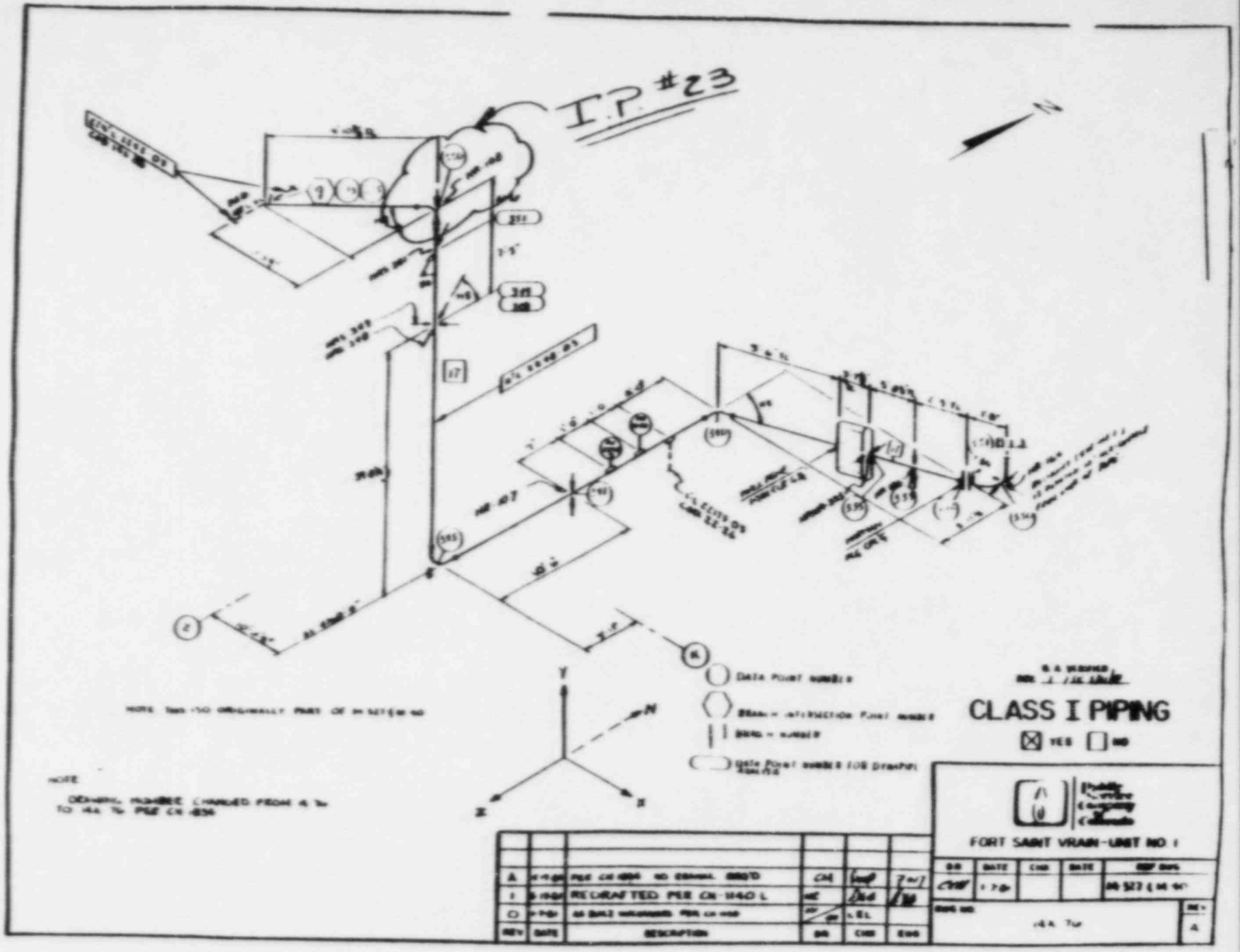
DWG NO A4 99 — REV A

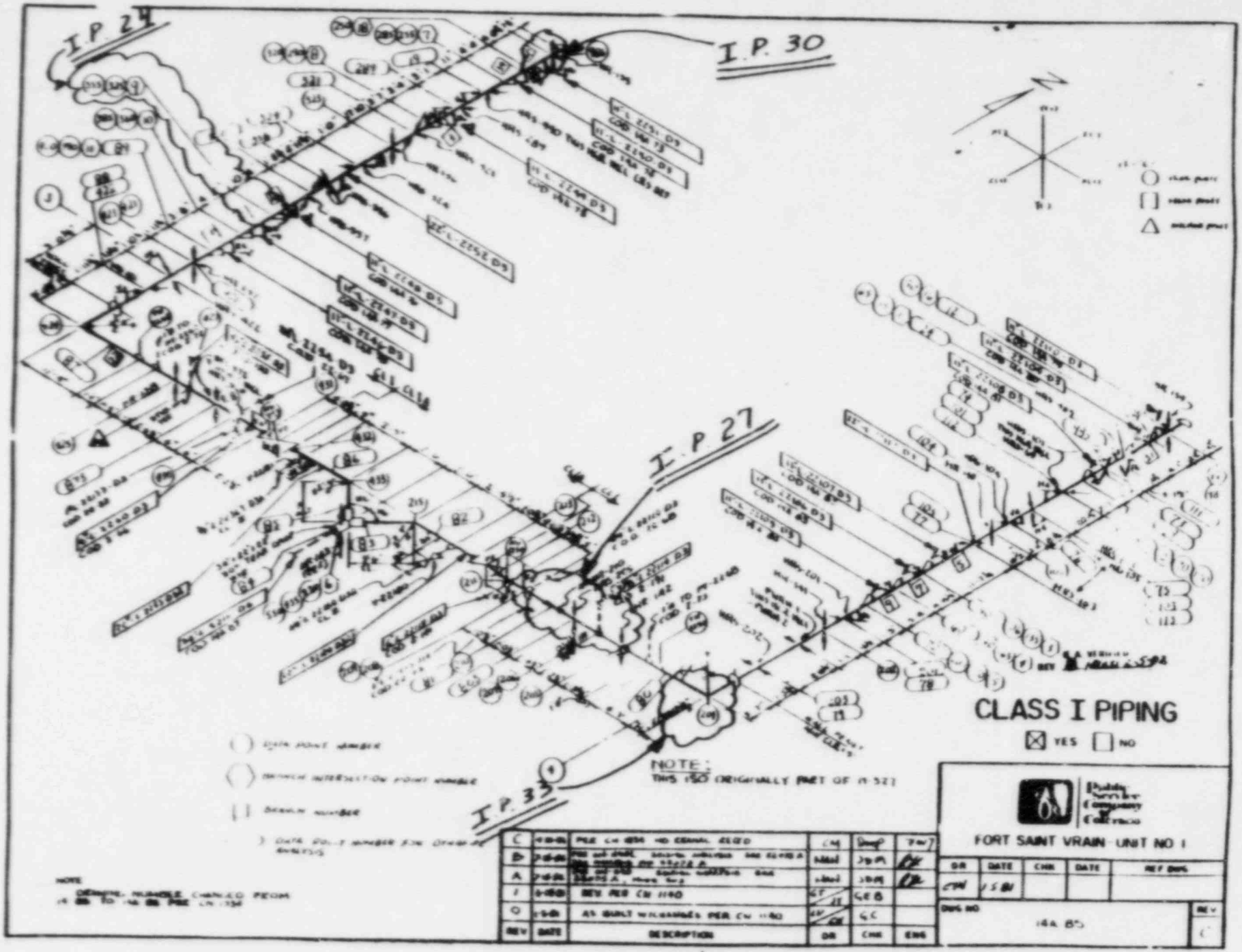

I.P. 12
SPEN
N
Y
Z
X
NOTE THIS LINE ORIGINAL PART OF M-326
CLASS IAPIPING
YES
NO
FORT SAINT VRAIN-UNIT NO 1
2 639

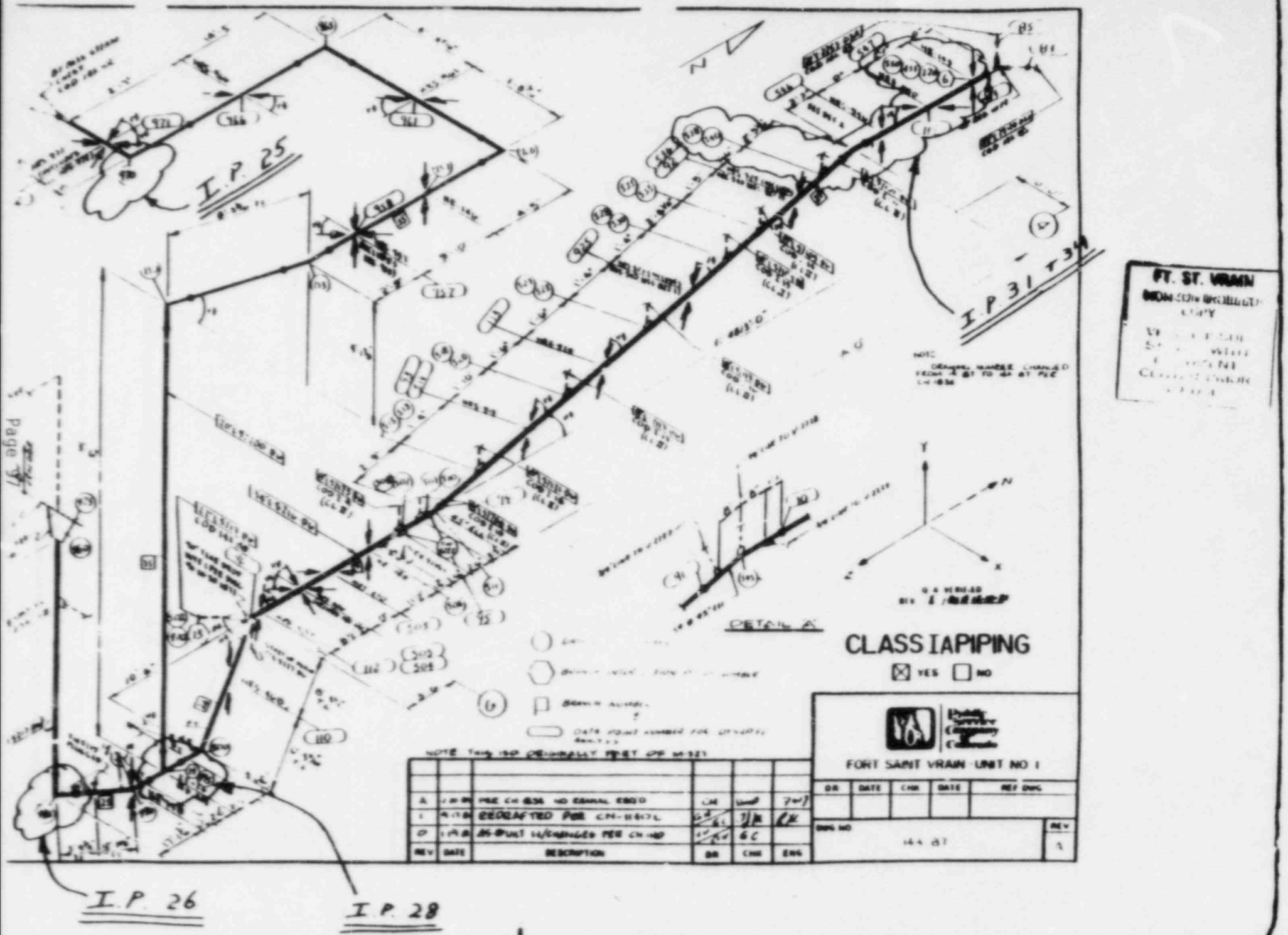


