PUBLIC SERVICE COMPANY OF COLORADO
P. O. BOX 840 · DENVER, COLORADO 80201

OSCAR R. LEE
VICE PRESIDENT

July 25, 1984
Fort St. Vrain
Unit No. 1
P-84230

50-267

Mr. Eric H. Johnson
Reactor Project Branch Chief
Region IV
Nuclear Regulatory Commission
611 Ryan Plaza Drive
Suite 1000
Arlington, Texas 76011

DOCKET NO. 50-267

SUBJECT: Fort St. Vrain Building 10

REFERENCE: NRC Letter Dated June 25, 1984 from Mr. J. T. Collins to Mr. O.R. Lee (G-84208)

Dear Mr. Johnson:

This letter is in response to the NRC concerns, regarding Building 10 at Fort St. Vrain, as indicated in the referenced letter. PSC's reply to the individual concerns are contained in Attachment A.

The concept to construct additional facilities was finalized within PSC in 1981. The NRC was aware of the pending construction of Building 10 through conversations with PSC as early as the latter part of 1981. Over the years, additional equipment installed to meet requirements had filled all available space within the existing three-room complex. The 480 Volt Room was experiencing higher temperatures than PSC felt desirable for electrical equipment. The Auxiliary Electric Equipment Room was becoming crowded and additional equipment installation was extremely difficult. PSC arrived at the point where continuing requirements to add equipment dictated that additional space must be made available. Thus the concept of Building 10 was finalized, to relieve the crowding conditions which were compounding and to accommodate the equipment replacements being planned by PSC.

The function of Building 10 is to provide protection for safety related equipment, however access to Building 10 is not required

H005
1/1

during emergency conditions to operate equipment for safe shutdown of the plant. Please refer to Table 2 of Attachment A for a listing of the safety related equipment that is installed in Building 10.

The design, construction and documentation of Building 10, its concomitant components and the operating equipment it houses were all accomplished by approved Change Notices and Controlled Work Procedures as stipulated by our approved procedures. A copy of the safety evaluation and design criteria/analysis portion for each of the change notices outlined below is included as Attachment B. A brief description of the CNs associated with Building 10 follows:

CN-1460: Design and construct structural portion of Building 10 and Walkover Structure.

CN-1461: Design and construct mechanical portion of HVAC and fire protection for Building 10.

CN-1462: Install electrical equipment and devices in Building 10. General areas covered are: lighting, fire protection, grounding, cable trays, power, communication, ducts, relocation of underground obstructions, and HVAC.

CN-1255: Upgrade 120V instrument power buses.

CN-1332: Upgrade 120V instrument power buses.

CN-1391: Replace station batteries 1A and 1B, and instrument battery 1C (PPS). NOTE: Portions of CN involving batteries 1A and 1B are not associated with the Building 10 project.

CN-1781: Install fire protection wrap on portion of cable trays.

During preparation of the original safety evaluations (Attachment B) for this project , PSC determined that the design and construction of Building 10 did not require a change in the Technical Specifications and was not an unreviewed safety question. These evaluations were performed in accordance with the provisions of 10CFR50.59, and therefore the modification did not require prior Commission approval. The construction and use of Building 10 constitutes a modification that does not require an amendment of the operating license. As a result 10CFR50.92 does not apply, and a construction permit was not required.

If you have any questions on these items, please contact Mr. M.H. Holmes at (303) 571-8409.

Very truly yours,

O. R. Lee, Vice President
Electric Production

ORL/JT:pa

Attachment

cc: J.T. Collins

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter	)	
	)	
Public Service Company of Colorado	)	Docket No. 50-267
Fort St. Vrain Unit No. 1	)	

AFFIDAVIT

O. R. Lee, being duly sworn, hereby deposes and says that he is Vice President of Public Service Company of Colorado; that he is duly authorized to sign and file with the Nuclear Regulatory Commission the attached response to the letter dated June 25, 1984, from J.T. Collins to O.R. Lee; that he is familiar with the content thereof; and that the matters set forth therein are true and correct to the best of his knowledge, information and belief.

O R Lee

O. R. Lee
Vice President

STATE OF Colorado)
)
COUNTY OF Denver)

Subscribed and sworn to before me, a Notary Public on this 25th day of July, 1984.

[signature]
Notary Public
4026 E. 113th Place
Denver, Co 80233

My commission expires August 19, 1987.

ITEM 1

NRC CONCERN

The safety evaluation contained in the Change Notice for the construction of Building 10 (CN-1460) concludes that the activity does not appear to involve an unreviewed safety question nor does it appear to be safety significant. We assume the basis for these conclusions is the statement that "the design criteria for the new structure meets or exceeds that applicable to the original plant." In order for us to determine your compliance with the provisions of 10 CFR Parts 50.59 and 50.92 we request that you provide a comparison of all applicable design criteria utilized for Building 10 to those of the original plant.

PSC RESPONSE

The Building 10 project consists of two structures, each of which is constructed separate and independent of the Turbine and Reactor Buildings and one another. The structure between the Turbine Building and Building 10 is referred to as the Walkover Structure. It provides shelter for electrical cables running between the two buildings, as well as an enclosed passageway for personnel.

The following change notices pertain to construction of Building 10: CN-1460 (Design and Construction of Structural Portion of Building 10 and Walkover Structure), CN-1461 (Design and Construction of Mechanical Portion for HVAC and Fire Protection for Building 10), and CN-1462 (Installation of Electrical Building Support Facilities in Building 10). Table 1 delineates the comparison between all applicable design criteria utilized for Building 10 per these change notices, and those corresponding to the original plant.*

*As modified by subsequent PSC regulatory commitments.

ITEM 2

NRC CONCERN

Provide a description of all of the safety related equipment located within Building 10 and briefly explain its function and/or significance; also include a discussion of any plans you may have for the installation of additional safety-related equipment.

PSC RESPONSE

The following change notices pertain to installation of specific safety related equipment within Building 10: CN-1255 and CN-1332 (Upgrade 120V Instrument Power Buses) and CN-1391 (Replace Station Batteries 1A and 1B, and Instrument Battery 1C). Note that batteries 1A and 1B are not within Building 10. Refer to Table 2 for a list and description of all of the subject safety related equipment and associated functions and/or significance. A comparison of applicable design criteria utilized for safety related equipment within Building 10 to design criteria for safety related equipment within the original plant, as they pertain to this equipment, is outlined in Table 3.

Building 10 has designated areas for installation of other safety related equipment. However, no other safety related equipment is scheduled for placement within Building 10 at the present time.

ITEM 3

NRC CONCERN

Provide a discussion on how the provisions of 10 CFR Part 50.48 are being fulfilled in the absence of a staff fire protection evaluation report accepting the adequacy of protection to BTP 9.5-1.

PSC RESPONSE

During initial design of Building 10, the fire protection features were reviewed to the same design criteria applicable to the remainder of the Fort St. Vrain plant (FSV): Branch Technical Position 9.5-1, Appendix A (BTP 9.5-1) and Appendix R to 10CFR50 (Sections III.G and III.J). A review of Building 10 to these criteria was performed by a fire protection consultant (see CN-1461A).

The application of Appendix R in its entirety to new construction features at FSV has been discussed in two meetings between the NRC and PSC (June 8, 1984 and July 10, 1984) with varying guidance being provided. Per an NRC request made at the June 8, 1984 meeting, PSC submitted on June 22, 1984 (P-84183) a set of Appendix R acceptance criteria applicable to the Fort St. Vrain plant. PSC plans to review Building 10 to these Fort St. Vrain Appendix R acceptance criteria. This review will be submitted to the NRC per the schedule also included in the June 22, 1984 submittal.

ITEM 4

NRC CONCERN

Since it would appear that changes may be necessary to at least one of the first four categories of information (Background, Generic Planning Base, Licensee Planning Base, Responsibility Matrix) and that changes to the safeguards contingency plan (together with detailed procedures and personnel training) are required, provide a discussion on how the provisions of 10 CFR Part 50.54(p) were fulfilled.

PSC RESPONSE

During the design of Building 10, PSC recognized that a revision to the Security System and the Security Plan would be required. The physical additions to the Security system were incorporated into the Building 10 design and construction. PSC, before and during construction of this facility, was in contact with the NRC Security Personnel discussing the proposed additions and certain compensatory measures which would be required during the 480 volt essential switchgear modification being performed at the same time Building 10 was being constructed. The compensatory measures were agreed to orally and implemented during construction.

The Security Plan, revised to include Building 10, was submitted to NRC, Region IV on January 31, 1984 (P-84039 Warembourg to Collins) under the provisions of 10CFR50.54(p).

TABLE 1
COMPARISON OF APPLICABLE DESIGN CRITERIA FOR BUILDING 10 PROJECT AND THE ORIGINAL PLANT

STRUCTURAL

ITEM	BUILDING 10 AND WALKOVER STRUCTURE DESIGN CRITERIA	ORIGINAL PLANT DESIGN CRITERIA	REMARKS
SEISMIC	Acceleration response spectra based on Reg. Guide 1.60. Maximum horizontal component of ground acceleration equal to 0.05g for OBE, 0.10g for DBE; ratio of vertical component to horizontal component varies from 2/3 to 1. Damping values per Reg. Guide 1.61.	Acceleration response spectra based on records of four actual earthquake events. (Fig. 14.1-1 of FSV FSAR). Maximum horizontal component of ground acceleration equal to 0.05g for OBE, 0.10g for DBE; ratio of vertical component to horizontal component equal to 2/3. Damping values per Table 14.1-2 of FSAR.	Reg. Guides 1.60 & 1.61 provide for a more conservative criteria. Reg. Guide earthquake spectra envelope FSAR earthquake spectra. (See Figures 1 and 2 on pages 8 and 9 of Attachment A for design ground acceleration response spectra comparisons).
TORNADO	As specified in FSV FSAR Section 14.1	As specified in FSV FSAR Section 14.1	Design criteria equal
MISSILE PROTECTION	As specified in FSV FSAR Section 14.1	As specified in FSV FSAR Section 14.1	Design criteria equal
FLOOR LIVE LOAD	Varies from 100 psf to 200 psf, depending on area, in order to safely support equipment or moveable loads	Varies as required to safely support equipment or prescribed uniformly distributed live loads	Design criteria equal
ROOF LIVE LOAD	30 psf	30 psf	Design criteria equal
BASIC DESIGN WIND	As specified in FSV FSAR Section 14.1	As specified in FSV FSAR Section 14.1	Design criteria equal

TABLE 1
COMPARISON OF APPLICABLE DESIGN CRITERIA
FOR BUILDING 10 PROJECT AND THE ORIGINAL PLANT

STRUCTURAL (CONTINUED)

ITEM	BUILDING 10 AND WALKOVER STRUCTURE DESIGN CRITERIA	ORIGINAL PLANT DESIGN CRITERIA	REMARKS
MATERIAL PROPERTIES	Reinforced Concrete - concrete strength fc'=3500 psi (min), reinforcing bars fy=60,000 psi; Structural Steel - minimum yield Fy=36,000 psi	Reinforced Concrete - concrete strength fc'=3500 psi (min), reinforcing bars fy=60,000 psi; Structural Steel - minimum yield FY=36,000 psi	Design criteria equal; Material properties verified by type of certificates or test reports for all critical items (i.e. foundation, wall and floor slab concrete and reinforcing bars; structural steel; missile resistant doors and wall panels)
FOUNDATION	Foundations shall be designed to safely support all loadings to be considered, in conjunction with site soil engineering data contained in "Soil and Foundation Investigation Report" by Woodward-Clyde-Sherard and Assoc., dated July 8, 1966.	Foundations shall be designed to safely support all loadings to be considered, in conjunction with site soil engineering data contained in "Soil and Foundation Investigation Report" by Woodward-Clyde-Sherard and Assoc., dated July 8, 1966.	Design Criteria equal
PRIMARY CODES AND STANDARDS FOR DESIGN	AISC: 1980 8th Ed. of Manual Steel Construction ACI: 318-77 Bldg. Code Requirements for Reinforced Concrete, and 349-76 Code Requirements for Nuclear Safety-related Concrete Structures AWS: D1.1 1982 Structural Welding Code - Steel UBC: Uniform Building Code, 1979	AISC: 1963 6th Ed. of Manual Steel Construction ACI: 318-63 Bldg. Code Requirements for Reinforced Concrete AWS: D1.1 Structural Welding Code-Steel (most current issue of code at time of design/construction) UBC: Uniform Building Code, 1964	Bldg. 10 and remainder of plant conform to building industry practice of using most current issue of codes at time of construction

TABLE 1
COMPARISON OF APPLICABLE DESIGN CRITERIA
FOR BUILDING 10 PROJECT AND THE ORIGINAL PLANT

ELECTRICAL
BUILDING SUPPORT FACILITIES

ITEM	BUILDING 10 AND WALKOVER STRUCTURE DESIGN CRITERIA	ORIGINAL PLANT DESIGN CRITERIA	REMARKS
ELECTRICAL	Specification 75-J-02	Specification 1-N-2	Specification 75-J-02 is equal to 1-N-2 or exceeds the requirements of 1-N-2

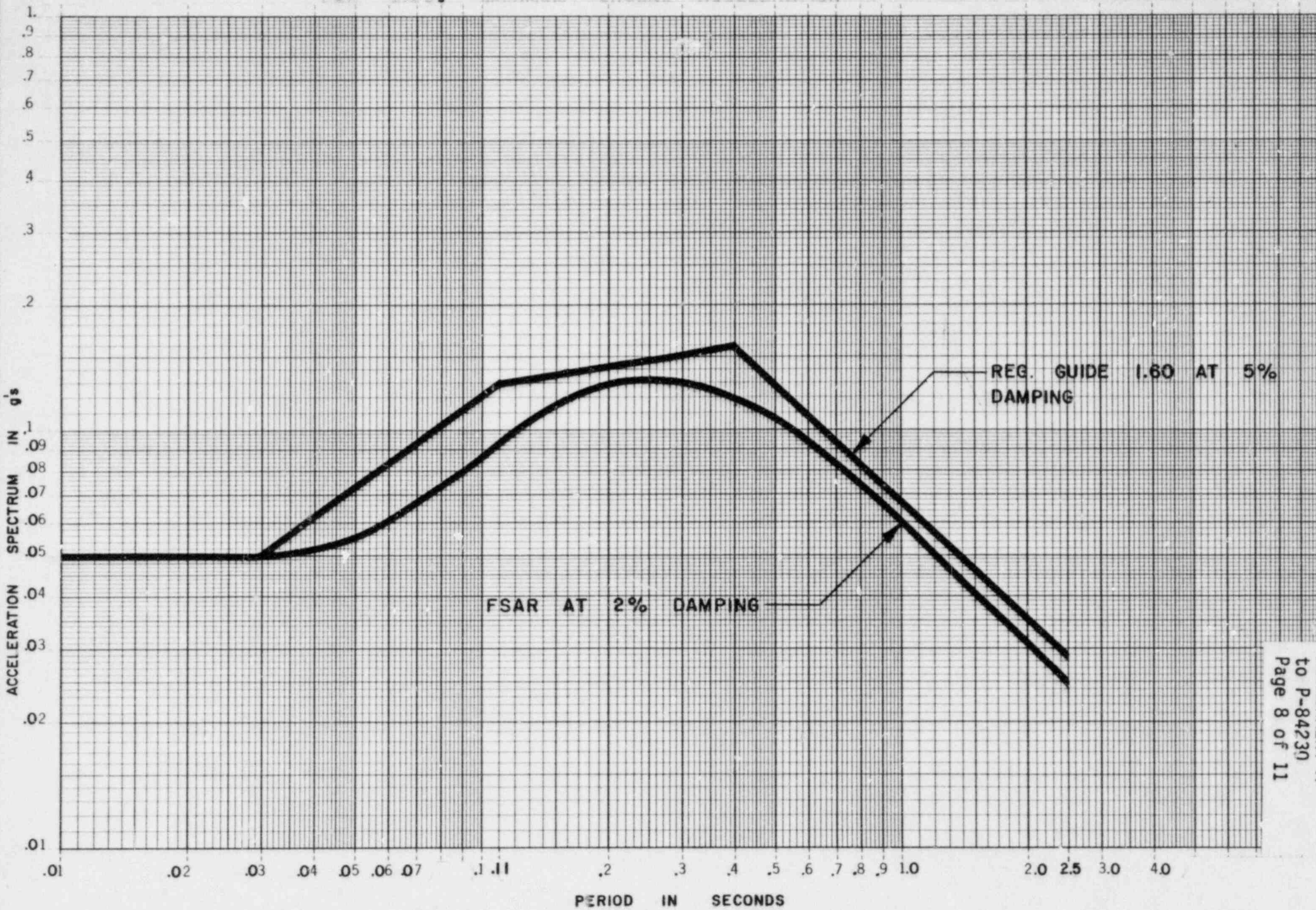
TABLE 1
COMPARISON OF APPLICABLE DESIGN CRITERIA
FOR BUILDING 10 PROJECT AND THE ORIGINAL PLANT

MECHANICAL
(NOTE: NON-SAFETY RELATED)

ITEM	BUILDING 10 DESIGN CRITERIA	ORIGINAL PLANT DESIGN CRITERIA	REMARKS
HVAC SYSTEM	Per Specification 75-J-02	Per Specification 1-J-09	Design criteria equal.
HVAC SYSTEM AND FIRE PROTECTION SYSTEM HANGERS	Designed so that hangers will not fail and allow damage to safety related equipment during a seismic event.	Designed so that hangers will not fail and allow damage to safety related equipment during a seismic event.	Design criteria equal.
FIRE PROTECTION SYSTEM	Designed per Building 10 fire hazards analysis in CN-1461A. Analysis was done per BTP 9.5-1 Appendix A, and 10CFR50 Appendix R sections III.G and III.J.	Designed per BTP 9.5-1, Appendix A, and 10CFR50 Appendix R sections III.G and III.J.	Design criteria equal.

Figure 1

HORIZONTAL ACCELERATION RESPONSE SPECTRUM
FOR 0.05g MAXIMUM GROUND ACCELERATION



ATTACHMENT A
to P-84230
Page 8 of 11

Figure 2

HORIZONTAL ACCELERATION RESPONSE SPECTRUM
FOR 0.10g MAXIMUM GROUND ACCELERATION

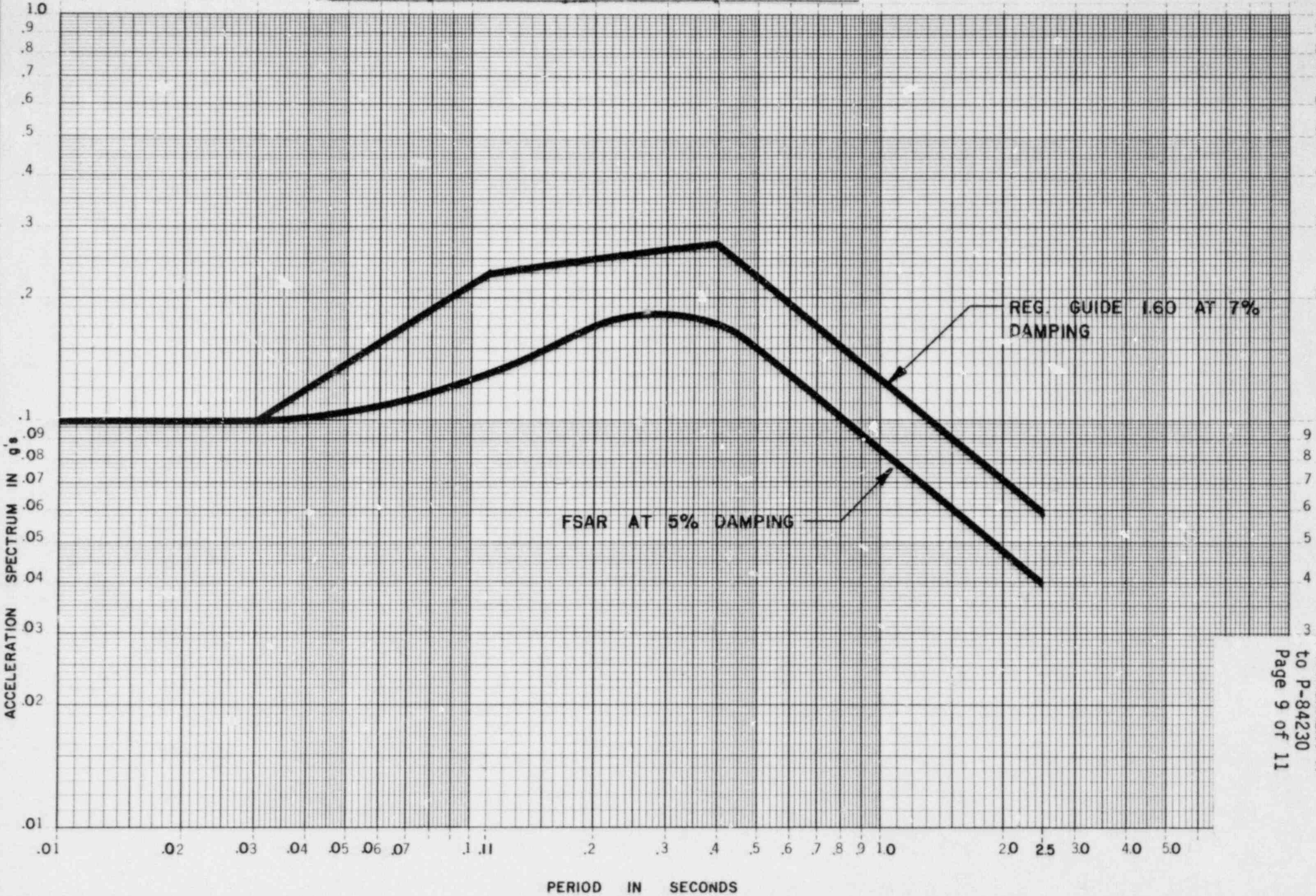


TABLE 2
SAFETY RELATED EQUIPMENT

EQUIPMENT	DESCRIPTION	LOCATION	FUNCTION AND/OR SIGNIFICANCE
N-9289	Inverter 1A	4791'-0" Building 10 - North	Invert 125V DC to 120V, single phase AC for Instrument Bus 1A
N-9290	Inverter 1B	4791'-0" Building 10 - South	Invert 125V DC to 120V, single phase AC for Instrument Bus 1B
N-9279	Inverter 1C	4800'-6" Building 10 - Mezz.	Invert 125V DC to 120V, single phase AC for Instrument Bus 1C
N-9277	Backup Power Transformer 1A-1	4791'-0" Building 10 - North	Supply instrument power to Bus 1A in the event of loss of 125V DC Bus 1A or Inverter 1A
N-9278	Backup Power Transformer 1B-1	4791'-0" Building 10 - South	Supply instrument power to Bus 1B in the event of loss of 125V DC Bus 1B or Inverter 1B
N-9269	Backup Power Transformer 1C-1	4800'-6" Building 10 - Mezz.	Supply instrument power to Bus 1C in the event of loss of 125V DC Bus 1C or Inverter 1C
N-92103	Distribution Panel 1A-1	4791'-0" Building 10 - North	Instrument Power Bus Non-interruptible
N-92104	Distribution Panel 1B-1	4791'-0" Building 10 - South	Instrument Power Bus Non-interruptible
N-92105	Distribution Panel 1C-1	4800'-6" Building 10 - Mezz.	Instrument Power Bus Non-interruptible
N-92125	1C Batteries	4791'-0" Bldg. 10 Battery Rm.	125V DC Power to N-9279, Inverter 1C
N-9253	Battery Charger 1C	4800'-6" Building 10 - Mezz.	Battery Charger for 1C Batteries
N-92118	Battery Test Switch	4791'-0" Building 10 - North	Provide method for discharge testing of batteries 1C
	Safety Related Cables	Building 10 and Walkover Structure	Equipment connection for non-interruptible instrument power

TABLE 3
COMPARISON OF APPLICABLE DESIGN CRITERIA FOR
SAFETY RELATED EQUIPMENT WITHIN BUILDING 10 AND THE ORIGINAL PLANT

ITEM	BUILDING 10 EQUIPMENT DESIGN CRITERIA	ORIGINAL PLANT EQUIPMENT DESIGN CRITERIA	REMARKS
SEISMIC QUALIFICATION	Equipment is qualified to withstand OBE and DBE seismic loading per amplified response spectra for the appropriate floor level as generated for Building 10	Equipment is qualified to withstand OBE and DBE seismic loading per amplified response spectra for the appropriate floor level as generated for the remainder of plant	Design criteria equal
ENVIRONMENTAL QUALIFICATION	Equipment is qualified to function for total loss of HVAC (120 degrees F)	Equipment is qualified to function for total loss of HVAC (120 degrees F)	Design criteria equal
SEPARATION AND SEGREGATION	Meet requirements of 1-N-2	Meet requirements of 1-N-2	Design criteria equal

ATTACHMENT B
to P-84230

SAFETY EVALUATIONS AND DESIGN PACKAGES FOR CHANGE NOTICES
1460, 1461, 1462, 1255, 1332, 1391, and 1781

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) / TCR / SCR / PC / TR
NO. 1460
PAGE 2

CATEGORY

TYPE:

- [X] CN OVERALL
- [ ] CN SUBMITTAL
- [ ] SETPOINT CHANGE REPORT
- [ ] TEST REQUEST
- [ ] TEMPORARY CONFIGURATION REPORT
- [ ] PROCEDURE CHANGE (FSAR)
- [ ] OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

	YES	NO		YES	NO
CLASS I	X		ENGINEERED SAFEGUARD		X
SAFE SHUTDOWN	X		PLANT PROTECTIVE SYSTEM		X
SAFETY RELATED	X		SECURITY SYSTEM		X

REMARKS ______________________

EVALUATION — USE ADDITIONAL SHEETS IF REQUIRED

1. IS THE ACTIVITY IDENTIFIED IN THE F.S.A.R. OR TECH SPEC? [ ] YES [X] NO

   LIST THE APPLICABLE SECTIONS REVIEWED: This activity involves construction of an entirely new facility. As such, it is not identified in either the FSAR or Technical Specifications.

2. DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE F.S.A.R. OR TECH SPEC? [X] YES [ ] NO

   LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE: FSAR Section 1.2.2 and Figures in Section 1.2 should be changed to reflect construction of the 3-Room Complex Addition. No Technical Specification changes are required for this structural only portion of the construction.

3. DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

   (A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE F.S.A.R. BEEN INCREASED?

   [ ] YES [X] NO STATE BASIS: The design criteria for the new structure meets or exceeds that applicable to the original plant.

   (B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE F.S.A.R. BEEN CREATED? [ ] YES [X] NO STATE BASIS: The design criteria for the new structure meets or exceeds that applicable to the original plant; therefore, the possibility for accidents or malfunctions is the same as, or less than, that of existing structures.

   (C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE F.S.A.R. BEEN REDUCED? [ ] YES [X] NO STATE BASIS: The new structure, being designed and constructed to criteria equal to or better than the existing structures, provides the same or better margins of safety.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION [ ] YES [X] NO
BE SAFETY SIGNIFICANT [ ] YES [X] NO

BY [signature] (SIGNATURE) 9-16-82 (DATE) *APPROVED [signature] (SIGNATURE) 9-15-82 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

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

Electrical ☐
Mechanical ☐
Structural ☒
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS

Sheet 1 of 1

Design a Three Room Complex Addition (3RCA) and Walkover Structure to be located directly East of the existing complex. The design shall be in accordance with the FSV Three Room Complex Addition structural design criteria. In general, the structural design criteria is from the Ft. St. Vrain FSAR.

The Main Building shall be of concrete construction, 30' wide X 40' long X 55' high and founded on drilled caissons anchored to bed rock.

The Walkover Structure is steel construction 10' wide X 22' long X 55'-6" high and founded on a spread footing.

Prepared By: /s/ Ed Hicks 9/8/82 Date   Approved By: /s/ L. Gunnerson 9/8/82 Date

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

SAFETY RELATED DESIGN ANALYSIS

Electrical ☐
Mechanical ☐
Structural ☒

I. Seismic Analysis:

The buildings were designed for seismic and found to meet the criteria of Attachment I, FSV Three Room Complex Addition Design criteria. For details of the seismic analysis see seismic book S2, Tab 9. New building response spectras were generated for this building using Reg. Guides 1.60 and 1.61. All Class I equipment for this building (see CN-1462) was ordered using the new response spectras.

II. Stress Analysis:

The Buildings were designed in accordance with Table 70.4 allowable structural stresses, FSV Three Room Complex Addition structural design criteria. For details of the stress analysis see seismic book S2, Tab 9. Table 70.4 is in the Blue Package of this CN. The design of this building is more conservative than that of the original main plant since a larger ground response spectra per Reg. Guide 1.60 was used vs the FSV Earthquake; for the analysis.

III. Piping/Hanger Analysis:

N/A See Mechanical CN-1461 And

Electrical CN-1462

IV. Hydraulic/Pneumatic Analysis:

N/A

CN 1460
BY Gunnerson
PAGE B3
FORM NO. 372-30-2650

SAFETY RELATED DESIGN ANALYSIS (continued)

V. Thermal Analysis:

N/A

VI. Nuclear Analysis:

N/A

VII. Fire Protection Analysis:

N/A SEE MECHANICAL CN-1461

VIII. Environmental Analysis:

N/A

IX. Compatibility of Materials, Equipment and Processes:

N/A

SAFETY RELATED DESIGN ANALYSIS (continued)
Sheet 3 of 3

X. Accessibility for In-Service Inspection, Maintenance and Repair:

N/A See Mechanical CN-1461 for accessibility requirements to maintain HVAC.

XI. Separation and Segregation Analysis:

N/A See Electrical CN-1462 for cable separation and segregation

XII. Electrical Analysis:

N/A See Electrical CN-1462 for Electrical analysis.

XIII. Accident Analysis:

No new or existing accident hazards would be created by this Change Notice.

Prepared By: /s/ R. Gunnerson 9/7/82
Date

CN 1460
BY Hicks
PAGE 85E
FORM NO. 372-30-2650

CHECK LIST OF DESIGN VERIFICATION QUESTIONS

FOR DESIGN REVIEW METHOD

YES	NO	N/A		
(X)	( )	( )	1.	Were the inputs correctly selected and incorporated into design?
(X)	( )	( )	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
(X)	( )	( )	3.	Are the appropriate quality and quality assurance requirements specified?
(X)	( )	( )	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
(X)	( )	( )	5.	Have applicable construction and operating experience been considered?
(X)	( )	( )	6.	Have the design interface requirements been satisfied?
(X)	( )	( )	7.	Was an appropriate design method used?
(X)	( )	( )	8.	Is the output reasonable compared to inputs?
(X)	( )	( )	9.	Are the specified parts, equipment, and processes suitable for the required application?
(X)	( )	( )	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
( )	( )	(X)	11.	Have adequate maintenance features and requirements been specified?
( )	( )	(X)	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
(X)	( )	( )	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
( )	( )	(X)	14.	Has the design properly considered radiation exposure to the public and plant personnel?
(X)	( )	( )	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

CN 1460
BY Hicks
PAGE 86E
FORM NO. 372-30-2650

CHECK LIST OF DESIGN VERIFICATION QUESTIONS - Cont'd.

YES	NO	N/A		
(X)	( )	( )	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
(X)	( )	( )	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
(X)	( )	( )	18.	Are adequate identification requirements specified?
(X)	( )	( )	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

Note: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES

UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

I have reviewed this CN and found it to be acceptable. Response spectra to be added by a reissue.

Mark [signature] 9/10/82

No change to original design verification

Mark Lombard by Keith B[signature]

I have reviewed this CN reissue "D" and found it to be acceptable.

[signature] 6/15/83

DESIGN DEFICIENCIES FOR REISSUE E DISCUSSED AND RESOLVED AS OUTLINED ON PAGE 86.1E.

John A. T[signature] 9/20/83

Mark Mullen 9/23/83

CALCULATIONS FOR		CALC. NO.	CN 1400
PREPARED BY	DATE	REF. DOCUMENTS:	BY TESNER
REVIEWED BY	DATE		PAGE 86.1E
			FORM NO. 372-30-2650

DESIGN DEFICIENCES FOR REISSUE E

ITEM	DESCRIPTION	RESOLUTION
(1) BLUE PP. 94E, 96E	MIN. TENSILE STRENGTH FOR A-36 STEEL PLATE SHOWN AS 70 KSI IN BOLT BEARING STRESS CHECK.	CORRECT FIGURE OF 58 KSI USED IN EQUATION RESULTS IN BEARING STRESS STILL BELOW CODE ALLOWABLE.
(2) BLUE ~~PP. 94E,~~ 95E, ~~96.1E THROUGH~~ 95.3E, 96E, 96.1E THROUGH 96.5E	NO CHECK MADE OF INDIVIDUAL PLATE EDGE DISTANCES (REF. NORTHERN STEEL DWG. E-4441-4) FOR MEETING STRENGTH REQUIREMENTS.	OF ALL 18 GUSSET PLATES, ONE (MARK Z-4) REQUIRED REINFORCING WITH WELDS. ALL OTHER EDGE DISTANCES ACCEPTABLE.
(3) BLUE PP. 95.4E THROUGH 95.9E, 96.6E THROUGH 96.15E, 98E	STRESS ANALYSIS OF GUSSET PLATES AND THEIR WELDED CONNECTIONS TO COLUMNS WERE MADE WITHOUT DUE CONSIDERATION OF OFFSETS BETWEEN CENTROID OF PLATE/WELD AND LINE OF ACTION OF APPLIED FORCE IN DIAGONAL BRACE MEMBERS.	DETAILED CHECK OF BRACING GUSSET CONNECTIONS REVEALED THAT FOR TWO PLATES (MARK Y-4 AND J-4), ORIGINALLY PRESCRIBED WELDS AND/OR PLATES WERE OF INSUFFICIENT SIZE TO CARRY DESIGN LOADS. THESE CONNECTIONS WERE REDESIGNED TO SAFELY HANDLE DESIGN LOADS WITHIN FSAR STRUCTURAL STRESS LIMITS.

THE UNDERSIGNED ACKNOWLEDGE THAT THE ABOVE DEFICIENCES WERE DISCOVERED AND INVESTIGATED IN THE COURSE OF THE INDEPENDENT REVIEW PROCESS AND WERE RESOLVED AS NOTED. FOR THOSE RESOLUTIONS REQUIRING FURTHER ACTION IN THE CONSTRUCTION/INSPECTION PHASE, APPROPRIATE ADDITIONS TO THE GREEN PACKAGE HAVE BEEN MADE. CALCULATIONS CONTAINED HEREIN ON PAGES B94E THROUGH B99E INCLUSIVE HAVE BEEN PREPARED AND INDEPENDENTLY REVIEWED (DETAILED CHECK) BY THE PARTIES BELOW.

John A. Tesner 9/19/83 Mark Walton 9/23/83

J. O. No. 13569.04

CN 1460
BY Gunderson
PAGE B7
FORM NO. 372-30-2650

Structural Design Criteria
Ft. St. Vrain
Nuclear Generating Station
Public Service Company of Colorado
Three Room Complex Addition

APPROVALS

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Date	4/28/82			
Revision	0	1	2	3

PSC QA Class I
Nuclear Safety Related

J.O. No. 13569.04

Structural Design Criteria
Fort St. Vrain
Three Room Complex Addition

I. Purpose

The purpose of this criteria is to provide the structural information required to design a new building to be constructed directly east of the existing three room complex. This new structure will be known as the FSV Three Room Complex Addition. In general, the structural design criteria from the Final Safety Analysis Report for Fort St. Vrain Nuclear Generating Station will be used.

II. Client-Furnished Criteria

A. The structure except training room and its components is classified as Class I as defined in Section 14.1.1.1 of the FSAR.

B. Attachment I is section 14.1 - Environmental Disturbance from the FSAR for the Fort St. Vrain Nuclear Generating Station. The information in the section shall be used for seismic and wind design criteria as modified in Section III.

C. Attached as Attachment II is Document No. DC-70 issue F, dated 3/3/69. This document shall be used for general structural design criteria with regard to the Three Room Complex Addition.

D. Attachment III is Table 3-1, Elastic Moduli Determination, from a report in Section II of the FSAR titled; "Geology and Seismology of Fort St. Vrain Nuclear Generating Station near Platteville, Colorado" by the Colorado School of Mines Foundation, Inc. This information shall be used to calculate soil spring constants.

E. Attachment IV is the Soil and Foundation Investigation Report (without the figures) prepared by Woodward-Clyde-Sherard and Associates dated May 31, 1966. The drilled pier section shall be used for design.

F. The following tabulation summarizes the information on the drawings:

Elevation	Floor Live Load
480 Volt Room, Elevation 4791'-0"	100 psf
Battery Room, Elevation 4791'-o"	200 psf
Mezzanine Floor, Elevation 4800'-6"	100 psf
Computer Room, Elevation 4812'-0"	100 psf
Office Room, Elevation 4824'-0"	100 psf
Equip. Room, Elevation 4824'-0"	100 psf
Training Room, Elevation 4835'-6"	100 psf
Roof, Elevation 4853'-0"	30 psf

Job No. 13569.04

CN 1460
BY
PAGE 89
FORM NO. 372-30-2650

Roof Equipment

Condensing Units	420 lbs. each
HVAC Unit	8770 lbs.

Computer Room

HVAC Unit	1600 lbs. each

Battery Room

60 batteries	187 lbs. each

G. The design codes used for the design of the structure are as listed in the above attachments and as modified below.

III. Modified Client-Furnished Criteria

A. The 1979 Uniform Building Code shall be used for the design of the new building. Wind and seismic loading shall be as specified in Attachments I and II and as modified in this Section.

B. Reinforced concrete shall be designed in accordance with the ACI 318-77 Building Code Requirements for Reinforced Concrete and the ACI 349-76 Code Requirements for Nuclear Safety Related Concrete Structure.

C. Structural steel shall be designed in accordance with the 1980 Eighth Edition of the AISC Manual of Steel Construction.

D. Masonry walls shall be designed in accordance with the 1970 edition of the Specification for the Design and Construction of Load Bearing Concrete Masonry, National Concrete Masonry Association.

E. The following materials shall be used:

1. Concrete strength f'c shall be 3,500 psi.
2. Reinforcing bars Fy shall be 60,000 psi.
3. Structural steel Fy shall be 36,000 psi.

F. Attachment V is a modification to table 70.4 of Attachment II This modification is necessary to meet the requirements of item IIIB and IIIC above.

G. The development of the building floor response spectra for both the Operating Base Earthquake (OBE) and the Safe Shutdown Earthquake (SSE) shall be based on the NRC Regulatory Guides 1.60 and 1.61.

H. The vertical and horizontal earthquakes shall be combined as follows to provide a maximum earthquake load:
a. 1.0 Horizontal North-South with 1.0 vertical
b. 1.0 Horizontal East-West with 1.0 vertical

CN 1460
BY Gunnerson
PAGE B10
FORM NO. 372-30-2650

Job No. 13569.04

IV. SWEC Developed Criteria

A. Bolts for structural steel members shall be 7/8" diameter ASTM-A325 high strength bolts. All bolts, nuts and washers shall conform to ASTM-A325.

B. Bolts for stair stringers and girts shall be 3/4" diameter ASTM-A307, Grade A.

C. Welding material shall be E70XX electrodes conforming to ASTM A233.

D. All anchor bolts shall conform to ASTM-A307.

E. Steel roof and floor deck shall be designed for the weight of wet concrete to be placed on the deck plus 25 psf for construction live load. Steel decking shall be at least 18 gauge.

F. The roof shall have 2" of rigid insulation with a single membrane roofing system and 2" of gravel protection. The roof shall be pitched at 1/4" per foot and shall have scuppers and downspouts.

G. Metal siding shall be 1 1/2" 22 gauge Robertson Huski-Rib metal siding with 3" of insulation

H. Doors shall be full flush type 1 3/4" insulated hollow metal doors with 14 gauge pressed metal frames and mortise locksets. All assembled units shall have a 3 hour fire rated UL label.

I. All grating and stair treads shall be 1 1/4 x 3/16 bar grating and shall be painted. All stair treads and top of landings shall have abrasive nosing. Stairs shall be designed for 100 psf or a concentrated load of 300 lbs on an area of 4 sq. inches at the center of the tread.

J. All handrail shall be 1 1/4 standard weight pipe (1.66) nominal outside diameter) with posts not more than 8 ft. 0 in. on center. All pipes shall conform to ASTM A53, Grade B. Handrails shall be painted "safety yellow."

K. In addition to the floor dead, live and seismic load combinations, all structural steel floor beams shall be designed with a 2 kip concentrated load placed at the center of the span.

L. The structure shall be designed as five (5) separate fire areas each area having a three (3) hour five rating. The five areas are as follows:

1. Battery Room - Elevation 4791
2. 480 volt Room - Elevation 4791 and Mezzanine Floor Elevation 4800'-6"
3. Computer Floor Elevation 4812'0"
4. Mezzanine Floor Elevation 4824'0"
5. Training Room Elevation 4835'-6"

CN 1460
BY Gunnerson
PAGE B11
FORM NO. 372-30-2650

M. All exterior doors shall be missle resistant except for the doors from the Training Room.

CN 1460
BY Gumerson
PAGE B12
FORM NO. 372-30-2650

GGA FORM 541 9-67

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DESIGN CRITERIA

STRUCTURES - GENERAL

SYSTEM 70

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DESIGN CRITERIA

Proj. No. 90 | Document No. DC-70 | Issue F | Date 3-31-69

CN 1460
BY Gunnerson
PAGE B13
FORM NO. 372-30-2650

Notations in this column indicate where changes have been made

TABLE OF CONTENTS

1. GENERAL
2. PLANS AND DRAWINGS
3. LOADS AND FORCES
   3.1 Foundation
   3.2 Wind Loads and Tornadoes
   3.3 Seismic Loads
   3.4 Crane Loads
   3.5 Roof Load
   3.6 Floor Loads
   3.7 Allowable Stresses
4. DESIGN CODES AND PRACTICES
   4.1 Building Design
   4.2 Concrete Design
   4.3 Masonry Design
   4.4 Steel Design
   4.5 Platforms and Stairways
   4.6 Miscellaneous Design Information
5. ELEVATIONS
6. FIGURES AND TABLES
   6.1 Figure 70.1
   6.2 Table 70.1
   6.3 Table 70.2
   6.4 Table 70.3
   6.5 Table 70.4

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By | Approved | Approved

Gulf General Atomic
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CN 1460
BY Gunnerson
PAGE B14
FORM NO. 372-30-2650

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Proj. No.	Document No. DC-70	Issue F	Date 3-31-69

ISSUE SUMMARY

Issue	Date	Prepared	Approved By	Purpose of Issue/ Sections Changed
A		NVC	TEN	For Design
B	2/8/67	NVC	TEN	For Design/Added Spectrum Curve for Seismic Design and minor version in Wind Load Design requirements.
C	5/1/67	NVC	TEN	For Design/Revised Spectrum Curve for Seismic Design & Tornado Loads added.
D	1/15/68	NVC	TEN	For Design/Wind & Tornad Loads incorporated, Allowable Stress Table added, Revised Spectrum Curve for Seismic Design and added Tables for Tornado Vector and Missile velocities
E	6/13/68	NVC/HLG	I.P. RBW JMK BLZ CHF	For Design/Added to Design Codes & Practices, Replaced Spectrum Curve for Seismic Design & made minor revisions in Allowable Stress Table
F	3/31/69	COP	COP CHF	For updating. See index for sections changed.