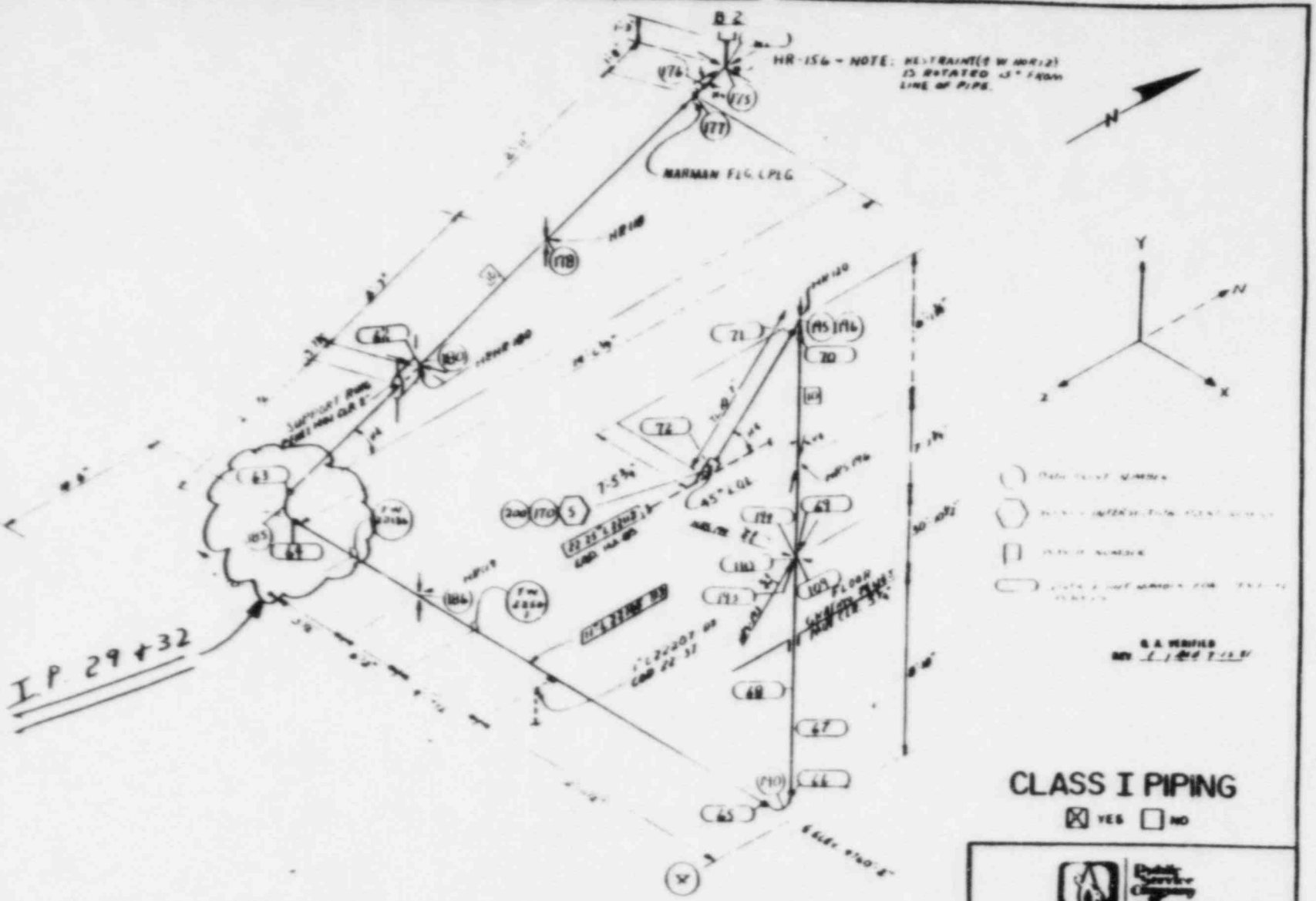

DETAIL #1
DETAIL #2
I.P. 16+20+22
CLASSIA PIPING
YES
NO
FORT SAINT VRAIN - UNIT NO 1
REDRAFTED PER CR-1140L
IIA-164

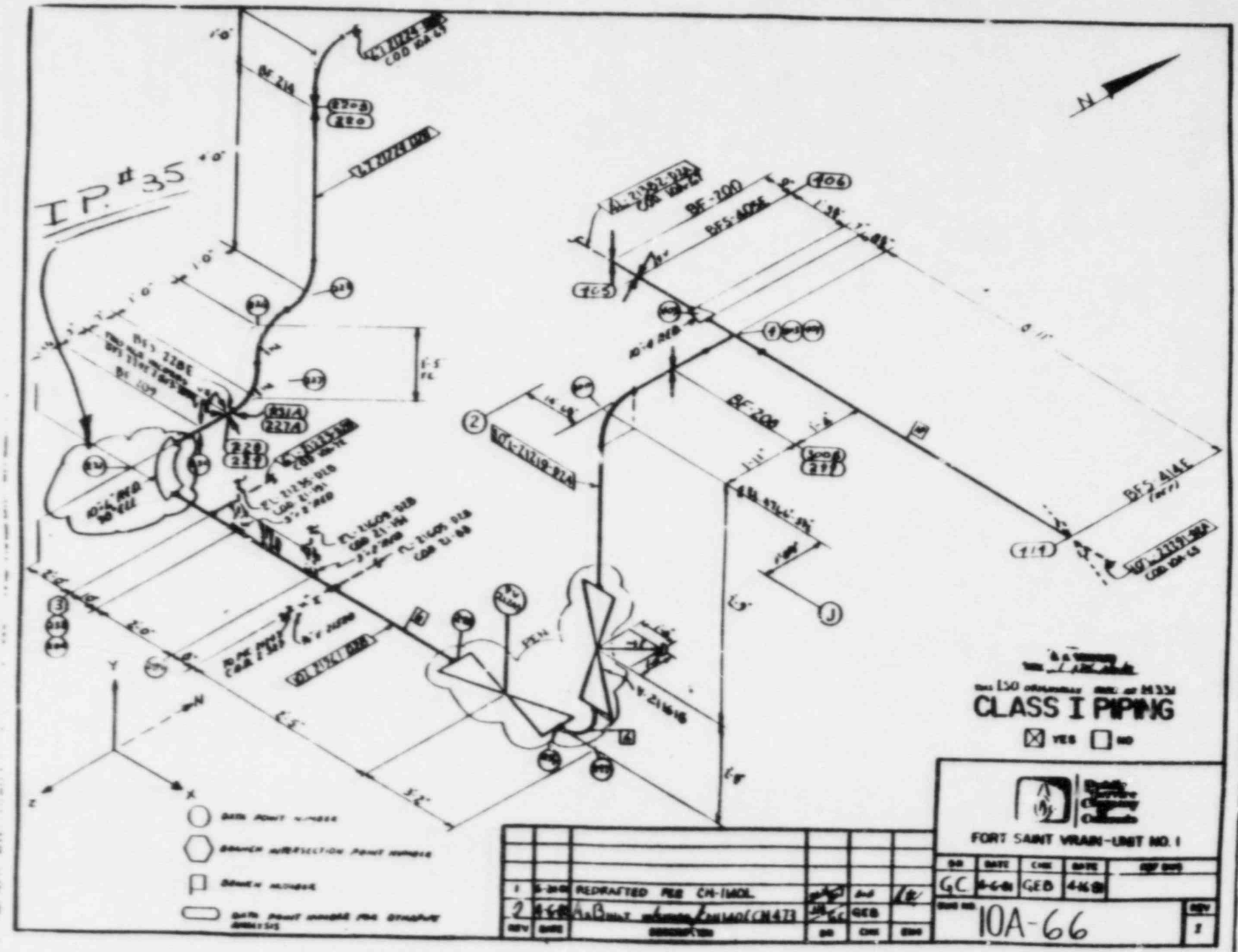

I. P. 18
CLASS I PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO 1
11A-156
RECRAFTED PER CN-1140 L

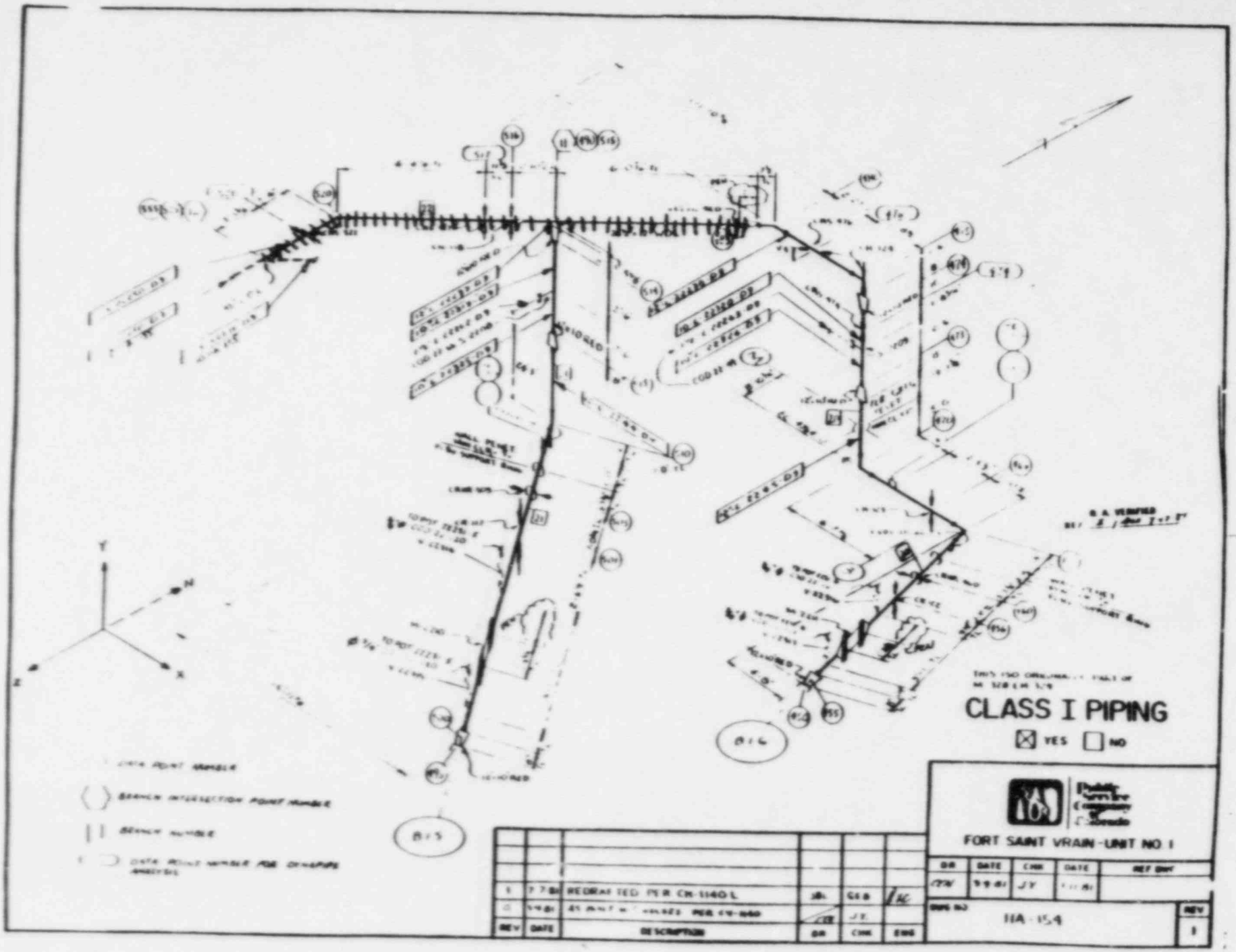

I.P. #23
N
CLASS I PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO 1

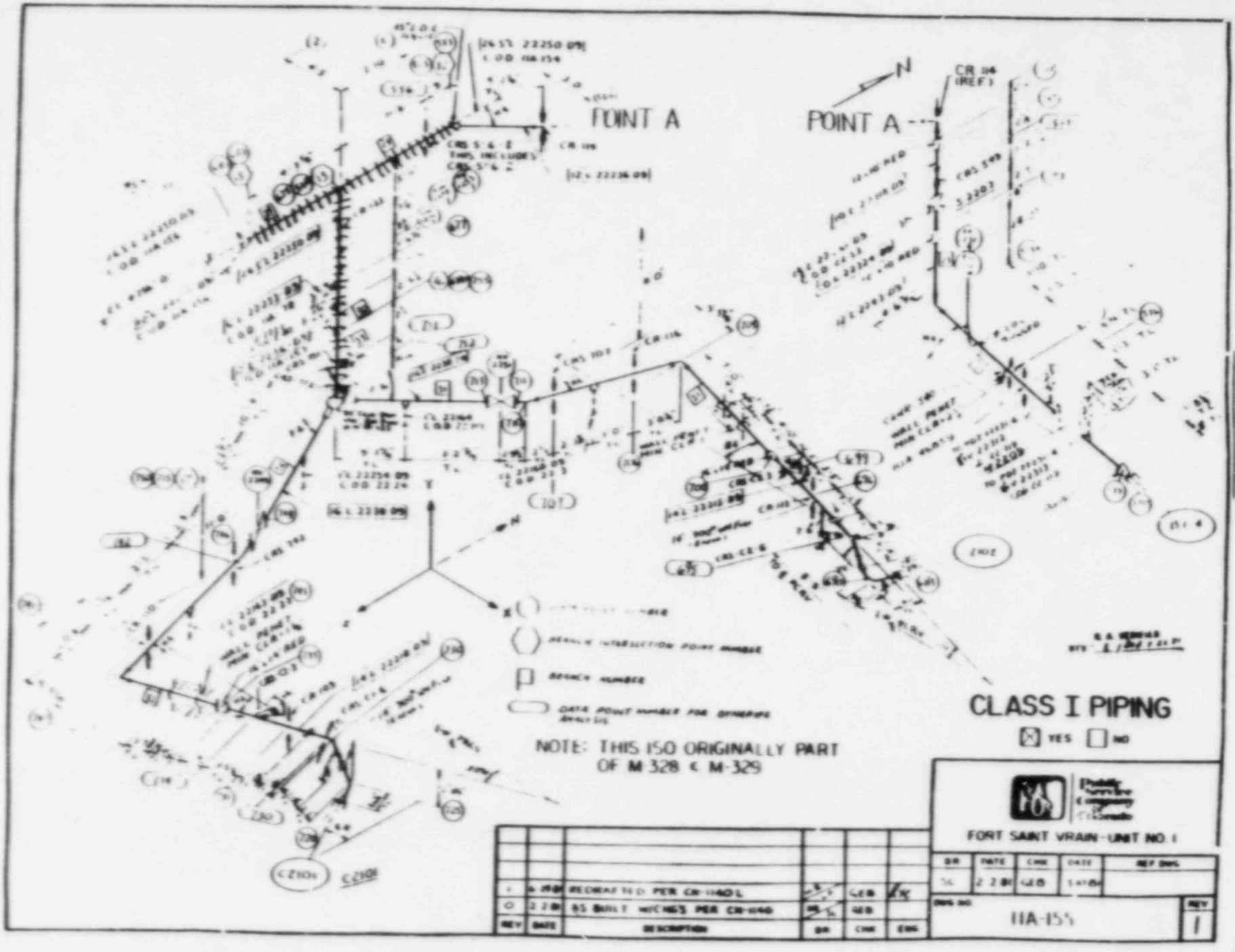

I.P. 24