By	Approved	Approved	Page ii of ii

DESIGN CRITERIA: STRUCTURES - GENERAL (SYSTEM 70)

Proj. No. 90	Document No. DC-70	Issue F	Date 3-31-69

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1. GENERAL

The design effort will be based on approved general arrangement drawings and technical information incorporated in the report titled "Preliminary Safety Analysis Report", dated September, 1966 and amendments thereto. The plant consists basically of a Reactor Building, Turbine Building, Cooling Towers, and an Electrical Switchyard. It is expected that additional and revised drawings and information will be issued as detailed design progresses including revisions to this criteria.

2. PLANS AND DRAWINGS

Structural drawings shall show load information, moments, shears, reactions or details of connections in crane girders, floor girders, columns, stresses in trusses and the size of all material.

3. LOADS AND FORCES

The steel frame, concrete floors and walls, and supporting substructure shall be designed to safely support all loading which may be applied.

3.1 Foundation

The basis for design of foundations will be the test borings, soil analyses, seismic data, ground water tests and investigation furnished by the Public Service Company of Colorado. This data, which includes the allowable bearing and shear values of various strata, is covered in "Soil and Foundation Investigation Report" by Woodward-Clyde-Sherard and Associates, Consulting Engineers of Denver, Colorado, dated July 8, 1966, and "Dynamic Soil Property Investigation" by Woodward-Clyde-Sherard and Associates, dated June 13, 1967.

3.1.1 The recommended foundation system for the Reactor Building and the Turbine Building is covered in Design Criteria DC-72-1 and DC-75, respectively.

3.1.2 The recommended foundation system for the Cooling Towers is a continuous concrete mat supported on medium dense sand.

3.1.3 The design of foundation shall take into consideration additional loads and pressures imposed by temporary construction operations.

3.1.4 All exposed surfaces of rock excavations shall be adequately protected from disintegration by a 1-1/2" to 3" thick layer of gunite concrete for long-term protection and Aerospray 52 Binder (American Cyanamid Company) for short-term protection.

3.2 Wind Loads and Tornadoes

The design of all structures, systems and components subjected to wind pressures induced by the basic wind or tornadoes will be in accordance with the provisions specified in the ASCE Paper No. 3269, "Wind Forces on

By	Approved	Approved	Page 1 of 11

Structures". The applied building wind pressure in psf is computed from 0.002558 V^2 multiplied by a shape factor of 1.4 (0.9 positive and o.5 negative), where V is wind velocity in miles per hour. On this basis, the design pressure on the windward side of the building will be taken as 90% of the wind pressure and the suction loading on the leeward side as 50% of the wind pressure.

3.2.1 Basic Wind

The basic wind is 90 mph wind velocity based on 100-year period of recurrence with an additional 10% gust factor. The basic wind velocity will increase with height according to the following variations:

Height Zone in Feet	Basic Wind Velocity in mph
0 to 50	90
50 to 150	105
150 to 400	125

3.2.2 Design Tornado

The design of the plant will be made to withstand a design tornado of 202 mph total horizontal wind velocity with the siding and roofing remaining in place. The allowable stresses for the design tornado combined with other loads are given in Table 70.4.

3.2.3 Maximum Tornado

The design of the plant will be made to withstand a maximum tornado of 300 mph total horzontal wind velocity without interference with safe shutdown of the plant.

F The total static pressure drop that would occur during the maximum tornado is assumed to be equal to 3 psi in 3 seconds.

F The items listed in the safe shutdown list in Section 4.3 of DC-1-2 will be designed such that they are capable of withstanding this maximum tornado winds and missiles and associated pressure drop without loss of function. The maximum tornado winds and missiles shall be assumed to act prior to and subsequent to but not concurrent with the pressure transient.

The structures over the fire water pumps and service water pumps will be designed so the functional integrity of these pumps will be maintained in case the cooling towers should fall on them.

The allowable stresses for the maximum tornado combined with other loads are given in Table 70.4.

3.2.3.1 Above Refueling Floor of Reactor Building and Operating Floor of Turbine Building Except Deaerator Bay

a) Siding and roof decking will be designed to blow off above 202 mph total horizontal wind velocity.

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GGA FORM 341 3-67

b) Siding girts, roof purlins, and main structural framing will remain in place above 202 mph total horizontal wind velocity.

3.2.3.2 Below Refueling Floor of Reactor Building and Below Operating Floor of Turbine Building and Complete Deaerator Bay

a) Siding and girts designed at yield stresses for 202 mph total horizontal wind velocity.

b) Siding and girts in areas of the reactor and turbine buildings that contain Class I piping, electrical ducts and equipment necessary for safe shutdown will be designed for 300 mph total horizontal wind velocity at yield stresses.

c) The structural framing will be designed for 300 mph total horizontal wind velocity at yield stresses.

d) The reactor building structural frami g can be assumed to lean against the PCRV, the hot service and refueling facility for maximum wind condition.

e) The turbine building structural framing can be assumed to lean against the turbine pedestal and foundation.

3.2.4 Tornado Missile Protection

The Class I structures, equipment and components essential for safe shutdown of the plant as listed in DC-1-2, except as noted therein, will be protected from missiles generated by any tornado up to the maximum of 300 mph. The protection will consist of: 1) concrete walls; 2) special heavy steel siding; 3) the shielding effect of other massive structures such as the PCRV, fuel storage vaults, and turbine pedestal; 4) localized protection where necessary; 5) ample separation to assure that a single missile will not damage related items of essential equipment.

The list of objects which will become airborne missile when acted on by the design tornado and maximum tornado is presented in Table 70.2. The velocity of each of these missiles was calculated as a function of the elevation above ground level. The terminal free fall vertical velocity component is independent of the tornado intensity or the elevation above ground level.

The resultant likelihood to become airborne and the magnitude of lift attained for the various missiles considered is presented in Table 70.3.

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3.3 Seismic Loads

3.3.1 Structures which are required to support the Class I components and systems, listed in DC-1-2, will be subjected to dynamic analyses, using the response spectra shown on Figure 70.1. This corresponds to a design earthquake of 5%g peak horizontal ground acceleration. The coincident vertical acceleration shall be assumed as 2/3 of the horizontal acceleration. The allowable stresses for combined seismic and other loads will be the design working stresses with no 1/3 increase for transient earthquake loading. The dynamic analyses will consider all factors such as soil and rock flexibility and torsion. To ensure an adequate factor of safety, the maximum earthquake of 10%g horizontal ground acceleration will be applied to the safe shutdown list given in DC-1-2. Refer to Table 70.4 "Allowable Structural Stresses" for load combinations.

The values of damping for elastic vibrations to be used in design will take into consideration the size and shape of the structure, the method of support and the material of construction. The values of the damping factors are given below in percentage of the critical damping.

	%
Reinforced concrete shear-wall building	5
Prestressed concrete structure supported on ground	2
Bare welded steel frame structure	1
Welded steel frame building	2-1/2
Steel pipes on firm supports	1
Vital steel piping on hanger supports . . .	1/2
Concrete support structure embedded in earth . .	7

3.3.2 All plant structures other than for Class I shall be designed to meet the requirements for Seismic Zone 1, as defined in the Uniform Building Code, 1964.

3.4 Crane Loads

3.4.1 Crane and trolley loads will be governed by the Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, AISC 1963. The lateral force on crane runways shall be provided by this specification or 10% of the wheel loads applied at the top of the rail on each side of the runway. Impact loads shall be considered applied to crane girders and their connections to the framework, but shall not be included in the design of supporting columns, column bases, and foundations. Where crane girders are carried on brackets, the impact and resulting moment shall be included in the design of the columns and anchor bolts, but not in the design of the foundation. Overstress and overload conditions will be considered for special cases, such as infrequent lifts of major equipment parts.

3.5 Roof Load

3.5.1 The roofs shall be designed for a uniformly distributed live load of 30 psf, in addition to dead loads.

3.5.2 In addition to specified live loads and dead loads, trusses shall be designed to withstand safely a suspended construction load of 2,000 lbs assumed to act at any one panel point of the lower chord.

3.5.3 Special provisions or investigation shall be made of roof areas where an abrupt change of elevation between adjacent roof levels may produce excessive accumulation of snow due to wind.

3.6 Floor Loads

3.6.1 Floors shall be designed to support safely the concentrated loads, impact loads, equipment weights or prescribed uniformly distributed live loads. A minimum live load of 100 psf shall be used for catwalks, elevated walkways, stairways, and service platforms. Refer to plant arrangement drawings for type of floor (concrete, checkered plate or steel grating).

3.6.2 Refer to plant arrangement drawings and layout criteria drawings for equipment weights. Manufacturer's recommendations for equipment loads will be followed with regard to design, loads and impact. When not specified by the manufacturer, the mass of the equipment foundation will be a minimum of 2-1/2 to 5 times the weight of the equipment depending upon whether it is centrifugal or reciprocating type of equipment. Effective areas of concrete floors acting with the foundations will be considered in the analysis.

The turbine-generator pedestal will be designed in conformance with manufacturer's recommendation with due regard to resonance.

3.7 Allowable Stresses

For allowable structural stresses to be used during design, see Table 70.4.

4. DESIGN CODES AND PRACTICES

4.1 Building Design

Unless specified otherwise, the design of the overall buildings and structures will have to comply with the local building ordinances and codes. In the absence of a local building code, the requirements of the Uniform Building Code (UBC) 1964 shall apply.

4.2 Concrete Design

Concrete design will be governed by good design practice and will be in conformance with the following codes, where applicable:

4.1.1 ASA A89.1-1964 Building Code Requirements for Reinforced Concrete.
4.1.2 ASTM Test and Codes
4.1.3 Portland Cement Association Bulletins.

4.3 Masonry Design

Masonry design will be governed by good design practice and will be in accordance with the following codes, where applicable:

4.3.1 ASA A41.1-1953 Building Code Requirements for Masonry

4.3.2 ASA A41.2-1960 Building Code Requirements for Reinforced Masonry

4.3.3 Portland Cement Association Bulletins

4.3.4 ASTM Test and Codes

4.4 Steel Design

Structural steel design will be governed by good design practice and will be in conformance with the following codes, where applicable:

4.4.1 Manual of the AISC, 1963

4.4.2 American Welding Society Codes

4.4.3 ASTM Test and Codes

4.5 Platforms and Stairways

4.5.1 Platforms, walkways, and stairways will be provided for access where required for operation, inspection or maintenance of the plant. These structures will be open grating.

4.5.2 Ladders will be used where they are the only possible means of access, but will be held to a minimum.

4.5.3 Grating panels will be removable, if necessary, for maintenance.

4.5.4 Abrasive nosing will be provided on stair treads and on platforms at the head of all stairways.

4.5.5 Stairs will preferably have a slope of not more than 38 degrees from the horizontal, and in no case will the slope exceed 42 degrees.

4.5.6 Except as otherwise provided, all handrailings for platforms and stairs will be fabricated from 1-1/4" diameter black iron standard pipe with neatly finished welded joints.

4.6 Miscellaneous Design Criteria

Supplemental miscellaneous structural design criteria prepared by the Architect-Engineer shall be submitted to Gulf General Atomic.

5. ELEVATIONS

5.1 Relative building elevations with respect to finished yard grade: see Plant Arrangement Drawings.

5.2 Finished yard grade elevation referenced to USCGS benchmark: 4790'-0" for areas immediately around Reactor and Turbine Buildings.

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Proj. No. 90	Document No. DC-70	Issue F	Date 3-31-69

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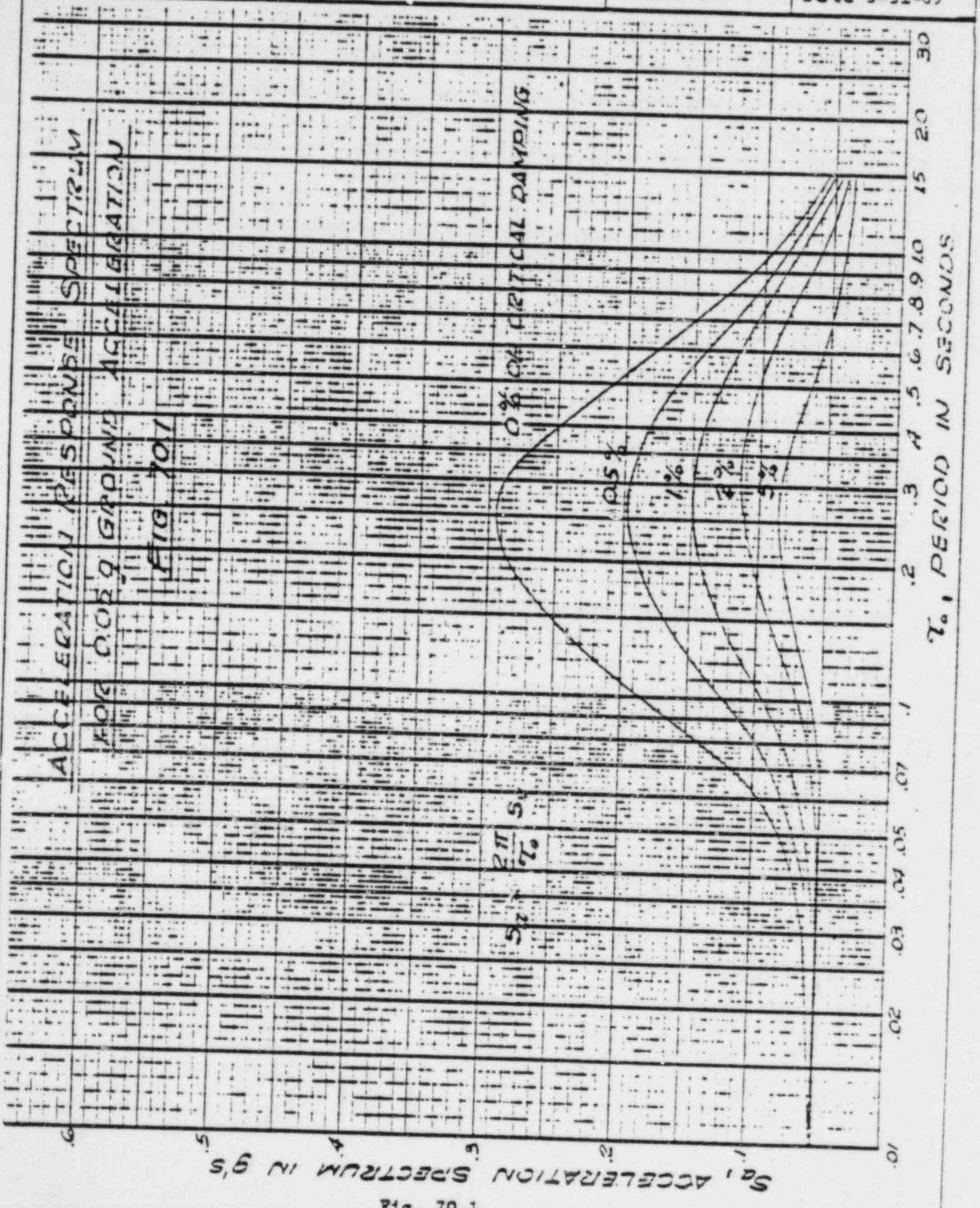

Fig. 70.1

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TABLE 70.1

WIND SPEED FOR THE DESIGN AND MAXIMUM TORNADO IN MPH

	DESIGN TORNADO				MAXIMUM TORNADO
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Elevation (ft)	Total Vector Velocity (Includes Translational Velocity)	Tangential Wind Speed	Total Horizontal Velocity = Tangential + Translational*	Building Design Horizontal Tornado Wind Load Without Exceeding Yield Stresses	Total Horizontal Wind Velocity Where Ultimate Stress or Buckling of Compression Members Will Not Occur**
≤6	148	89	139	202	300
25	172	103	153	202	300
50	172	103	153	202	300
75	217	129	179	202	300
100	217	152	202	202	300
125	217	152	202	202	300
≥150	240	152	202	202	300

*Tornado translational velocity = 50 mph

**Stresses in the basic building structure will not exceed 85% of ultimate stresses and buckling of compression members will not occur. Safe plant shutdown would not be impaired.

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Proj. No. 90	Document No. DC-70	Issue F	Date 3-31-69

TABLE 70.2

MAXIMUM MISSILE VELOCITY vs ELEVATION FOR "DESIGN" AND "MAXIMUM" TORNADOES
(Tornado Translational Velocity = 50 mph)

	Missile	Elevation (ft)	DESIGN TORNADO Maximum Missile	MAXIMUM TORNADO Velocity in mph	Terminal Free Fall Vertical Velocity Component mph *
	Cooling Tower Slat:	≤6	130	181	
	Corrugated Asbestos	25	154	218	
	8 ft x 2 ft x .5 in,	50	154	218	
	14 lbs	75	199	285	
F		100	199	285	21
		125	199	285	
		150	224	325	
		175	224	325	
		200	224	325	
	Corrugated Metal Sheet:	≤6	107	158	
	8 ft x 4 ft,	25	131	195	
	100 lbs	50	131	195	
		75	176	195	
F		100	176	262	41
		125	176	262	
		150	202	302	
		175	202	302	
		200	202	302	
	Fir Plank:	≤6	98	151	
	12 ft x 1 ft x 4 in,	25	122	188	
	105 lbs	50	122	188	
	(Design Missile)	75	167	255	
F		100	167	255	68
		125	167	255	
		150	193	295	
		175	193	295	
		200	193	295	
	Bolted Wood: Grating:	≤6	81	133	
	12 ft x 4 ft x 4 in,	25	105	170	
	450 lbs	50	105	170	
		75	150	237	
F		100	150	237	71
		125	150	237	
		150	176	277	
		175	176	277	
		200	176	277	
	Cedar Fence Post:	≤6	31	87	
	6 in x 6 in sq x 6 ft	25	31	46	
	33 lbs	50	-	46	
		75	-	113	
F		100	-	113	80
		125	-	113	
		150	-	153	
		175	-	153	
		200	-	153	

F *Note that missiles may simultaneously have a horizontal component up to the cosine of 20° for the 300 mph tornado and 17° for the 202 mph tornado times the maximum missile velocity stated above.

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By	Approved	Approved	Page 9 of 11

TABLE 70.3

Missile	Design Tornado 202 mph Horizontal Velocity Airborne	Design Tornado 202 mph Horizontal Velocity Lift	Maximum Tornado 300 mph Horizontal Velocity Airborne	Maximum Tornado 300 mph Horizontal Velocity Lift
Cedar Fence Post	Yes	25 Feet	Yes	All elevations
Cooling Tower Slat	Yes	All elevations	Yes	All elevations
Corrugated Metal Sheet	Yes	All elevations	Yes	All elevations
Fir Plank (Design Missile)	Yes	All elevations	Yes	All elevations
Bolted Wood Grating	Yes	All elevations	Yes	All elevations
Subcompact Automobile	Yes	3 Inches	Yes	Very small
Full Size Automobile	No	None	Yes	Small
Railroad Flat Car	No	None	No	None
Locomotive	No	None	No	None

TABLE 70.4

ALLOWABLE STRUCTURAL STRESSES

LOADING CONDITIONS:	Structural Steel F_y = 36,000 psi		Concrete f'_c = 3500 to 6000 psi		Reinforcing Bars F_y = 60,000 psi	
	Tension = F_t Bending = F_b	Compression-F_a	Basic Design Stress	Compressive Stress	% F_y	Tensile Stress F_s
A) Dead Load (D.L.) + Live Load (L.L.)	F_t = 22,000 psi F_b = 22,000 psi	F_a from Table 1-36 of AISC** Specifications 1963	ACI† Building Code (ACI 318-63)	f_c=0.45 f'_c	0.4 F_y	24,000 psi
B) Portions of Structures Supporting Class 1 Equipment	F_t = 22,000 psi	F_a from Table				
1. D.L. + L.L. + Design Earthquake (E)	F_b = 22,000 psi	1-36 of AISC Specifications	ACI 318-63	f_c=0.45 f'_c	0.4 F_y	24,000 psi
2. D.L. + O.L. + Double Earthquake (E')	F_t = 0.85 F_u* F_b = F_y	1.67 F_a from Table 1-36 AISC	1.67 x ACI	f_c=0.85 f'_c	0.85 F_y	51,000 psi
3. D.L. + L.L. + Design Wind (90 mph)	F_t = 29,300 psi F_b = 29,300 psi	1.33 F_a from Table 1-36 AISC	1.33 x ACI	f_c=0.60 f'_c	0.53 F_y	32,000 psi
4. D.L. + L.L. + Design Tornado Wind (202 mph)	F_y	1.67 F_a from Table 1-36 AISC	1.67 x ACI	f_c=0.85 f'_c	0.85 F_y	51,000 psi
5. D.L. + O.L. + Maximum Tornado Wind (300 mph)	F_t = 0.85 F_u* F_b = F_y	1.67 F_a from Table 1-36 AISC	1.67 x ACI	f_c=0.85 f'_c	0.85 F_y	51,000 psi

*F_u = Ultimate stress of steel

**AISC = American Institute of steel Construction

†ACI = American Concrete Institute

O.L. = Operating load

TABLE 3-1

ELASTIC MODULI DETERMINATION

SITE	DEPTH	TRANSIT TIME milliseconds t_S	TRANSIT TIME milliseconds t_L	σ POISSON'S RATIO	MOIST DENSITY lbs/cu ft	VERTICAL VELOCITY ft/ms	"E" YOUNG'S MODULUS psi	"k" BULK MODULUS psi	"μ" SHEAR MODULUS psi
UH1	20	42.0	5.9	0.49	110*	1.2	$<3.4 \times 10^3$	33×10^3	$<8.5 \times 10^2$
	65	14.8	3.8	0.46	138**	7.4	310×10^3	1463×10^3	104×10^3

SYMBOLS: t_S - transit time, shear wave t_L - transit time, longitudinal wave

*110 lbs/cu ft assumed.