I.P. 30
I.P. 27
I.P. 33
CLASS I PIPING
YES
NO
NOTE:
FORT SAINT VRAIN UNIT NO 1

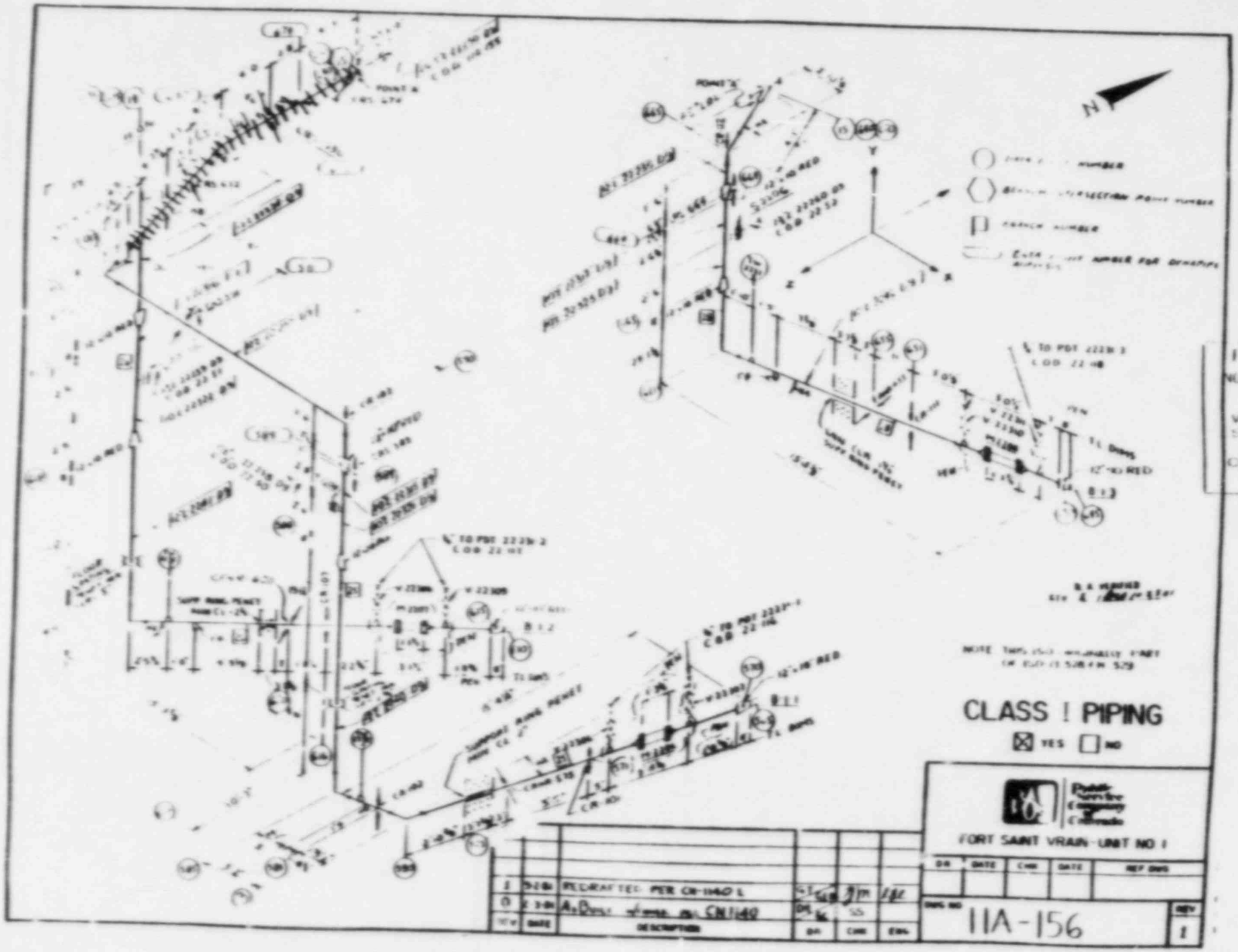

I.P. 25
I.P 31 T 3N
I.P. 26
I.P. 28
DETAIL A
CLASS IA PIPING
YES
NO
FORT SAINT VRAIN UNIT NO 1
FT. ST. VRAIN