**138 lbs/cu ft averaged from Woodward-Clyde-Sherard and Associates

ATTACHMENT III
Structural Design
Criteria
Fort St. Vrain
Three Room Complex Addi
J. O. No. 13569.04

CN 1460
BY Gunnerson
PAGE B26
FORM NO. 372-30-2650

DESIGN INPUT

PROVIDE A LAP SPLICE FOR CAISSON REINF STEEL FOR 3 ROOM COMPLEX ADDITION
ACI 318· , 315
CRSI
REINFORCED CONCRETE FUNDAMENTALS, 2ND EDITION, PM FERGUSON Pg 689

ANALYSIS

THE BASIC DEVELOPMENT LENGTH PER ACI 318-77 Pg 50
DESIGN FOR #10 BARS

$Bl = .04\ A_b F_y / \sqrt{F_c}$

$F_y = 60{,}000$ PSI
$F_c = 3500$ PSI
Bl = BASIC LENGTH

$$Bl = \frac{.04 \times 1.27 \times 60000}{\sqrt{3500}}$$

$Bl = 51.52''$

NO BAR SHALL BE LESS THAN $.004 d_b F_y$

$.0004 \times 1.27 \times 60000$

$= 30.48''$

SINCE THERE IS PERHAPS ONE TOP BAR IN THE VERTICAL CAISSON I HAVE ASSUMED THAT THE DESIGN WILL BE THE BASIC DEVELOPMENT LENGTH & CLASS C SPLICE (ACI 318 pg 53)

$$\frac{A_s \text{ REQ'D}}{A_s \text{ PROVIDED}} = \frac{18.1 \square''}{19.05 \square''} = .95 < 1$$

USE CLASS C Tension lap splice, PER ACI 318

LAP SPLICE

CLASS C 1.7 l_d

1.7 × 51.52 = 87.58" MIN LENGTH

87.58" ÷ 1.27" = 68.96 BAR DIAMETERS

FOR MINIMUM LENGTH OF TENSION LAP SPLICE

USE 70 BAR DIAMETERS

CN 1460 A
BY ED HICKS
PAGE B29A
FORM NO. 372-30-2650

BASIC DEVELOPMENT LENGTH = l_d

$$l_d = \frac{.04\, A_b f_y}{\sqrt{f'_c}} = \frac{.04 \times .79 \times 60{,}000}{\sqrt{3500}} = 32.04'' > 24''$$

l_d = .0004 × 1 × 60000 = 24" bar splice shall not be less than 24"

l_d = 32.04 × 1.4 = 44.856" (TOP BAR)

DESIGN FOR A CLASS C SPLICE

$1.7 l_d$

44.856 × 1.7 = 76.25"

$$\frac{76.25''}{1''} = 76 \text{ BAR DIAMETERS}$$

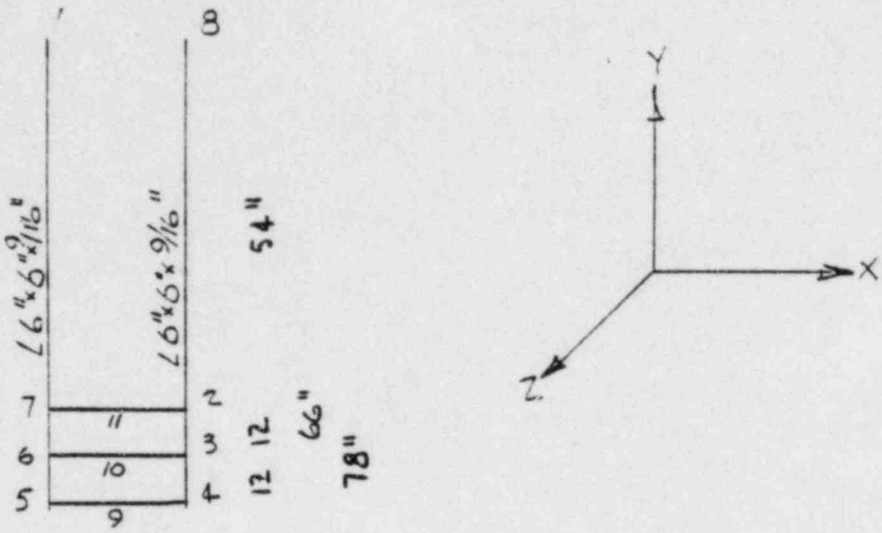
USE 80 BAR DIAMETERS. FOR HORIZONTAL BEAM BAR SPLICES AS SHOWN ON DWG B 449-1 & PER ACI 318

CN 1460 A
BY Hicks
PAGE B30A
FORM NO. 372-30-2650

THE HANDRAILS IN BUILDING 10 ARE DESIGNED NOT TO FAIL AND WILL NOT REDUCE THE FUNCTION OF CLASS 1 COMPONENTS

(THE HANDRAIL WELDS WILL BE ABLE TO RESIST A SHEARING LOAD OF APPROXIMATELY 1200 POUNDS PER INCH, SO AN EXTREMELY HIGH FORCE CAN BE RESISTED BY THE HANDRAIL WELD)

CN 1460 A
BY Hicks
PAGE B31A
FORM NO. 372-30-2650



JOINT 1 & 8 ELEV CABLE TRAY SUPPORT

X = -2524.49976 # } FORCE
Y = 1560.0 #

FOR FORCE CALCULATION SEE CN 1462 A

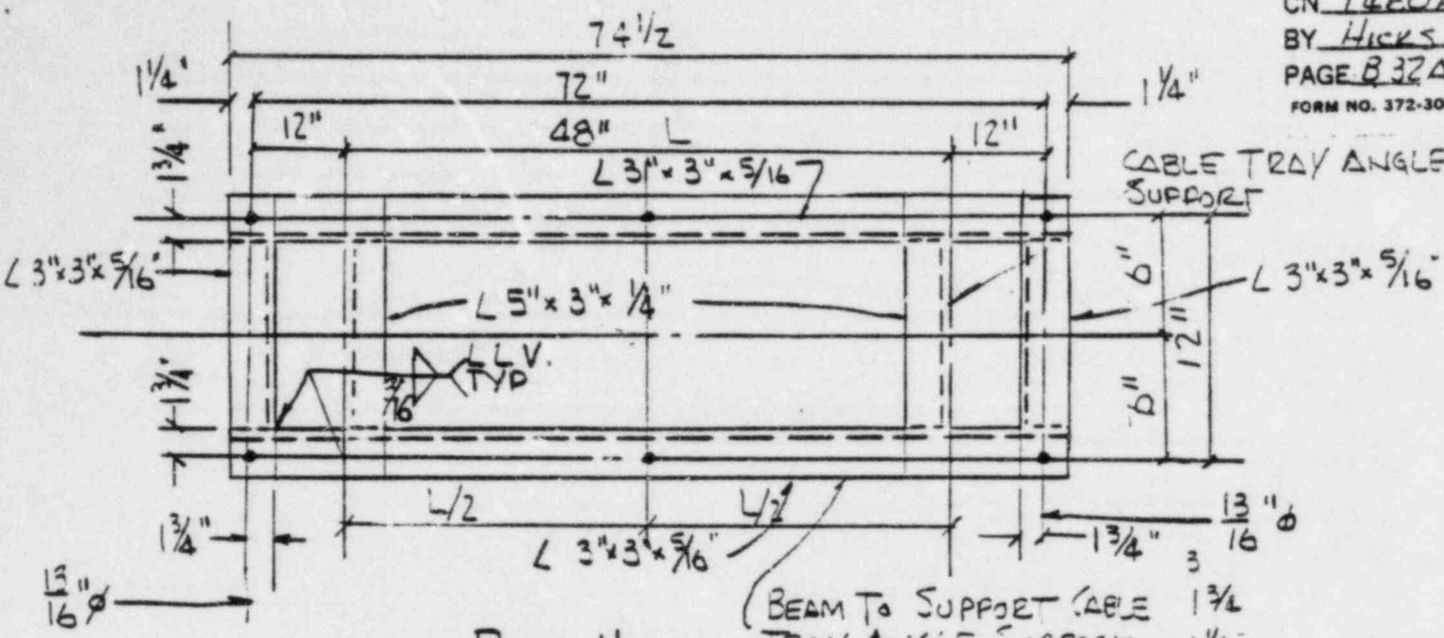
Z = 166 616.937 in Lbs } MOMENT

STRESS 132.1731 PSI

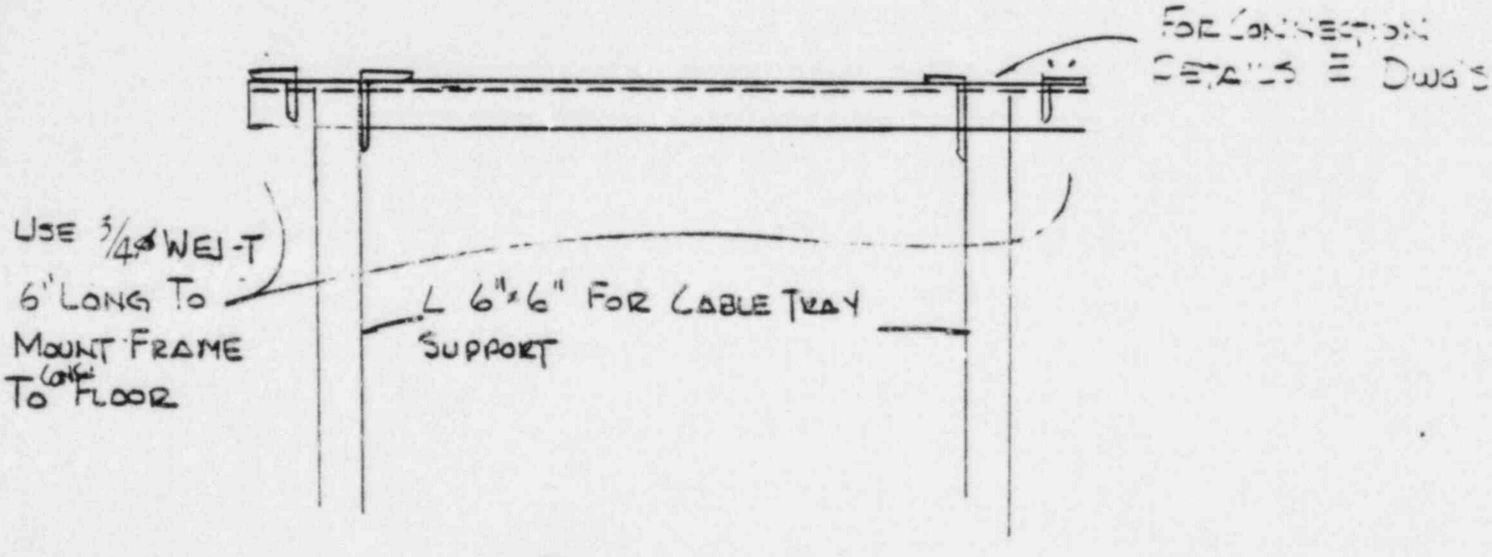
DESIGN CABLE TRAY SUPPORT
MOUNTING BRACKET

CALCULATIONS FOR CABLE TRAY HANGER SUPPORT, BUILDING 10

CN 1460A
BY Hicks
PAGE B32A
FORM NO. 372-30-2650

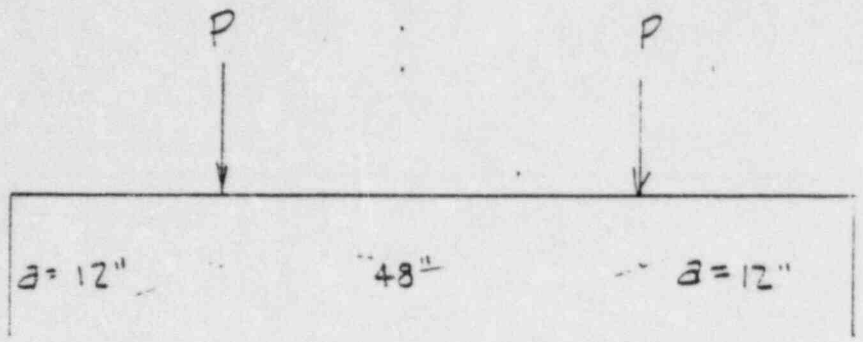


PLAN VIEW
CABLE TRAY SUPPORT FRAME



ELEVATION

CN 1460A
BY Hicks
PAGE B33A
FORM NO. 372-30-2650



BEAM TO SUPPORT CABLE TRAY ANGLE SUPPORT

SEE AISC FOR DESIGN INPUT

$P = 1560 \div 2 = 780\#$

$M = Pa = 780 \times 12 = 9360 \text{ in}\#$

$S_m = \frac{9360}{22000} = .42 \text{ in}^3$

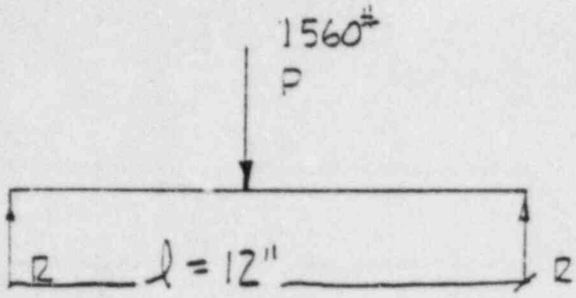
$\Delta_{MAX} = \frac{Pa}{24EI}(3l^2 - 4a^2) = \frac{780 \times 12}{24 \times 29 \times 10^6 \times 1.51}(3 \times 72^2 - 4 \times 12^2)$

$.00000891\,(15552 - 576)$

.13" DEFLECTION

$\frac{l}{360} = \frac{72}{360} = .2$" DEFLECTION

USE $\angle$ 3" × 3" × 5/16" Sm = .707



SUPPORT FOR CABLE TRAY ANGLE SUPPORT

P = 1560#

$M = \frac{Pl}{4} = \frac{1560 \times 12}{4} = 4680$ in Lbs

$S_m = \frac{4680}{22000} = .21 \text{ in}^3$

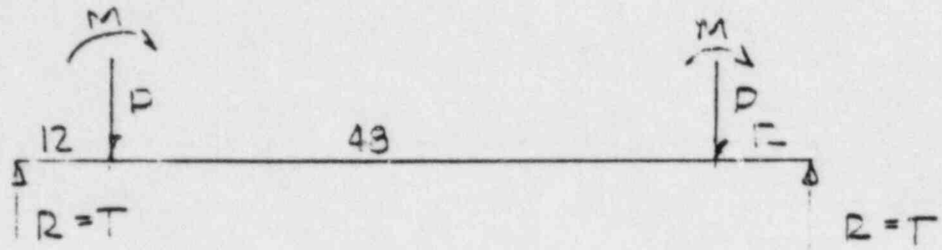
BECAUSE 2 HOLES MAY BE REQD TO SUPPORT THE CABLE TRAY SUPPORT
MIN SIZE ANGLE IS 5 × 3 × 1/2" Sm = 1.53 in

DEFLECTION

$\frac{Pl^3}{48EI} = \frac{1560 \times 12^3}{48 \times 29 \times 10^6 \times 5.[illegible]} = .0003"$

ANCHOR BOLT DESIGN

$M = Pa$
$166,617 = P12$
$P = 13844$



P = 1560

T = TENSION

$\frac{\Sigma M}{72} = \frac{1560 \times 12 + 166,617 + 1560 \times 60 + 166,617}{72"}$ = TENSION

$= \frac{185\,337 \text{ in}^{\#}\ 260\,217 \text{ in}^{\#}}{72 \text{ in}} = 6188.25^{\#}$

TENSION = $6188.25^{\#}$

TRY WEJ IT 3/4 × 6 = 21530 × .9875 × .25 = 5315
5/8 × 6 = 14372 × .9875 × .25 = 3548

$\frac{6189}{3548} = 1.74$ REQ'D # OF ANCHOR BOLTS

CHECK SHEAR
USE 6684.1# SHEAR

2524.5
6189 → = 6684.1
S.F.

SHEAR 3/4" 27607# ÷ 4 = 6901.75# × 2 = 13,803.5
SHEAR 5/8" 25674# ÷ 4 = 6418.5# × 2 = 12,837
TENSION 3/4" 21530# ÷ 4 = 5382.5# × 2 = 10,765# PER SIDE
USE 3/4" × 6" WEJ IT 6 REQD

THE 3/4" × 6" WEJ IT EXCEED THE LOAD REQUIREMENTS BY A S.F. (SAFETY FACTOR) OF GREATER THAN 3 & ARE THEREFORE SATISFACTORY

CN 1460A
BY HICKS
PAGE: 536 A
FORM NO. 372-30-2650

WELD REQUIREMENT

DESIGN 3RD EDITION PG 4-53 ELWYN SEELYE

$M = P \times a$
$M = 1560 \times 6$
$M = 9360$

$I_o = \frac{L^3}{12} = \frac{12^3}{12} = 144$

$H = \frac{M}{I_o} \times \frac{L}{2} = \frac{9360}{144} \times \frac{12}{2} = 390$

MAX STRESS $R = \sqrt{V^2 + H^2}$

$V = 2524$ $\sqrt{2524^2 + 390^2}$

$R = 2553.95$

$\frac{2553.95}{13600} \times \frac{1}{.707} = .265'' \div 2 = .13''$

USE 3/16" WELD = .1875"

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

CN 146C A
BY Hicks
PAGE B37 A

FORM NO. 372-30-2650

5010.64 (FRONT)

CLIENT & PROJECT	PAGE 1 O.
PSC - FSV 3 ROOM ADDITION	6

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
MISCELLANEOUS DETAILS	☒ I - NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ ____ OTHER

CALCULATION IDENTIFICATION NUMBER				
J. O. OR W.O. NO.	DIVISION & GROUP	CURRENT CAL.C. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
13569.04	S	C1.8	510	N. A.

*APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC NO.	SUPERSEDES *CALC. NO. OR REV. NO.	CONFIRMATION *REQUIRED (✓)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
D. D KAWAMOTO 12-8-82 D Kawamoto	M. R. LINGLE 12-8-82 M. R. Lingle	J W McCOLLEY 12-8-82 J W McColley	0			✓

DISTRIBUTION*

GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE)	Project file ✓ Fire file ✓ Jdo book ✓				

CN 1460 A
BY HICKS
PAGE B38A

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION
13569.04 -SC 1.8	0

FORM NO. 372-30-2650

A601G81

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REV
D. KAWAMOTO 12-8-82		

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
PSC - FSV 3 ROOM ADDITION	I

TABLE OF CONTENTS AND HISTORIC DATA
(Revisions, Additions, Deletions, Etc.)

PAGE NO.	DESCRIPTION	ORIG. REVIEW	REVISION NO.	REVISION DATE	REMARKS
1	TITLE PAGE				
2	TABLE OF CONTENTS				
3	CALC SUMMARY				
4	INVESTIGATION OF DETAIL "G"				
5, 6	INVEST. OF DETAIL "J"				

CALCULATION SUMMARY

STONE & WEBSTER ENGINEERING CORPORATION

A5010.62

J.O./W.O./CALCULATION NO.	REVISION	
13569.04 SC1.8	0	CN 1460A
		BY Hicks
CLIENT/PROJECT: FSU 3 ROOM ADDITION	QA CATEG	PAGE B39A

FORM NO. 372-30-2650

SUBJECT/TITLE

MISCELLANEOUS DETAILS

OBJECTIVE OF CALCULATION

TO INVESTIGATE DETAILS "G" AND "J" SHOWN ON DRAWING 13569.04-FC-1C.

CALCULATION METHOD/ASSUMPTIONS

1 ANCHOR BOLTS CONSIDERED PLAIN BAR AND FULL LENGTH WHICH GOVERNS OVER TAKING THE ALLOWABLE TENSILE STRESS ON THE AREA OF BOLT.

SOURCES OF DATA/EQUATIONS

1) AISC MANUAL OF STEEL CONSTRUCTION, 8th ED.

2) ACI 318-63, PARA 918 (h), ANCHORAGE REQUIREMENTS.

3) MASONRY WALL CALC 13569.04 SC1.6

CONCLUSIONS

RESULTS FOR DETAIL "G" SHOWN ON PAGE 4

RESULTS AND RECOMMENDATIONS FOR DETAIL "J" SHOWN ON PAGES 5, 6.

REVIEWER(S) COMMENTS	PREPARER	DATE
	D. Kulamoto	12-8-72
	REVIEWER/CHECKER	DATE
	INDEPENDENT REVIEWER	DATE

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

A5010 61

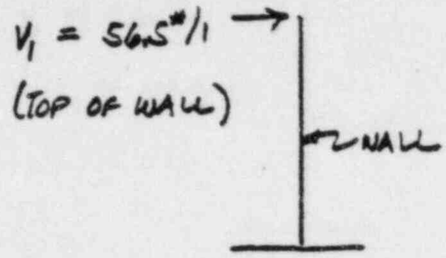
J.O./W.O./CALCULATION NO.	REVISION
13569 .04	0

CN 1460 A
BY Hicks
PAGE B40 A
FORM NO. 372-30-2650

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REV
D. KAWAMOTO 12-7-82		

SUBJECT/TITLE	QA CATEGC
MISCELLANEOUS DETAILS	

INVESTIGATE DETAIL 'E' DWG 13569.04-FC-1C (MASONRY WALLS)



FROM PAGE A5, MASONRY WALLS CALC # C1.6

SIZE OF WELD < 1/8" BY INSPECTION SINCE LOAD IS SMALL. ALLOWABLE WELD STRESS = 21,100 PSI

USE 1/8" FILLET 2" LONG 12" O.C.

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	
13569.04	C	CN 1460 Δ
PREPARER/DATE: D. KAWAMOTO 12-7-82	REVIEWER/CHECKER/DATE	INDEPENDENT R	BY HICKS
SUBJECT/TITLE: MISCELLANEOUS DETAILS		QA CATE	PAGE B41 Δ

FORM NO. 372-30-2650

INVESTIGATE DETAIL "J" DWG 13569.14-FC-16 (FLOOR SLAB)

a) FOR ALLOWABLE TENSION
1) USING ALLOWABLE TENSILE STRESS FOR A 36 $f_t = 19.1$ KSI
2) USING BOND ON PLAIN BARS FOR LENGTH DESCRIBED IN ACI 318-63 918 (h) $u = 160$ psi (WSD)

FOR $\frac{1}{2}"$ φ BOLT IN 6" SLAB LENGTH OF BOLT = $6 - 1\frac{1}{2} - .75 - .5 + 3 = 6.25"$

a) $T = \pi d^2/4 \times 19.1 = 3.75^K$ (CROSS-SECTION OF BOLT)

b) $T = \pi d \times 6.25 \times 160 = 1570\#$ (BOND - WSD)

USE ALLOWABLE $\underline{T = 1.57^K}$ (NO LOAD FACTORS FOR SEISMIC)

FOR $\frac{3}{8}"$ φ BOLT IN 6" SLAB

a) $T = \pi (3/8)^2/4 \times 19.1 = 2.11^K$ (CROSS SECTION OF BOLT)

b) $T = \pi (3/8) \times 6.25 \times 160 = 1.18^K$ (BOND - WSD)

USE ALLOWABLE $\underline{= 1.18^K}$ (NO LOAD FACTORS FOR SEISMIC)

FOR $\frac{1}{2}"$ φ BOLT IN 12" SLAB LENGTH = $12 - 3 - .75 - .5 + 3 = 10.75$

$T = \pi d \times 10.75 \times 160 = \underline{2.7^K}$ (NO LOAD FACTORS FOR SEISMIC)

FOR $\frac{3}{8}"$ φ BOLT IN 12" SLAB

$T = \pi d \times 10.75 \times 160 = \underline{2.03^K}$ (NO LOAD FACTORS FOR SEISMIC

STONE & WEBSTER ENGINEERING CORPORATION

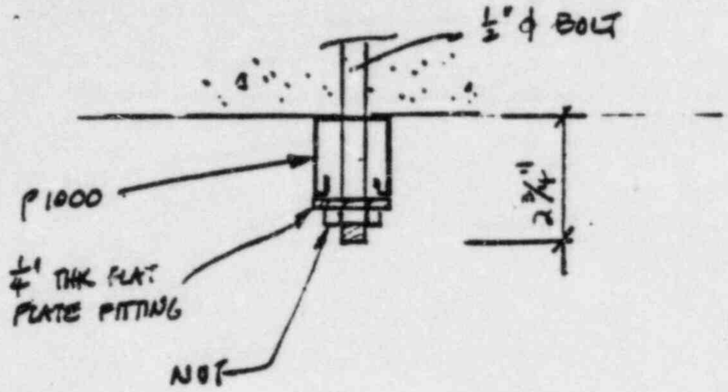
CALCULATION SHEET

A5010 61

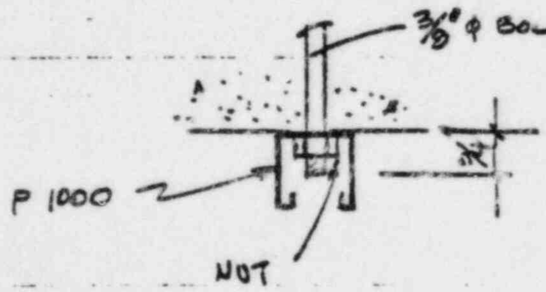
J.O./W.O./CALCULATION NO.	REVISION	
13569.04		CN 1460 A
PREPARER/DATE: D KAWAMOTO 12-7-72	REVIEWER/CHECKER/DATE	INDEPENDENT REV — BY Hicks
		PAGE B42 A
SUBJECT/TITLE: MISCELLANEOUS DETAILS	QA CATEG	FORM NO. 372-30-2650

(FLOOR SLAB)

RECOMMENDED PROJECTION FOR 1/2" φ BOLT



RECOMMENDED PROJECTION FOR 3/8" φ BOLT



DISCUSSION

ORIGINAL DESIGN FOR BUILDING 10 WALKOVER STRUCTURE FOUNDATION WAS A RAFT-TYPE REINFORCED CONCRETE FOOTING (OVERALL DIMENSIONS: 8 FT BY 38 FT IN PLAN BY 6 FT IN DEPTH)* WHICH BEARS ON MEDIUM DENSE SAND AT THE PROPOSED LOCATION. BASED ON THE SITE'S SOIL REPORT (WOODWARD-CLYDE, JULY 1966), ANTICIPATED ALLOWABLE BEARING PRESSURE OF SOIL AT THE BASE OF THE FOUNDATION IS 6000 PSF.

UPON EXCAVATION OF THE AREA TO A DEPTH OF 6 FT BELOW GRADE, IT WAS NOTED THAT THE SOIL MATERIAL WAS QUITE LOOSE AND POSSIBLY NOT CAPABLE OF THE BEARING CAPACITY REQUIRED. FOUR TEST HOLES IN THE FOUNDATION AREA WERE DRILLED; DETAILS, RESULTS AND RECOMMENDATIONS OF THIS TESTING ARE FOUND ON PAGES 844D THROUGH 863D.

FINDINGS OF THE REPORT INDICATE THAT THE IN SITU SOIL AT DEPTH OF 6 FT BELOW GRADE IS CAPABLE OF PROVIDING ONLY 1000 PSF BEARING. A NUMBER OF ALTERNATIVE FOUNDATION SCHEMES WERE SUGGESTED (P. 845D) IN ORDER TO TRANSFER THE LOAD TO A MORE DENSE STRATUM. OF THESE, THE REMOVAL OF AN ADDITIONAL 9 FT OF SOIL TO BE FILLED WITH LEAN CONCRETE WAS CHOSEN DUE TO COST AND SCHEDULE CONSIDERATIONS. MINIMUM LEAN CONCRETE STRENGTH NECESSARY TO SAFELY RESIST DESIGN LOADS DELIVERED FROM THE RAFT FOUNDATION IS 42 PSI COMPRESSIVE STRENGTH (6000 PSF); THIS WAS ACHIEVED BY USING A FOUR-SACK MIX DESIGNED FOR 2000 PSI 28 DAY COMPRESSIVE STRENGTH.

TYPE II CEMENT IS SPECIFIED IN THE PLACING PROCEDURE (SEE P. 630D) BECAUSE OF ITS RESISTANCE TO SOIL SULFATE ATTACK. HOWEVER, DISCUSSIONS WITH SARGENT & LUNDY ENGINEERS ON 6/10/83 CONFIRMED THAT FOR ALL-CONCRETE BACKFILL OF THE TYPE PROPOSED, TYPE I CEMENT IS ACCEPTABLE AND FULFILLS THE REQUIREMENTS OF THE ORIGINAL CONCRETE WORK SPECIFICATION 1-J-30.1. CONCRETE WITH TYPE I CEMENT WAS USED FOR THE FIRST POUR (APPROXIMATELY 1/3 OF TOTAL VOLUME); THE REMAINDER UTILIZES TYPE II CEMENT.

DURING PLACEMENT OF THE LEAN CONCRETE FILL, SOIL IN THE AREA OF THE TURBINE BUILDING/ACCESS BAY GRADE BEAM SLUMPED TO BEAR AGAINST THE TIMBER BRACING

GA 268 Rev. 1-74

GENERAL ATOMIC COMPANY

CALCULATIONS FOR			CN 1460
EQUIP. NO.	PROJ. NO.	CALC. NO.	BY TESNER
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B43.1D
REVIEWED BY	DATE		FORM NO. 372-30-2650
APPROVED BY	DATE		

ERECTED TO HOLD THE CUT IN PLACE. VOIDS BENEATH THE GRADE BEAM WERE FILLED AND PACKED WITH THE LEAN CONCRETE MIX AND THE POUR CONTINUED. AS A RESULT A REGION OF SOIL ESTIMATED TO BE 15 FT LONG BY 8 IN. WIDE IN PLAN AND 15 FT DEEP ENCROACHES THE CONCRETE BACKFILL VOLUME ALONG ITS WEST EDGE. IN ADDITION, A PORTION OF THE PLYWOOD COMPRISING THE SHORING REMAINS CAST IN THE BACKFILL WHEN SAID PLYWOOD STRIPPED AWAY FROM THE 4x4 TIMBER BRACING DURING ITS ATTEMPTED REMOVAL. IN LIGHT OF NUMEROUS CONSERVATISMS EXHIBITED IN THE DESIGN (LIMITING ACTUAL BEARING STRESS ON SOIL TO 6000 PSF AS OPPOSED TO THE SOIL REPORT'S CONCLUSION OF 9200 PSF ALLOWABLE BEARING ON SOIL 15 FT BELOW EXISTING GRADE [SEE P. 846D, 859D], GENEROUS FACTOR OF SAFETY IN LEAN CONCRETE STRENGTH) THE AS-INSTALLED BACKFILL WILL FUNCTION AS ADEQUATE FOUNDATION MATERIAL CAPABLE OF SAFELY SUPPORTING ALL DESIGN LOADS IMPOSED BY THE WALKOVER STRUCTURE.

PREPARED BY: J.A. Tesner DATE: 6/10/83

* ACTUAL DIMENSIONS OF FOUNDATION (REF. DWG. B-455): 7'-10" WIDE BY 36'-0 LONG BY 4'-0 DEEP STEPPED UP TO 6'-0 DEEP FOR THE MIDDLE 23'-2". USE OF DIMENSIONS INDICATED ON PREVIOUS PAGE WILL NOT SIGNIFICANTLY ALTER THE RESULTS OF CALCULATIONS OR CONCLUSIONS NOTED ON PAGES B43D THROUGH B-64D.

CN 1460
BY TESNER
PAGE 844D
FORM NO. 372-30-2650

CTL/THOMPSON, INC.
CONSULTING GEOTECHNICAL AND MATERIALS ENGINEERS

June 3, 1983

G.E. Johnson Construction Company
16805A-WCR
19 1/2 Road
Platteville, Colorado 80651

DRAFT

Attention: Mr. Jim Buridge

Subject: Walk-Over Structure
Fort St. Vrain Nuclear Generating Station
Platteville, Colorado
Job No. 9127

Gentlemen:

In accordance with your request, we have completed the geotechnical investigation for the subject structure. It is our understanding the walk-over structure is planned to be founded on a raft type foundation measuring 38 feet by 8 feet with a thickness of 6 feet. Loads imposed on the soil range from 1,500 psf under normal conditions to 6,000 psf during tornadic winds. No information was available concerning the superstructures, intended use, or structural details.

FIELD AND LABORATORY INVESTIGATION

The field investigation consisted of drilling and sampling 4 exploratory borings within the completed 6 foot excavation. The locations of the borings were selected by Public Service Company of Colorado and are shown on the attached Fig. 1. Borings extended from 25 to 52 feet below the bottom of the excavation. Standard Split-Spoon penetration tests (ASTM D 1586), California Drive Samples and Shelby tubes were used to obtain samples of the subsoils for testing. Graphical logs of the soils encountered, penetration resistance tests and laboratory test results are presented on Fig. 2. Gradation analyses are presented on Figs. 3 through 9.

The subsoils consist of 4 to 6 feet of sand fill underlain by clean to silty sands which extended to the full depth of borings TH-1, TH-2, and TH-4. Boring TH-3 extended to 52 feet and encountered a zone of gravelly sand extending from 33 to 42 feet below grade underlain by weathered and unweathered claystone bedrock. A bedrock sample contained approximately 78 percent clay and silt sized particles and testing indicates a liquid limit of 24 percent and a plasticity index of 12 percent. Cuttings suggest the material is a sedimentary formation commonly known as the "Denver Blue". A previous report published by

82-206-1-J

Woodward Clyde (Job No. 9594-9309) recommended allowable pressures for piers in the bedrock of 60,000 psf end bearing and 6,000 psf skin friction.

DISCUSSION

Considering the size of the raft, loads and subsurface conditions, we do not recommend placement of the raft on soils encountered in the excavation. Our preliminary analyses indicate the natural soils and fill will support loads of only 1,000 psf assuming a limiting settlement of 1 inch. Since this is far below the anticipated loads, we have considered several foundation alternatives for the structure. Four alternatives involves treatment of the subsoils and use of the designed raft foundation. The remaining two alternatives involve supporting the structure on pier or pile foundations.

1. Removal of 9 feet of the natural soils and fill and supporting the raft on lean concrete.

2. Removal and compaction of at least 9 feet of the natural soils and fill beneath the proposed raft.

3. Grouting the loose upper soils using a cementing grout to transfer loads of the raft to denser soils.

4. Compaction grouting to densify and strengthen the soils and fill beneath the raft.

5. Supporting the structure on driven piles founded in the sound bedrock.

6. Constructing the walk-over on drilled piers into bedrock.

Of the alternatives evaluated, the pile (5) and pier (6) options are the safest and most reliable. We understand that time requirements for re-engineering the foundation have precluded these options from consideration. Should conditions change, we will be happy to provide additional data.

The grouting alternatives (3) and (4) offer significant cost and speed advantages. Compaction grouting is performed by injecting sand-cement grout at the exterior boundaries of the excavation under high pressure. After the exterior is fully injected, additional points in the center of the pad are compaction grouted. This process is normally done on 3 to 6 foot centers using pressures ranging up to 1,500 psi. Cement grouting is normally done at pressures of 50 to 150 psi, depending upon conditions, using sand-cement or silicate chemical compounds. Cement grouting is normally more expensive than compaction grouting. Should either of these alternatives be selectd for additional study, we will supply detailed recommendations.

82-206-1-J

The primary alternatives which were being considered by the owner and contractor were removal of 9 feet of material below the bottom of footing and replacement with compacted sand (2) or lean concrete (1). These alternatives require an excavation which will be a total depth of 15 feet from grade. At this elevation, the natural soils have a SPT value of about 14. The density of the soils increases with depth. The primary difficulties with these alternatives are; the possible loss of support for surrounding slab-on-grade construction, difficulty in bracing, and the hand work required. The benefits are that the labor and equipment is available and construction will not be further delayed. Our understanding is that the accepted scheme is to backfill with lean concrete.

ANALYSES AND RECOMMENDATIONS

We have performed our analyses of the proposed removal and replacement scheme using concrete. In effect, this will transfer the imposed raft loads down to the natural soils at a depth of 9 feet (15 feet below-grade). Three analysis methods were used to predict the foundation's behavior. The allowable stress on the natural soils was determined using the Terzaghi analysis method. The results indicate a maximum allowable pressure on the soil is 9,200 psf. The settlement potential was analyzed using a method contained in Hough's text Basic Soils Engineering and a second technique developed by Meyerhof and presented in Scott's text Foundation Analysis. The analyses are based upon results of Standard Penetration Test conducted in the exploratory borings. The analyses indicated a potential settlement of approximately 2.1 inches using Hough's method and up to 1.6 inches based on Meyerhof's method. Copies of the calculation sheets are contained in Appendix A.

Considering the potential for settlement, we recommend isolating the walk-over from adjacent buildings using flexible connections. Any plumbing, electrical or structural connections should delayed until the majority of the dead load has been applied. It should be noted that construction and settlement of the foundation could affect other elements of the walk-over and adjacent building. An engineer familiar with the project details should carefully review the structural implications.

Our work on this project has been limited to determination of subsurface conditions, provision of foundation alternatives and analyses. Only limited information was available regarding the walk-over structure and the adjacent construction. Given the limited information, we have made the assumptions that the foundation under consideration is free of any other structure and acts as an independent unit. These assumptions should be verified.

NOTE: THE BUILDING 10 WALKOVER STRUCTURE AND ITS FOUNDATION HAVE BEEN ISOLATED FROM THE ADJACENT STRUCTURES BY USE OF FLEXIBLE-TYPE CONNECTIONS IN THE DESIGN AND A CLEARANCE OF 1"± FROM OTHER BUILDINGS.

82-206-1-J

JAT
6/10/83

CN 1460
BY TESNER
PAGE 8470
FORM NO. 372-30-2650

If you have any questions concerning this information or require additional analyses, please call.

Very truly yours,

CTL/Thompson, Inc.

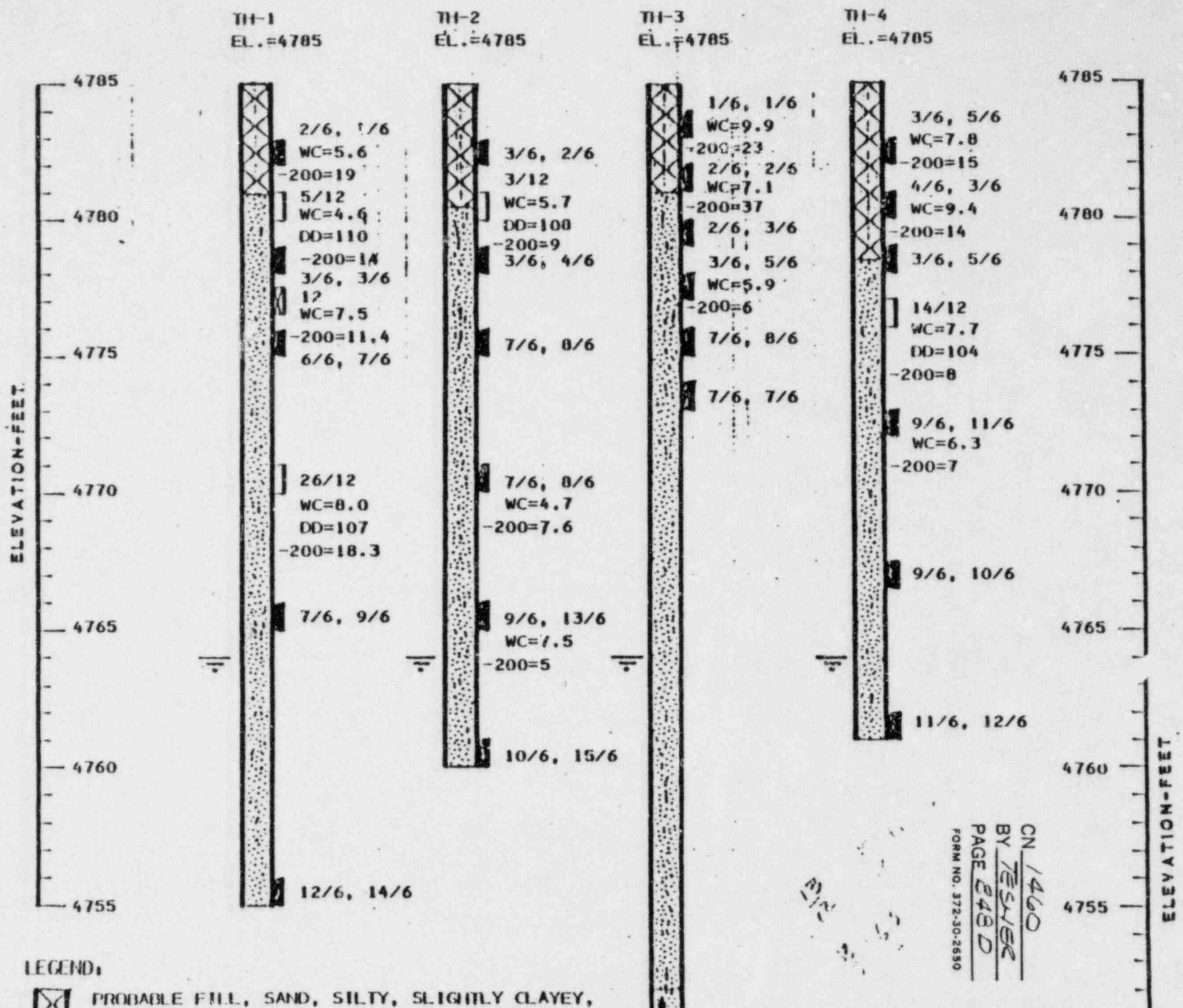
By
Darrel V. Holmquist, P.E., Vice President

DARREL V. HOLMQUIST
REGISTERED
16287
PROFESSIONAL ENGINEER
STATE OF COLORADO

DVH:jc

(3 copies sent)

82-206-1-J



LEGEND:

PROBABLE FILL, SAND, SILTY, SLIGHTLY CLAYEY,

CN 1460
BY TESHER
PAGE 248D
FORM NO. 372-30-2650

5-1-206-83

SAND, CLEAN TO SLIGHTLY SILTY, LOOSE TO MEDIUM DENSE, MOIST, LIGHT BROWN, RUST, (SP-SM, SM)

SAND, GRAVELLY TO GRAVEL, SANDY, LOOSE TO MEDIUM DENSE, WET, BROWN (SP, GP)

SEVERELY WEATHERED CLAYSTONE WITH SANDSTONE LENSES, MEDIUM HARD, MOIST, BROWN, BLUE-GRAY

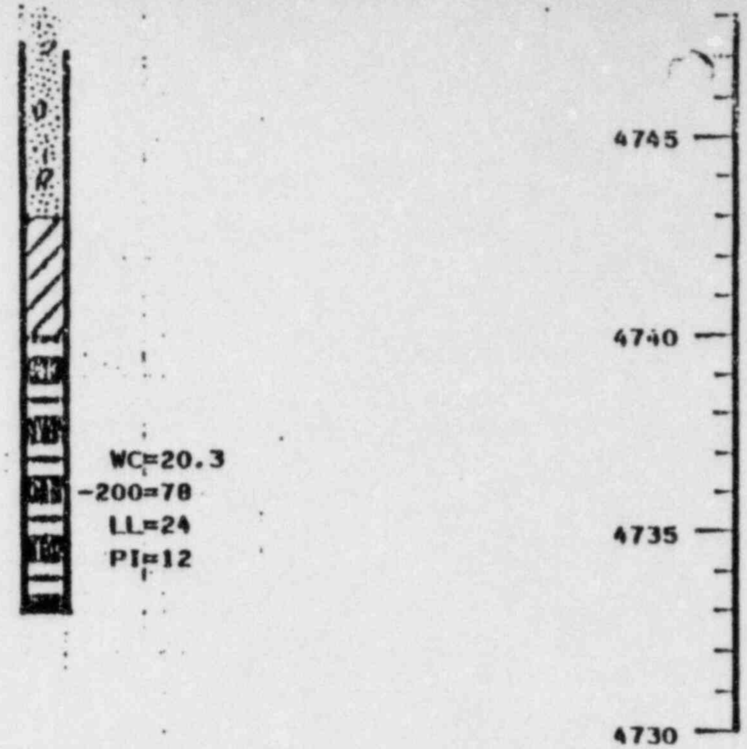
BEDROCK, CLAYSTONE, HARD, MOIST, BLUE-GRAY

INDICATES LEVEL OF FREE GROUN WATER AT THE TIME OF DRILLING.