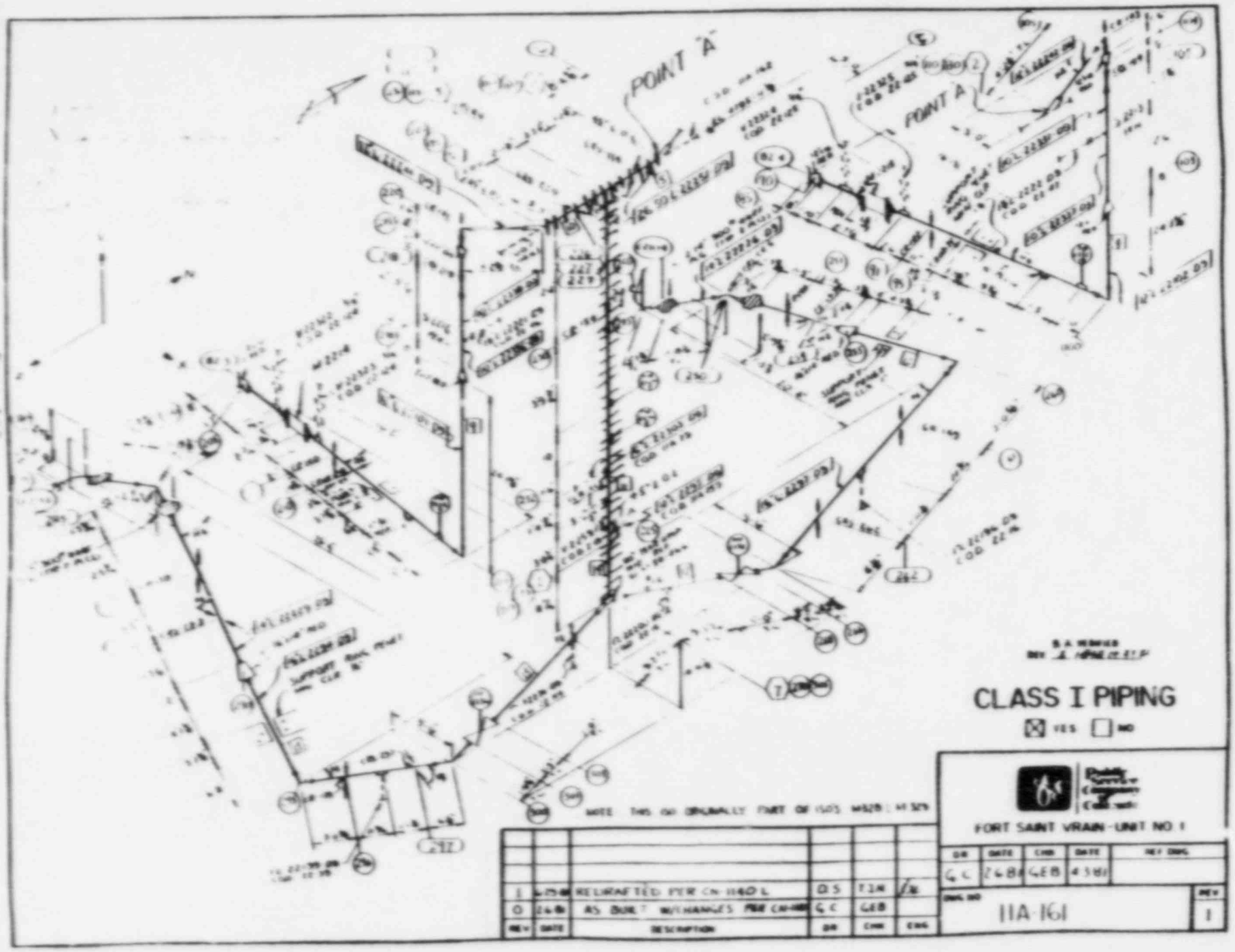

B2
HR-156 - NOTE: RESTRAINT(S) W/ HOR. (2) IS ROTATED 45° FROM LINE OF PIPE.
N
HARMAN FLG. CPLG.
Y
N
Z
X
IP 29+32
7-5¾"
45° ELL
CLASS I PIPING
YES
NO
FORT SAINT VRAIN - UNIT NO 1
H.N. 2-5-81 J.Y. 2-5-81
DWG NO 44 84
REV A