STANDARD SPLIT SPOON SAMPLE. THE SAMPLER WAS INITIALLY DRIVEN 6 INCHES INTO THE RELATIVELY UNDISTURBED SOILS. THE SYMBOLS 2/6 AND 1/6 INDICATE THAT 2 BLOWS OF A 140 POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.0 INCH SAMPLER A SECOND 6 INCHES AND 1 BLOW WAS REQUIRED TO DRIVE THE SAMPLER A THIRD 6 INCHES.

DRIVE SAMPLE. THE SYMBOL 5/12 INDICATES THAT 5 BLOWS OF A 140 POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5 INCH O.D. SAMPLER 12 INCHES.

SHELBY TUBE SAMPLE. THE SYMBOL 12 INDICATES THAT A 2.5 INCH I.D. THIN-WALLED TUBE WAS PUSHED 12 INCHES INTO THE RELATIVELY UNDISTURBED SOILS.



NOTES:

1. THE BORINGS WERE DRILLED MAY 25 AND 26, 1983 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.

2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS AS CONTAINED IN THIS REPORT.

3. WC - INDICATES NATURAL MOISTURE CONTENT (%)
DD - INDICATES DRY DENSITY (PCF)
-200 - INDICATES PERCENT PASSING NO. 200 SIEVE
LL - INDICATES LIQUID LIMIT (%)
PI - INDICATES PLASTICITY INDEX (%).

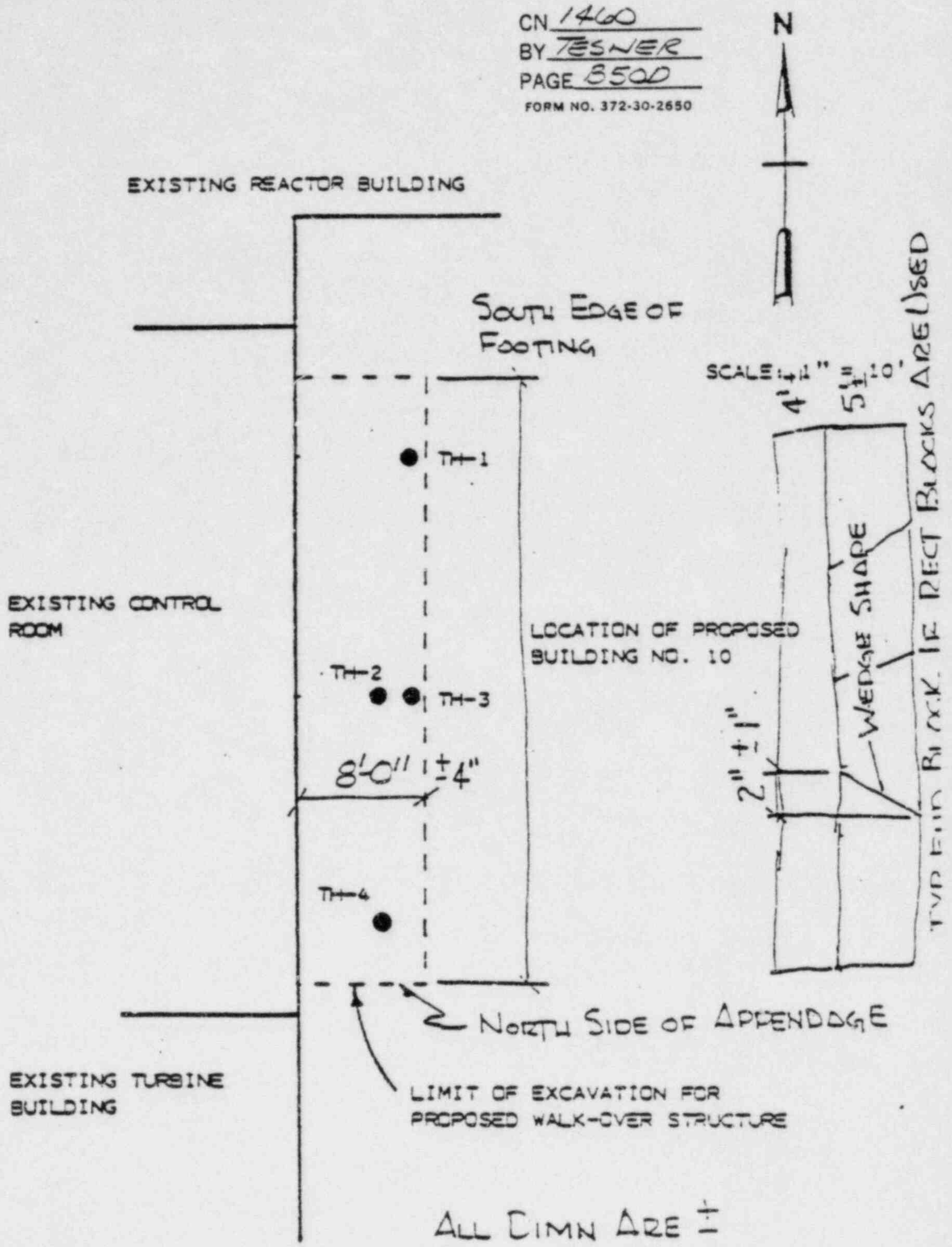
LOGS OF EXPLORATORY BORINGS

JOB NO. 9127

CN 1460
BY TESHER
PAGE E49D
FORM NO. 372-30-2650

FIG. 2

CN 1460
BY TESNER
PAGE 8500
FORM NO. 372-30-2650



LOCATION OF EXPLORATORY BORINGS

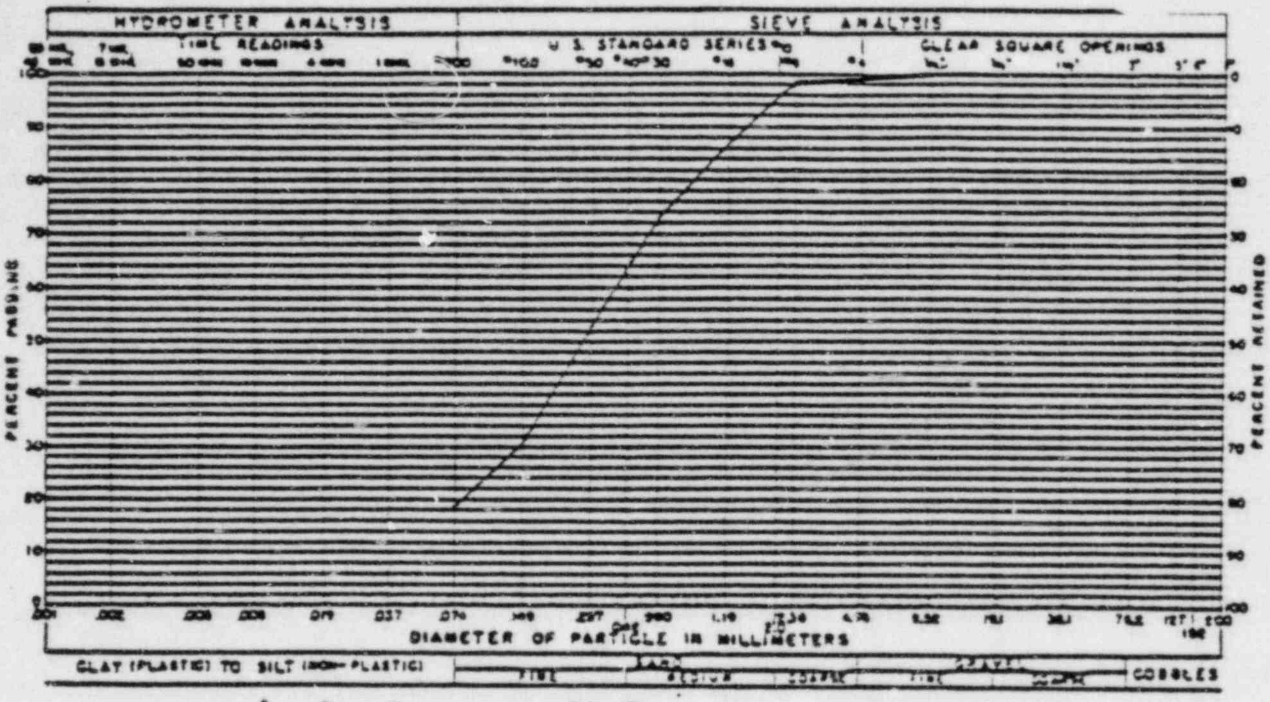
82-206-1-J

JOB NO. 9127

FIG. 1

CN 1460
BY TESHEK
PAGE 8510

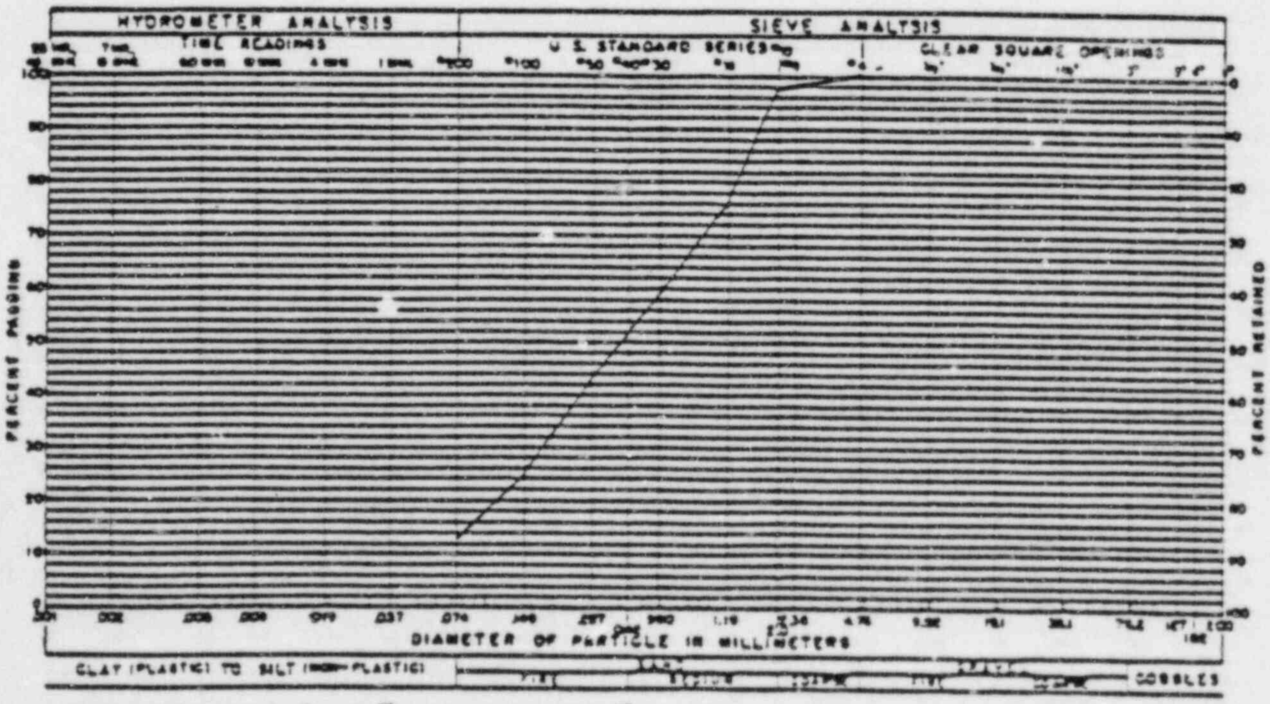
FORM NO. 372-30-2650



GRAVEL 0 % SAND 81 % SILT AND CLAY 19 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SM) FROM TH-1 AT 2 FEET



GRAVEL 0 % SAND 86 % SILT AND CLAY 14 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SM) FROM TH-1 AT 4 FEET

Form 12

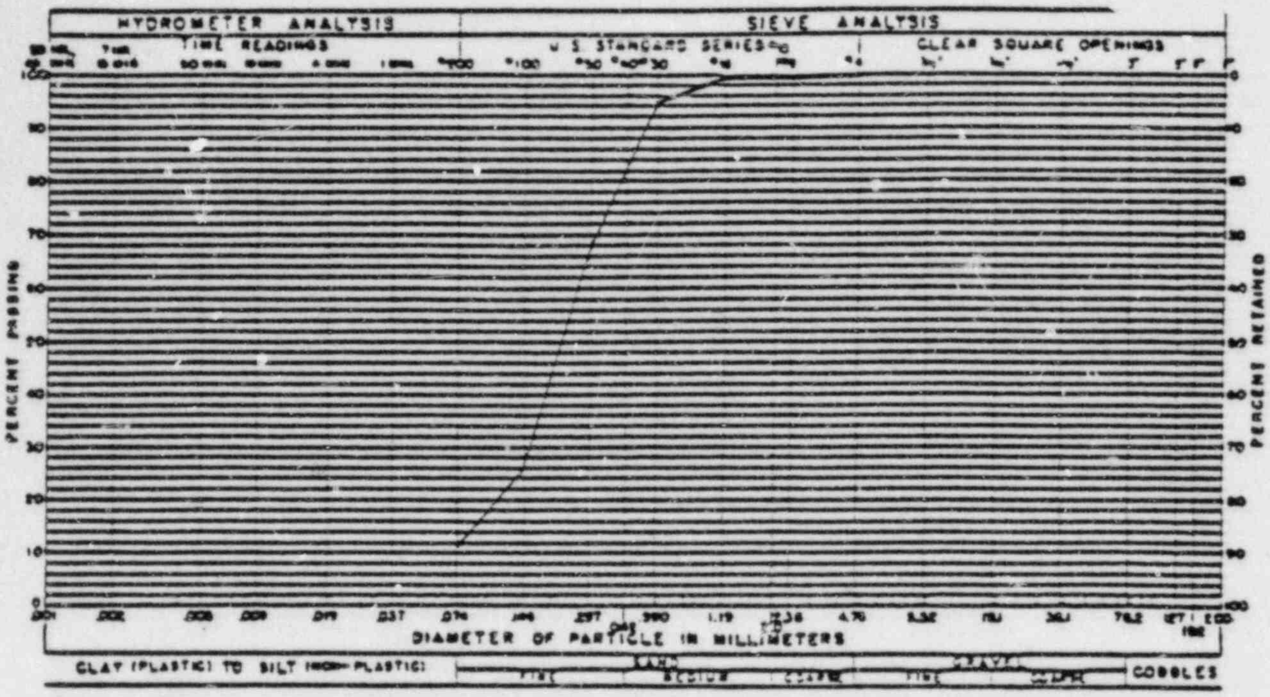
GRADATION TEST RESULTS

82-206-1-J

JOB NO. 9127

FIG. 3

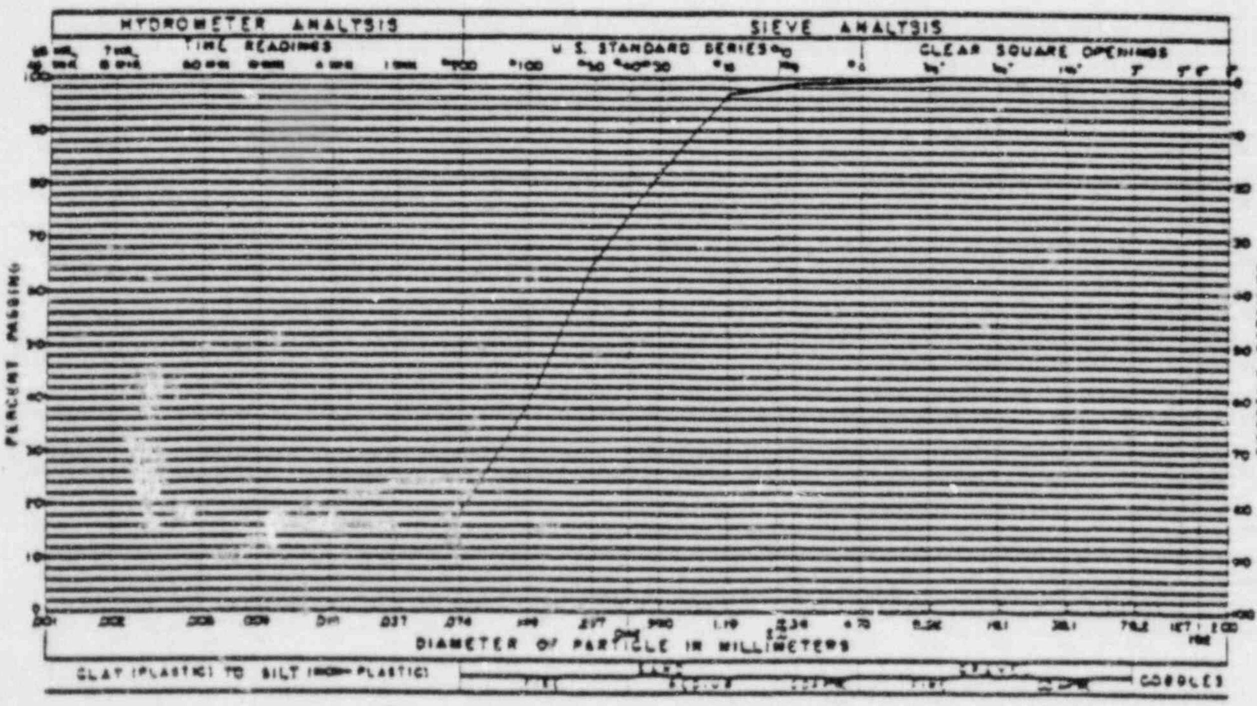
CN 1460
BY TESNER
PAGE 852D
FORM NO. 372-30-2650



GRAVEL 0 % SAND 89 % SILT AND CLAY 11 %

LIQUID LIMIT —— % PLASTICITY INDEX —— %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-1 AT 7.5 FEET



GRAVEL 0 % SAND 82 % SILT AND CLAY 18 %

LIQUID LIMIT —— % PLASTICITY INDEX —— %

SAMPLE OF SAND, SILTY (SM) FROM TH-1 AT 14 FEET

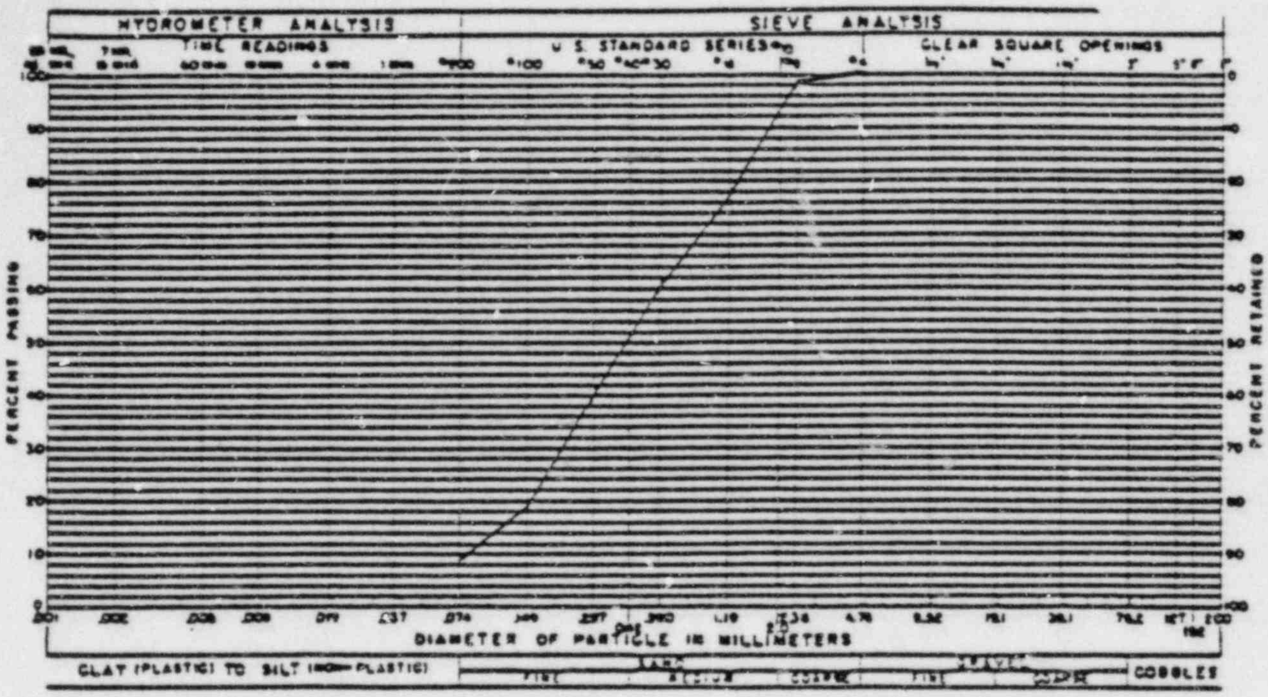
GRADATION TEST RESULTS

82-206-1-J

JOB NO. 9127

FIG. 4

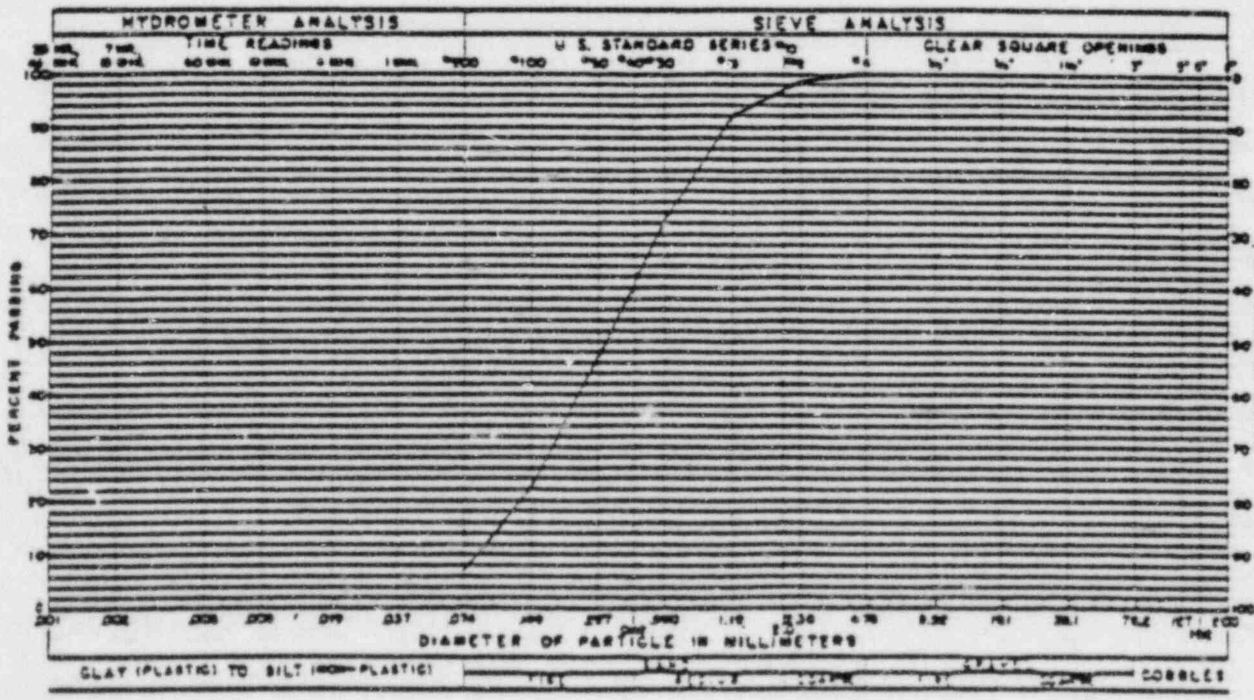
CN 1460
BY TESNER
PAGE 853D
FORM NO. 372-30-2650



GRAVEL 0 % SAND 91 % SILT AND CLAY 9 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-2 AT 4 FEET



GRAVEL 0 % SAND 92 % SILT AND CLAY 8 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-2 AT 14 FEET

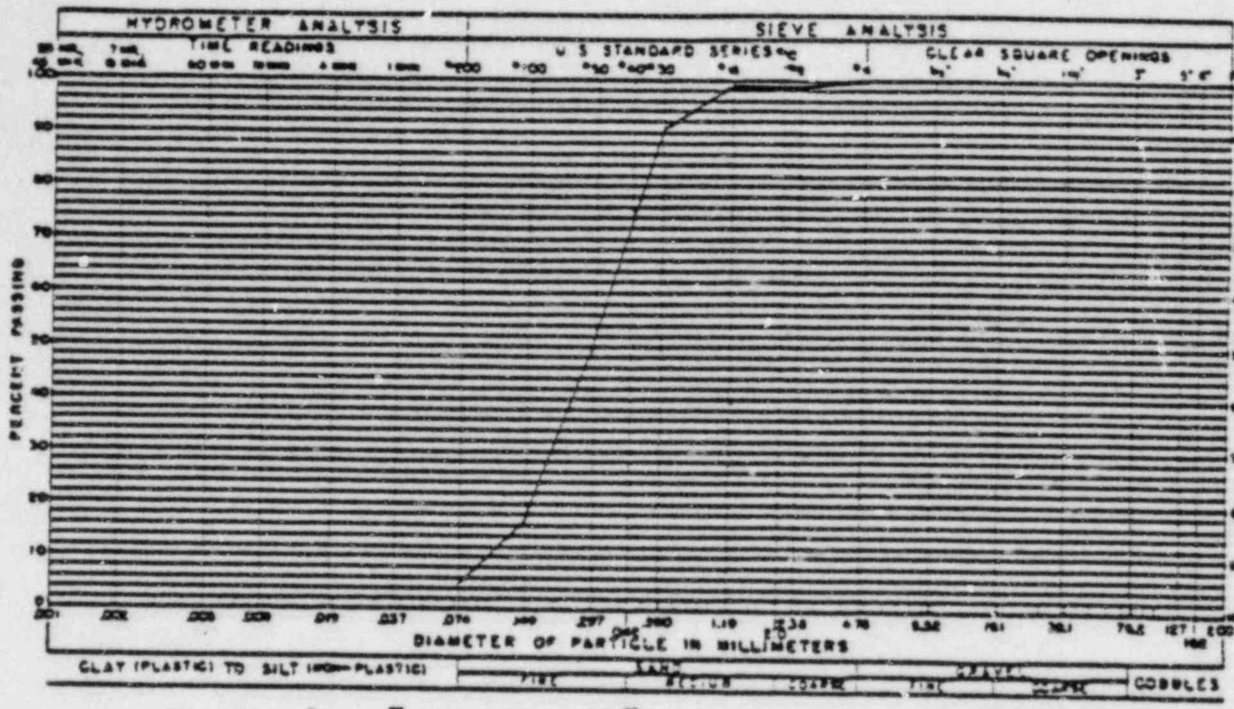
Form 12

GRADATION TEST RESULTS

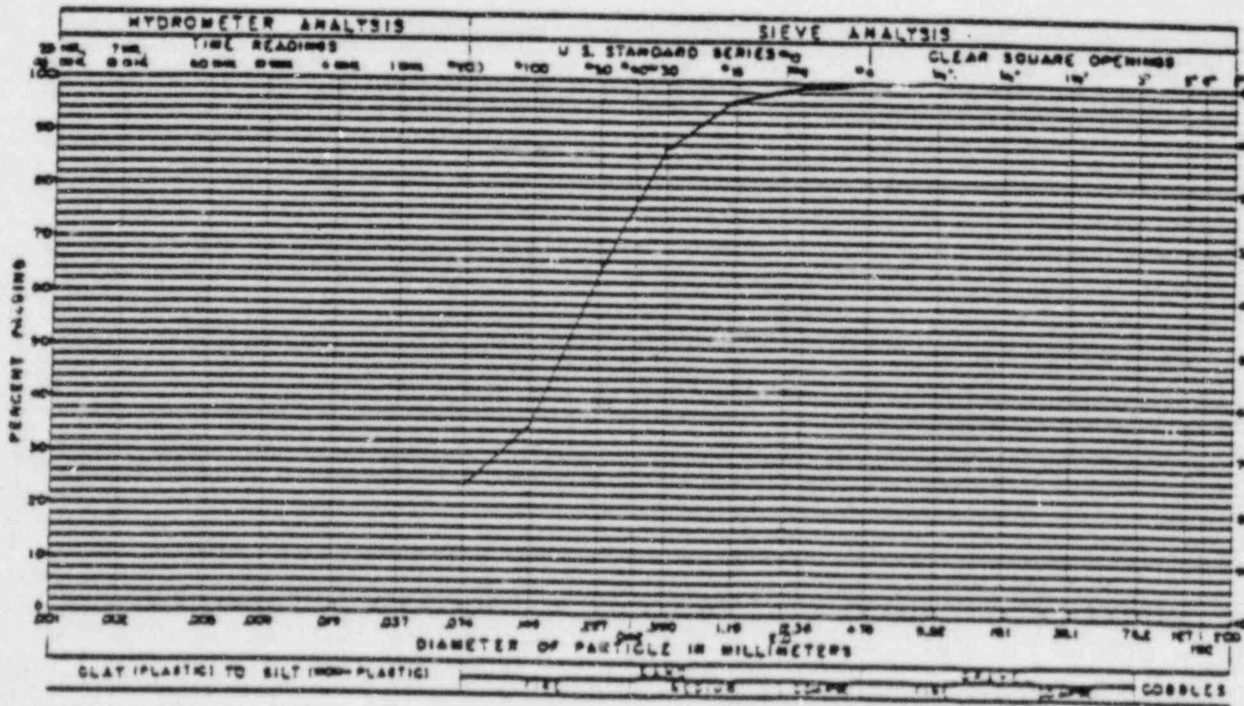
82-206-1-J

JOB NO. 9127 FIG. 5

CN 1460
BY TESNER
PAGE E54D
FORM NO. 372-30-2650



GRAVEL 0 % SAND 95 % SILT AND CLAY 5 %
LIQUID LIMIT — % PLASTICITY INDEX — %
SAMPLE OF SAND, SILTY (SP-SM) FROM TH-2 AT 19 FEET



GRAVEL 0 % SAND 77 % SILT AND CLAY 23 %
LIQUID LIMIT — % PLASTICITY INDEX — %
SAMPLE OF SAND, SILTY (SM) FROM TH-3 AT 1 FOOT

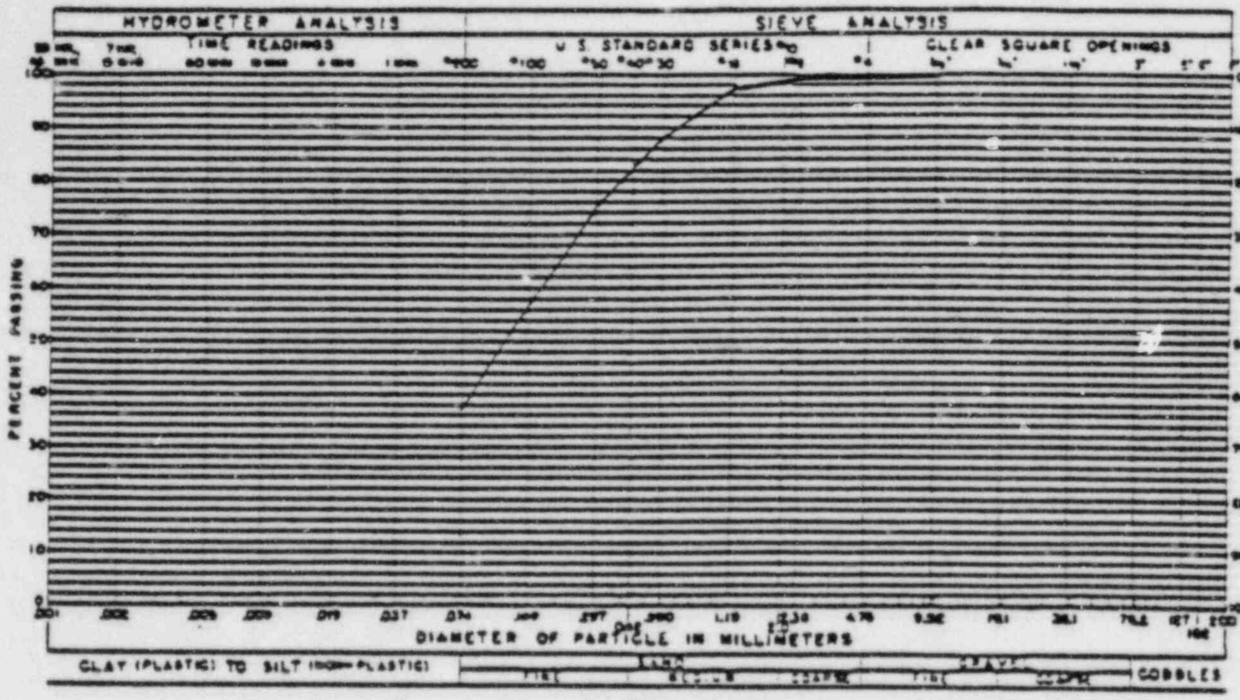
GRADATION TEST RESULTS

82-206-1-J

JOB NO. 9127

FIG. 6

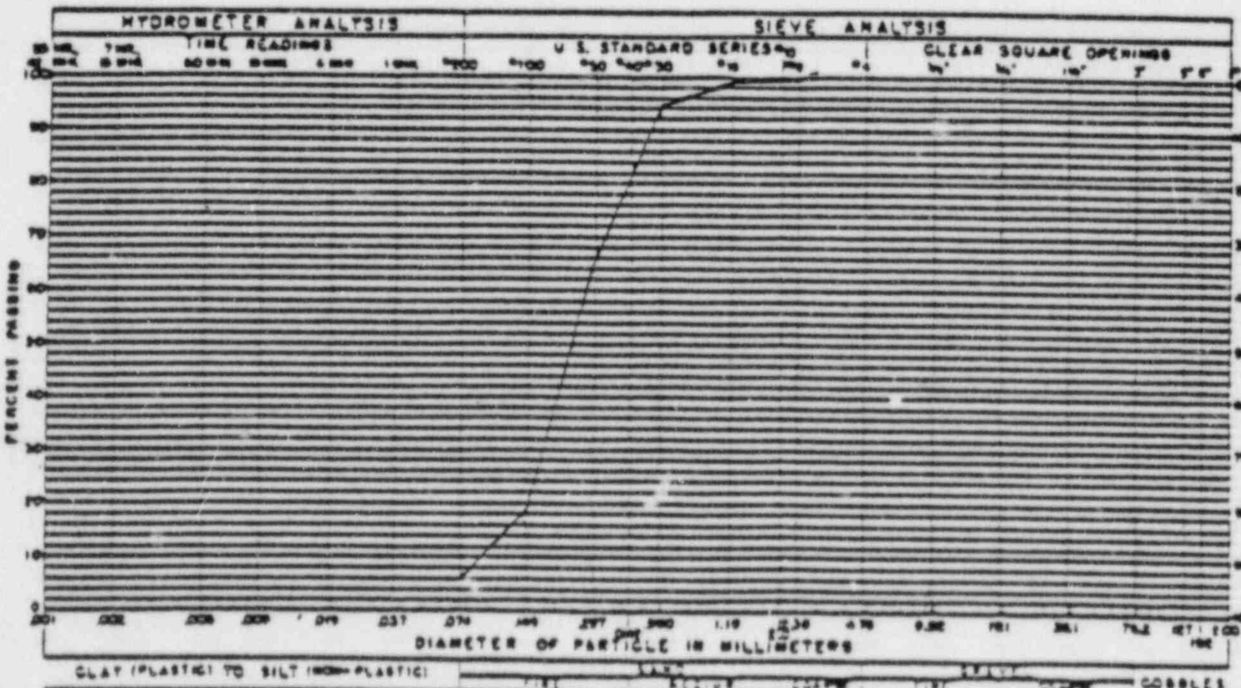
CN 1460
BY TESNER
PAGE 855D
FORM NO. 372-30-2650



GRAVEL 0 % SAND 63 % SILT AND CLAY 37 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, CLAYEY, SILTY (SC, SM) FROM TH-3 AT 3 FEET



GRAVEL 0 % SAND 94 % SILT AND CLAY 6 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-3 AT 7 FEET

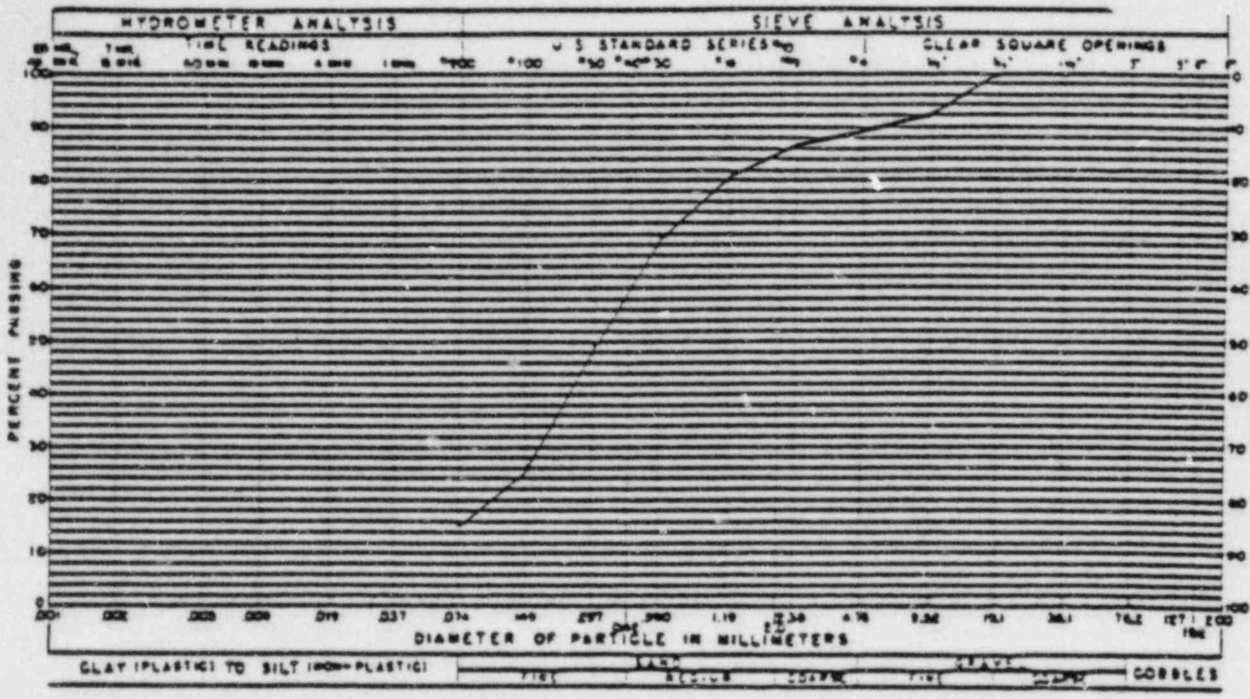
Form 12

GRADATION TEST RESULTS

82-206-1-5

JOB NO. 9127

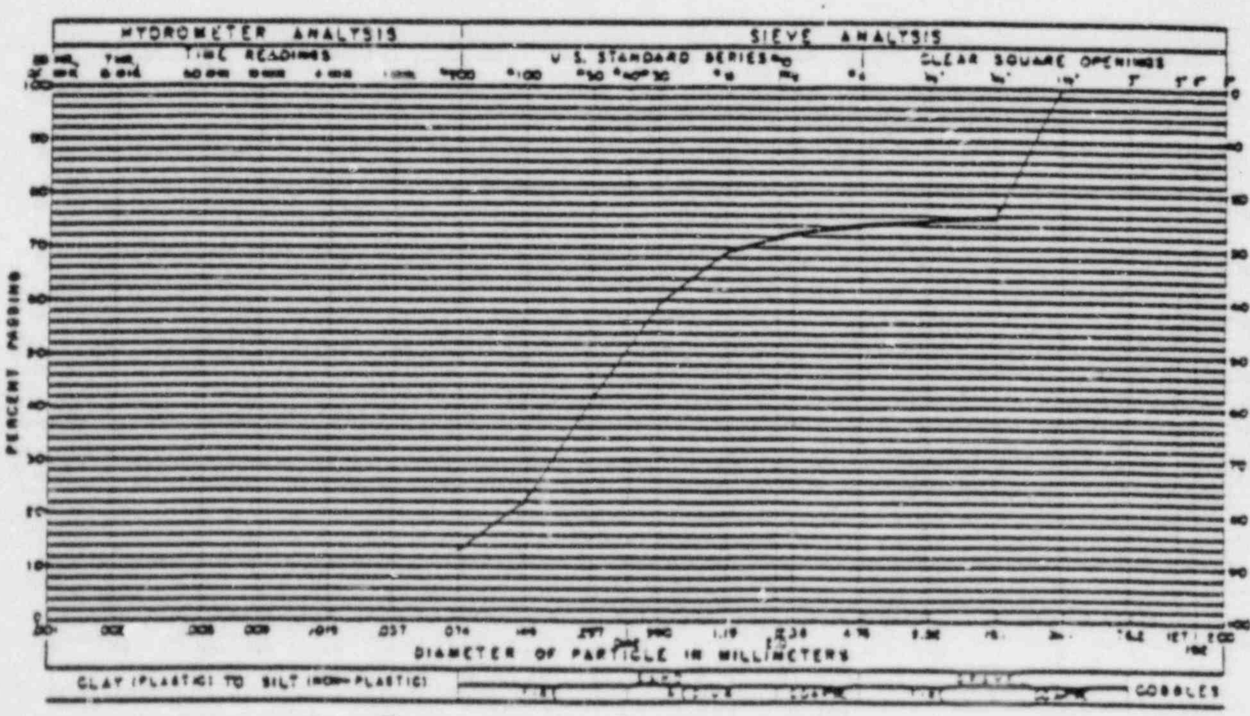
CN 1460
BY TESNER
PAGE 856D
FORM NO. 372-30-2650



GRAVEL 11 % SAND 74 % SILT AND CLAY 15 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY, SLIGHTLY GRAVELLY (SM) FROM TH-4 AT 2 FEET



GRAVEL 26 % SAND 60 % SILT AND CLAY 14 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, GRAVELLY, SILTY (SM) FROM TH-4 AT 4 FEET