I.P. #35
CLASS I PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO. 1
10A-66
REDRAFTED PER CH-1MOL


CLASS I PIPING
YES
NO
FORT SAINT VRAIN - UNIT NO 1
HA-154


POINT A
POINT A
N
CR 114
(REF)
CLASS I PIPING
YES
NO
NOTE: THIS ISO ORIGINALLY PART
OF M-328 & M-329
FORT SAINT VRAIN-UNIT NO. 1
IIA-155
REV
1


CLASS I PIPING
YES
NO
Public Service Company of Colorado
FORT SAINT VRAIN - UNIT NO 1
DWG NO
11A-156
REV
1



CLASS I PIPING

☒ YES ☐ NO

PUBLIC SERVICE COMPANY OF COLORADO

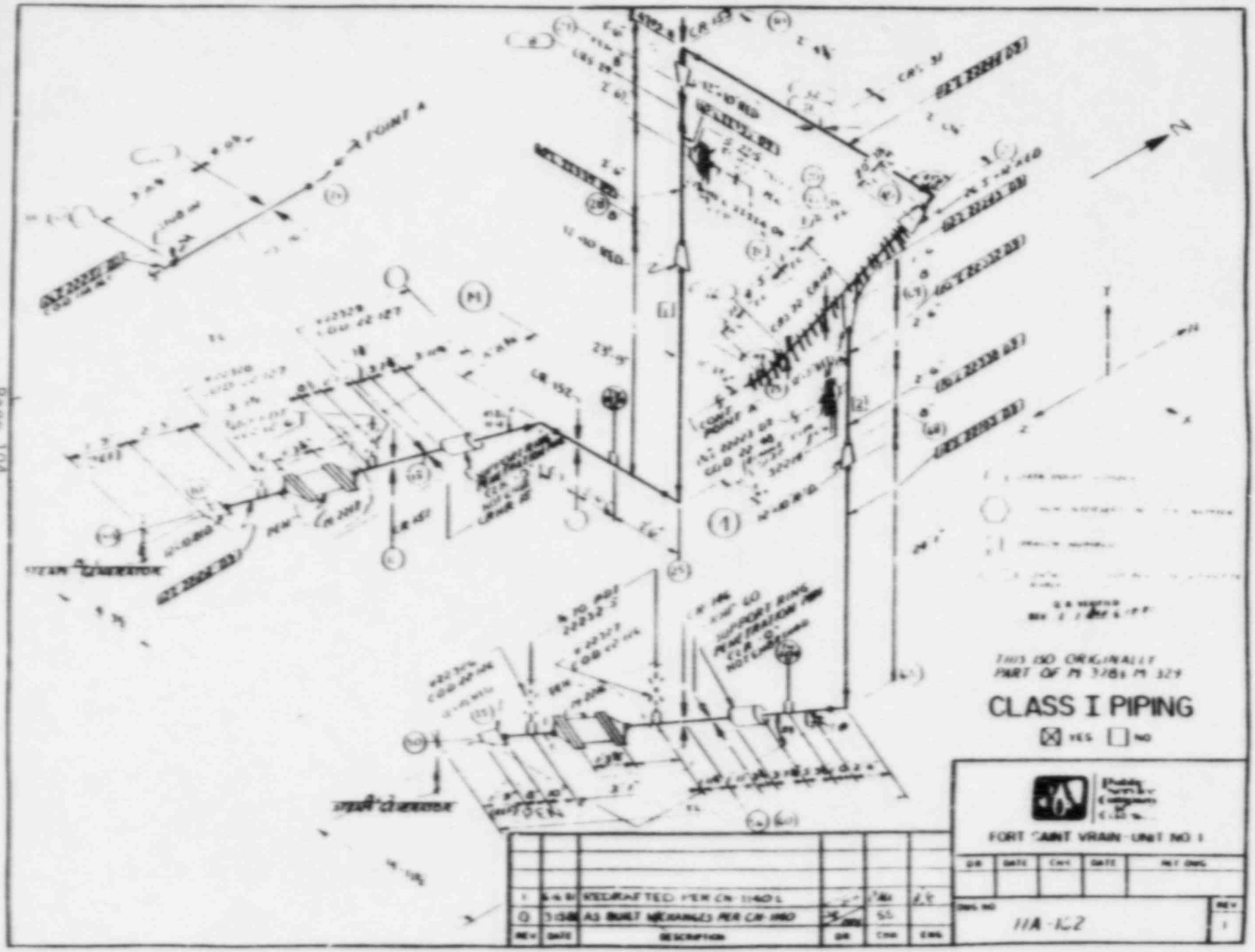
FORT SAINT VRAIN - UNIT NO. 1

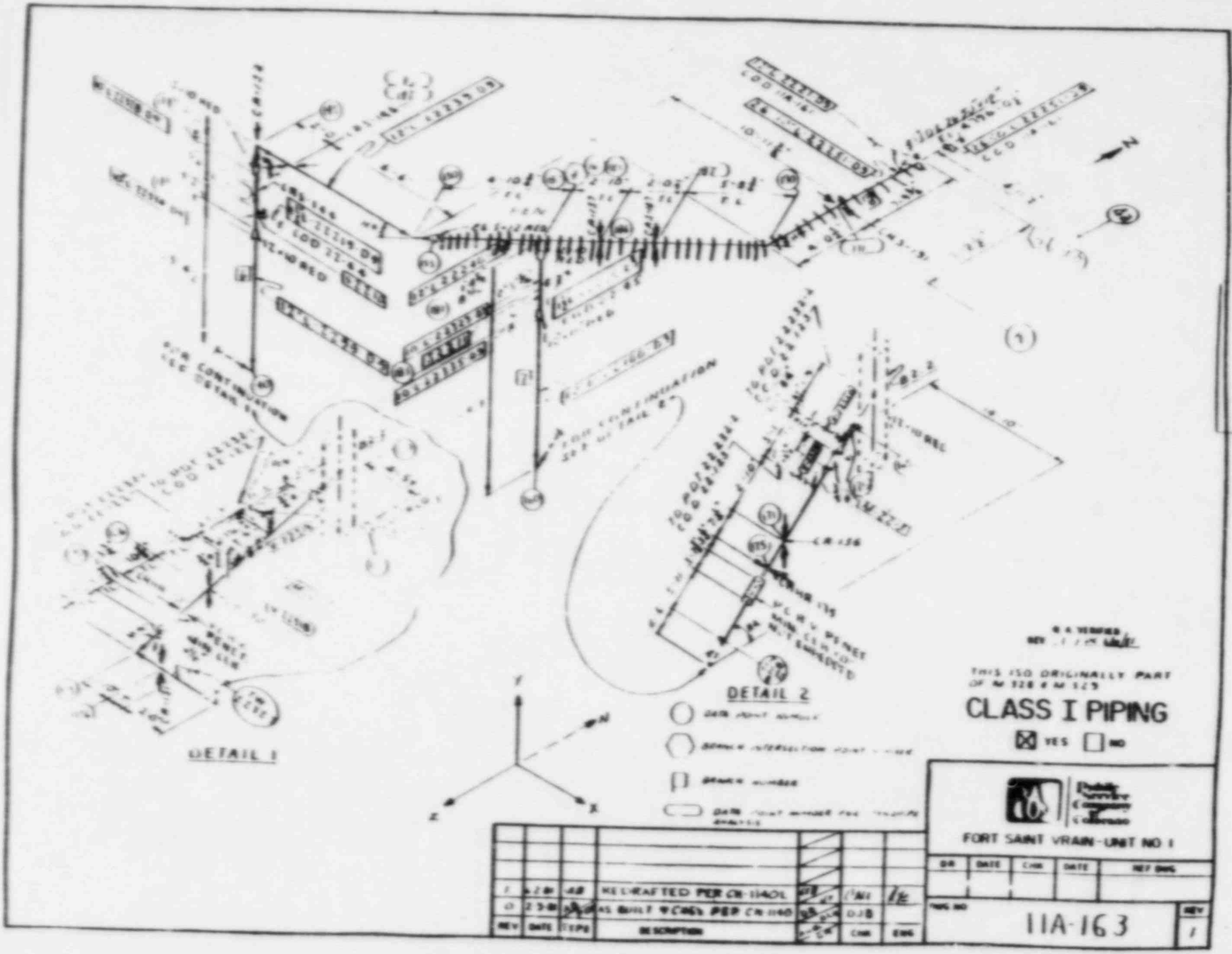
DR	DATE	CHK	DATE	REV. DWG.
G.C.	2-6-81	G.E.B.	4-3-81	

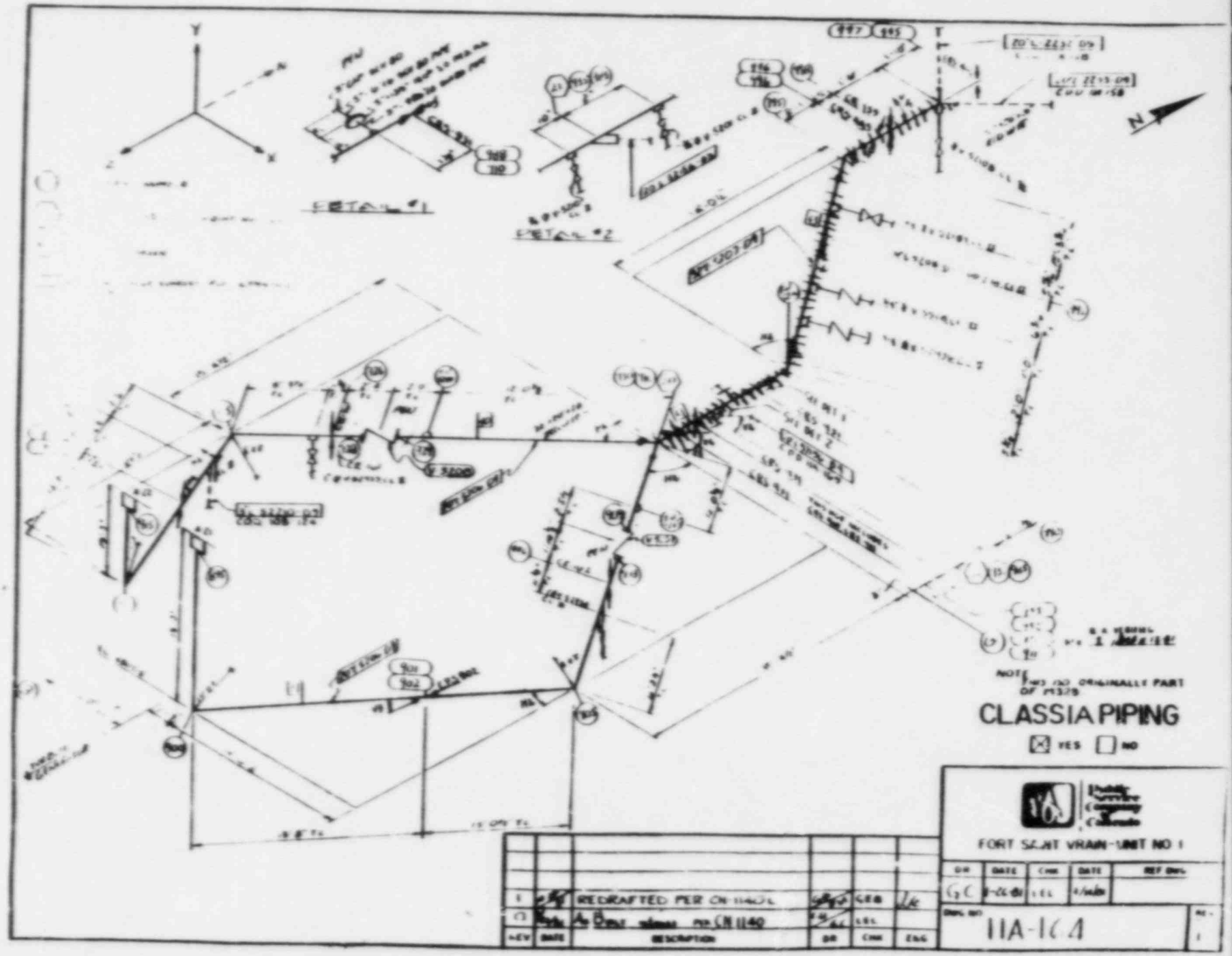
DWG. NO. IIA-161 REV. 1

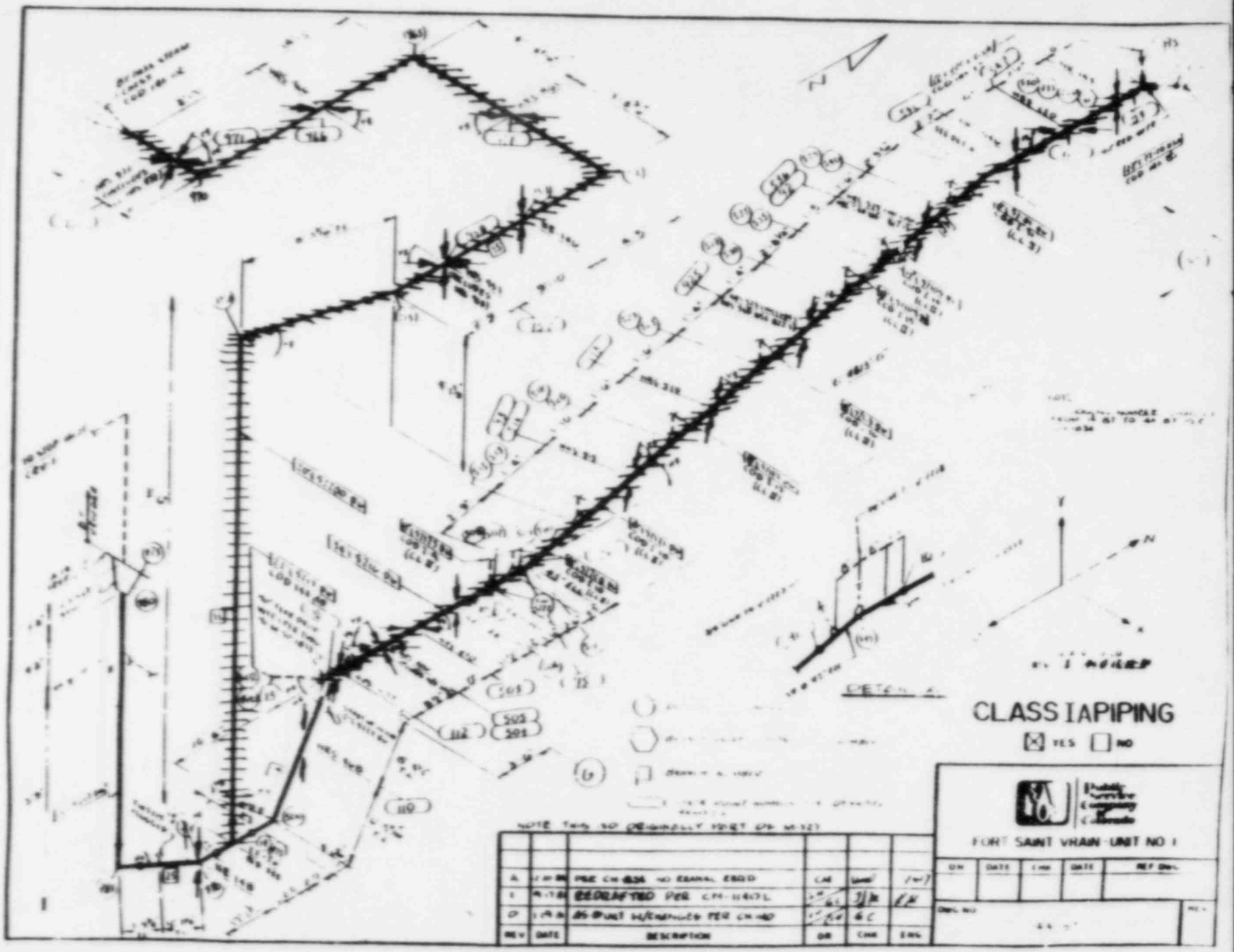
REV	DATE	DESCRIPTION	DR	CHK	ENG.
1	4-27-81	RE-DRAFTED PER CN-1160 L	D.S.	T.J.M.	
0	2-6-81	AS BUILT WITH HANGERS PER CN-1160	G.C.	G.E.B.	

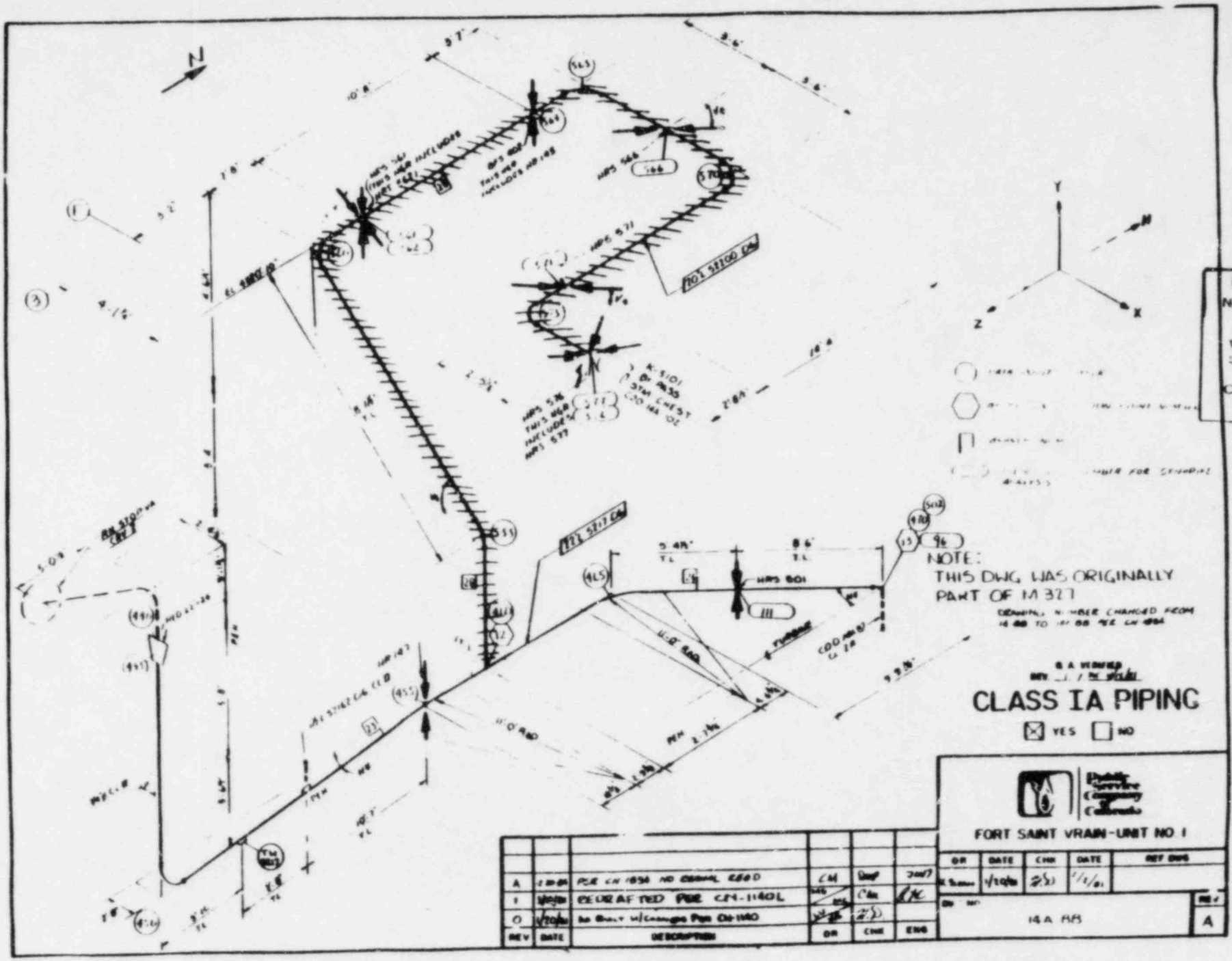
NOTE: THIS DWG ORIGINALLY PART OF DWG. M-329 (-M-329)


THIS ISO ORIGINALLY
PART OF PI 3186 PI 329
CLASS I PIPING
YES
NO
FORT SAINT VRAIN - UNIT NO 1
DWG NO
IIA-K2
REV
1


DETAIL 1
DETAIL 2
THIS ISO ORIGINALLY PART OF M 328 & M 329
CLASS I PIPING
YES
NO
FORT SAINT VRAIN - UNIT NO 1
11A-163
REVISED PER CN-1140
AS BUILT PER CN-1140
DESCRIPTION


CLASSIA PIPING
YES
NO
FORT ST. VRAIN - UNIT NO. 1
REDRAFTED PER CR 1140
DESCRIPTION
IIA-1C4


CLASS I APIPING
YES
NO
FORT SAINT VRAIN UNIT NO 1
DESCRIPTION


N
NOTE:
THIS DWG. WAS ORIGINALLY
PART OF M 327
CLASS IA PIPING
YES
NO
FORT SAINT VRAIN-UNIT NO 1
14A PIPING
A
FT ST VR
NON CONTROL
COPY
VERIFY
STATUS
DOCUME
CENTER
TO DS4