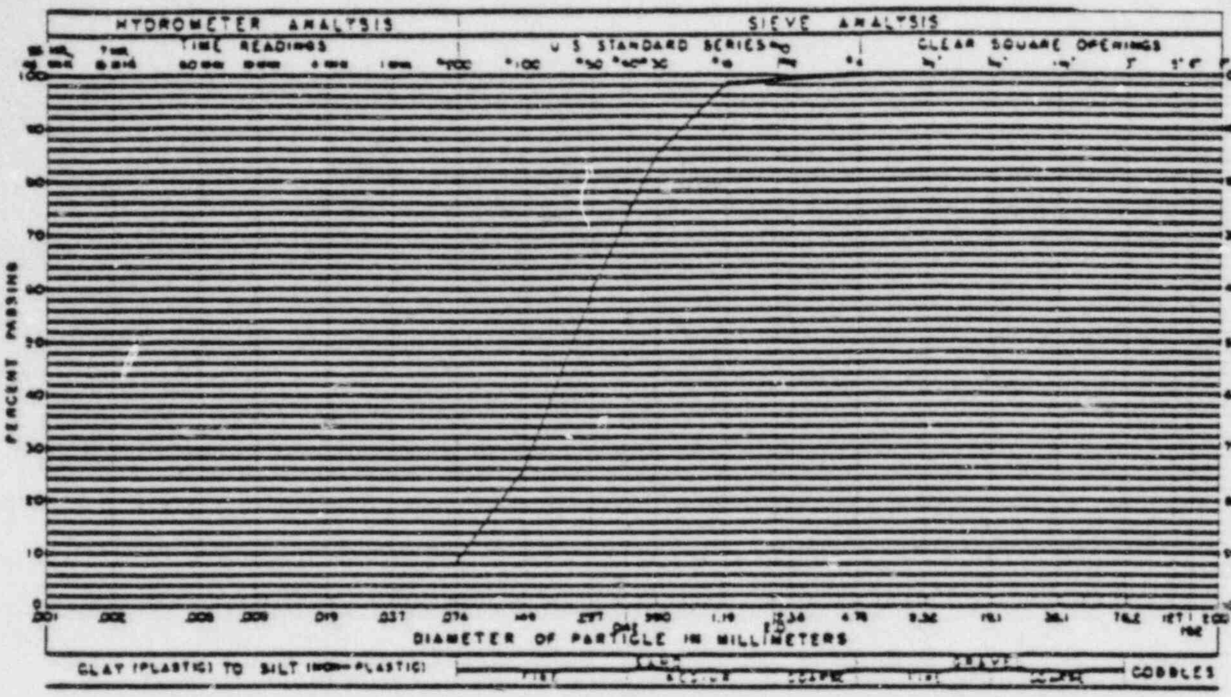
GRADATION TEST RESULTS

82-206-1-J

JOB NO. 9127

FIG. 6

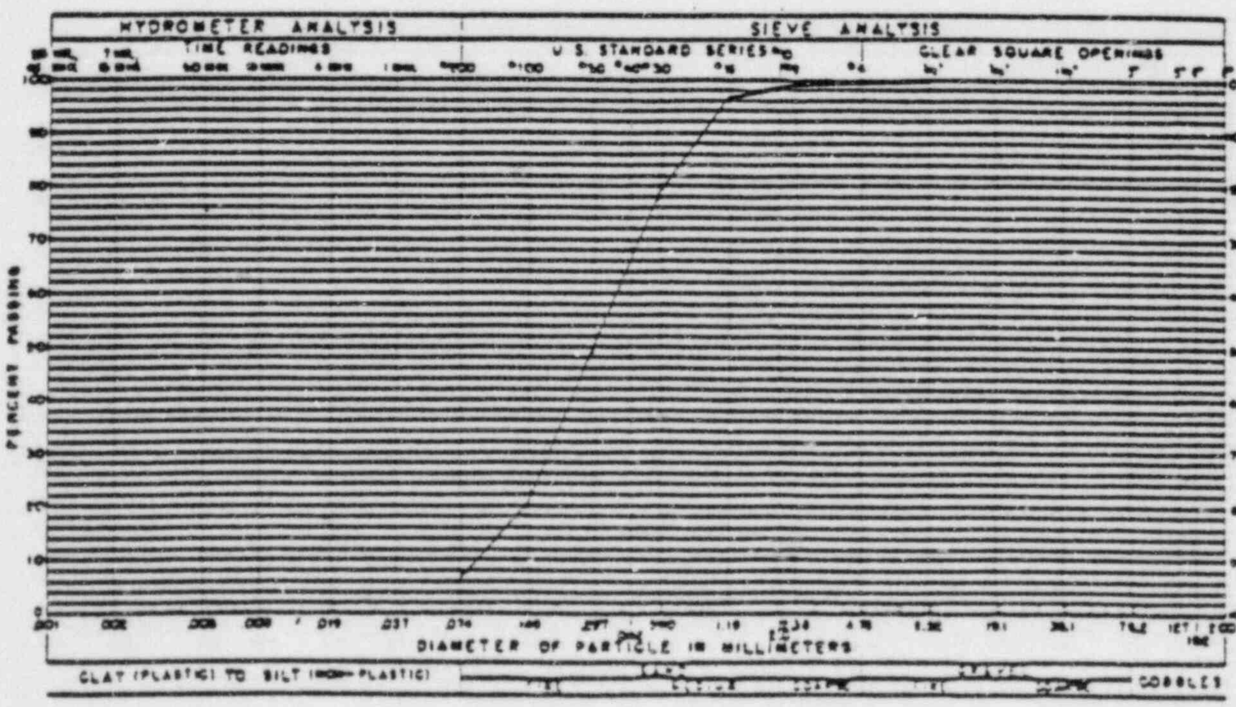
CN 1460
BY TESNETC
PAGE B57D
FORM NO. 372-30-2650



GRAVEL 0 % SAND 92 % SILT AND CLAY 8 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-4 AT 9 FEET



GRAVEL 0 % SAND 93 % SILT AND CLAY 7 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SP-SM) FROM TH-4 AT 12 FEET

Form 12

GRADATION TEST RESULTS

82-206-1-J

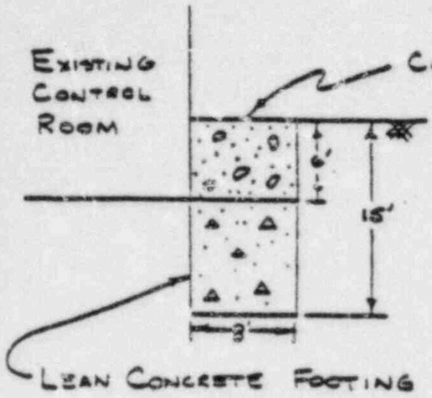
CN 1460
BY TESNER
PAGE 8580
FORM NO. 372-30-2650

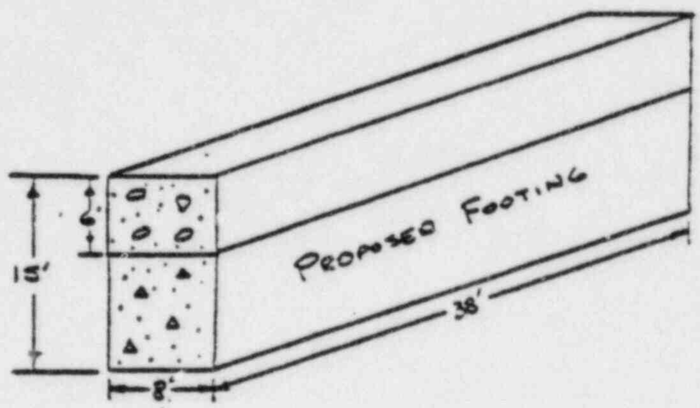
APPENDIX A

82-206-1-5

JOB NO. 9127
JOB NAME: ADDITION TO CONTROL ROOM
CALCS. BY: RAP
REVIEWED BY: DVH

I. BEARING CAPACITY





ASSUMPTIONS:

1.) FOOTING FOUNDED IN SAND; $N_{AVE.} = 14$ & $\gamma_T = 125$ PCF

2.) FOOTING DIMENSIONS; $B = 8'$ $D_F = 15'$

FROM PECK, HANSON, & THORNBURN (1)

$$Q_d = \frac{1}{2} B \gamma_T N_\gamma + \gamma_T D_F (N_q - 1) \qquad \text{Eq. (14.8)}$$

WHERE Q_d = ULTIMATE BEARING CAPACITY (PSF)

$N_\gamma = 10$, $N_q = 13$ } FROM FIG. 14.2 (PECK, HANSON, THORNBURN) FOR N = 14

$$Q_d = \tfrac{1}{2}(8)(125)(10) + (125)(15)(13-1)$$
$$= 5000 + 22500$$
$$= 27500 \text{ psf}$$

LET SAFETY FACTOR = 3

Q_a = ALLOWABLE BEARING CAPACITY

$Q_a = 27,500/3$

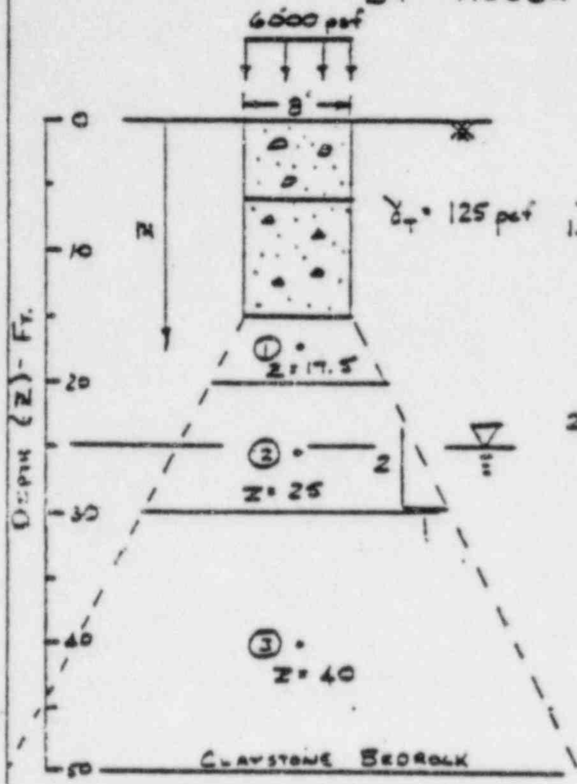
$Q_a = 9167$ PSF (> 6000 PSF: PEAK STRESS)

82-206-1-J

Job No. 9127
Job Name: Addition To Control Room
Calcs. By: RAP
Reviewed By: DVH

II. Settlement Estimate

Method A: As Described By Hough (2)



Assumptions:

1.) Stress Distribution Beneath Footing Is Described By A Trapezoid Having Side Slopes Of 1:2 (Horizontal To Vertical)

2.) Ground Water Table Is Located At Depth Of 25 Feet.

3.) $S = \sum_{0}^{3} \frac{H}{C} \log_{10} \left(\frac{p + \Delta p}{p}\right)$

Where:

S = Total Settlement (Feet)
H = Thickness Of Layer (Feet)
C = Bearing Capacity Index
Δp = Pressure Increase Due To Footing (Psf)
p = Overburden Pressure At Midpoint Of Layer (Psf)

4.) $\Delta p = \frac{6000 (8)}{(8 + D)}$

Where:

D = Depth Below Footing (Feet)
6000 = Peak Applied Stress (Psf)

5.) $p = \gamma_t (z)$ Above GWT

$p = (\gamma_t)(z) - [(z - 25)(125 - 62.4)]$ Below GWT ($z > 25$)

Where:

γ_t = Total Unit Weight (Pcf)
z = Depth To Midpoint Of Layer (Feet)
62.4 = Unit Weight Of Water (Pcf)

82-206-1-J

JOB NO. 9127
JOB NAME: ADDITION TO CONTROL ROOM
CALCS. BY: RAP
REVIEWED BY: DVH

LAYER	D (ft.)	N*	H (ft)	C**	P (psf)	Δp (psf)	S (ft.)
①	2.5	15	5	38	2188	4571	0.064
②	10	21	10	43	3125	2667	0.062
③	25	25	20	50	4061	1455	0.053

S = 0.179 FEET
= 2.1 INCHES

*: AVERAGE BLOW COUNT (SPT)

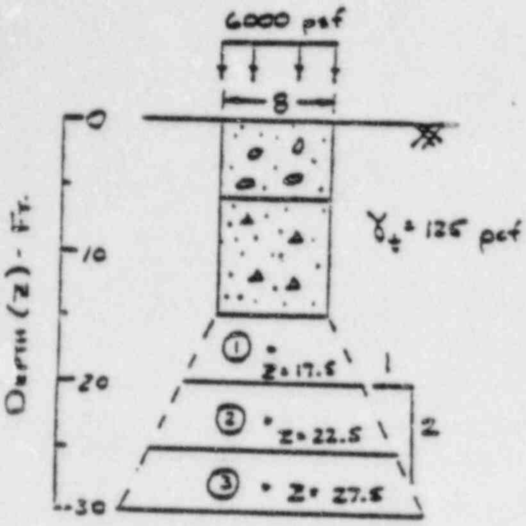
**: FROM FIG. 9-6 (HOUGH)

TOTAL ESTIMATED SETTLEMENT FOR PEAK STRESS OF 6000 PSF = 2.1 INCHES

JOB No. 9127
JOB NAME: ADDITION TO CONTROL ROOM
CALCS BY: RAP
REVIEWED BY: DVH

III. SETTLEMENT ESTIMATE

METHOD B: AS DESCRIBED BY SCOTT (3)



ASSUMPTIONS:

1.) STRESS DISTRIBUTION BENEATH FOOTING IS DESCRIBED BY A TRAPEZOID HAVING SIDE SLOPES OF 1:2 (HORIZONTAL TO VERTICAL)

2.) EFFECT OF GROUND WATER TABLE IS TAKEN INTO ACCOUNT BY THE BLOW COUNT VALUE (N)

3.) $S_t = C_1 C_2 (\Delta p) \sum_{0}^{2B} \frac{I_z}{E_s} \Delta Z$ (B = 8 FEET)

WHERE:

S_t = TOTAL SETTLEMENT (FEET)
C_1 = FOOTING DEPTH FACTOR
C_2 = TIME FACTOR (CREEP)
Δp = PRESSURE INCREASE DUE TO FOOTING (TSF)
I_z = VERTICAL STRAIN INFLUENCE FACTOR
E_s = COMPRESSION MODULUS
ΔZ = THICKNESS OF SAND LAYER (FEET)

$E_s = 4N$

$C_1 = 1 - 0.5 \frac{p_o}{\Delta p}$ $(1 > C_1 \geq 0.5)$

p_o = OVERBURDEN PRESSURE AT MIDPOINT OF LAYER (PSF)
$p_o = \gamma_t (Z)$
γ_t = 125 pcf
Z = DEPTH TO MIDPOINT OF LAYER (FEET)

$C_2 = 1 + 0.2 \log_{10} (10t)$

t = TIME IN YEARS

4.) METHOD ASSUMES $I_z = 0$ AT DEPTH EQUAL TO 2B BELOW THE BOTTOM OF FOOTING

5.) $\Delta p = \frac{6000(8)}{(8+D)}$

WHERE: D = DEPTH BELOW FOOTING (FT.)
6000 = PEAK APPLIED STRESS (PSF)

JOB NO. 9127
JOB NAME: ADDITION TO CONTROL ROOM
CALCS. BY: RAP
REVIEWED BY: DVH

LAYER	D (FT.)	Δp (PSF)	Δp (TSF)	Z (FT.)	P_o (PSF)	C_1*	D/B	I_z**	N	E_s	ΔZ (FT.)	S (FT.)
1	2.5	4571	2.29	17.5	2188	0.76	0.31	0.40	15	60	5	0.058
2	7.5	3097	1.55	22.5	2813	0.55	0.94	0.43	20	80	5	0.023
3	12.5	2341	1.17	27.5	3438	0.50	1.56	0.18	22	88	5	0.006

*: C_1: $1 > C_1 > 0.5$
**: FROM FIG. 7-4 (SCOTT)

S_t = 0.087 FEET
= 1.04 INCHES

INCLUDING TIME FACTOR (C_2)

t	C_2	S_t (IN.)
1	1.20	1.25
5	1.34	1.39
10	1.40	1.46
20	1.46	1.52
50	1.54	1.60

TOTAL ESTIMATED SETTLEMENT FOR PEAK STRESS OF 6000 PSF

IV. REFERENCES

(1) FOUNDATION ENGINEERING, PECK, RALPH B., HANSON, WALTER E., AND THORNBURN, THOMAS H., JOHN WILEY AND SONS, INC., NEW YORK, 1953.

(2) BASIC SOILS ENGINEERING, HOUGH, B. K., THE RONALD PRESS COMPANY, NEW YORK, 1969.

(3) FOUNDATION ANALYSIS, SCOTT, RONALD F., PRENTICE-HALL, INC., ENGLEWOOD CLIFFS, NEW JERSEY, 1981.

WALKOVER STRUCTURE FOUNDATION SETTLEMENT

REF. METHOD A, P. 860 D

$$S = \sum_{0}^{3} \frac{H}{C} \log_{10}\left(1 + \frac{\Delta p}{p}\right)$$

Δp BASED ON NORMAL BEARING PRESSURE AT BASE OF REINFORCED FOOTING OF 1500 PSF

S = TOTAL SETTLEMENT
H = THICKNESS OF LAYER
C = BEARING CAPACITY INDEX
Δp = PRESSURE INCREASE DUE TO FOOTING (PSF)
p = OVERBURDEN PRESSURE AT MIDPOINT OF LAYER (PSF)

$$\Delta p = \frac{1500(8)}{(8+D)}$$

FOR TRAPEZOID STRESS DISTRIBUTION WITH SIDE SLOPE OF 1:2

$\Delta p_1 = 471$ (D = 17.5 FT)

D = DEPTH BELOW FOOTING TO MIDPOINT OF LAYER

$\Delta p_2 = 364$ (D = 25 FT)

$\Delta p_3 = 250$ (D = 40 FT)

$p_1 = (17.5)(125) = 2188$ PSF

$p_2 = (25)(125) = 3125$ PSF

$p_3 = (40)(125) - [(40-25)(125-62.4)] = 4061$ PSF

$H_1 = 5$ FT

$H_2 = 10$ FT

$H_3 = 20$ FT

$C_1 = 38$
$C_2 = 43$
$C_3 = 50$

RELATED TO BLOW COUNT RECORD, REF. FOUNDATION CALCS.

$$S = \frac{5}{38} \log_{10}\left(1 + \frac{471}{2188}\right) + \frac{10}{43} \log_{10}\left(1 + \frac{364}{3125}\right) + \frac{20}{50} \log_{10}\left(1 + \frac{250}{4061}\right)$$

$$= 0.011 + 0.011 + 0.010 = 0.032 \text{ FT} = 0.384 \text{ IN.}$$

THIS AMOUNT OF SETTLEMENT IS ACCEPTABLE; TIME DURATION FOR SUSTAINED LOADING ON STRUCTURE NEEDED TO ACHIEVE 6000 PSF BEARING UNDER EDGE OF FOOTING IS EXTREMELY SHORT (THIS IS DUE TO TORNADO WIND CONDITION). SETTLEMENTS OF THE MAGNITUDE CALCULATED ON P. 860D-863D ARE FOR THIS REASON HIGHLY IMPROBABLE.

Dunner

CN 1460
BY HICKS
PAGE 865E
FORM NO. 272-30-2550

SARGENT & LUNDY
ENGINEERS
FOUNDED 1891
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603
(312) 269-2000
TWX 910-221-2807

August 5, 1983
Project No. 6117-32

Public Service Company of Colorado
Fort St. Vrain - Unit 1

Evaluation of Caisson #5 for Building #10

JRR 8/15/83

Mr. J. R. Reesy
Nuclear Design Manager
Public Service Company of Colorado
2420 W. 26th Avenue - Suite 100-D
Denver, Colorado 80211

Dear Mr. Reesy:

As requested in your letter of July 21, 1983 (NDG-83-0553), we have reviewed the effect of rotation of the reinforcing steel cage which took place during construction of Caisson #5 for the new Building #10 at Fort St. Vrain.

Since the design of the caisson and of the building was performed by another engineering firm, our review was based on the following information provided in your letters NDG-83-0553, dated July 21, 1983, and NDG-83-0584, dated July 29, 1983, and telecons between Mr. J. Tesner of PSC and S. Wahlert of S&L:

1. The portion of the reinforcing bars projecting above the top of concrete have rotated 270° clockwise about the bar cage longitudinal axis as indicated by their position before and after temporary casing removal.

2. All projecting bars have an angle from plumb of 2° to 3° in a direction confirming a clockwise rotation of the reinforcing cage.

3. The top of the projecting reinforcing bars has dropped 7" to 8" from the time the cage was placed in the hole to casing removal.

4. The bottom of casing was set about 6" to 1'-0" into bedrock.

5. For other information used in our review, see attachments 'A' and 'B' which were furnished in the referenced letters.

CN 1460
BY HICKS
PAGE B66E
FORM NO. 372-30-2650

Mr. J. R. Reesy
Public Service Company of Colorado

August 5, 1983
Page 2

The review was based on an assumed profile for the reinforcing. (see Page 3 of Attachment 'C'). The profile was based on the above information supplied by PSC, the conservative assumption that the maximum slope and maximum change in slope of the reinforcing occurs at the point of maximum bending moment, and the assumption that the portion of the cage below the bottom of the casing remained vertical and did not rotate.

Summary of Results

Calculations were performed to determine the effect of the twisted reinforcing cage on the load carrying capacity of the caisson. The calculations are included in attachment 'C'.

The increase in tensile stress, where the angle between the bars and vertical is maximum, was calculated to be less than 2%. The increase is negligible and the effect on the capacity of the caisson is not significant even assuming the reinforcing is stressed to its ultimate capacity.

For compression loads, it was assumed that the reinforcing steel is stressed to the maximum possible compressive force (N Ø fc' Ast). This force was conservatively assumed to occur at all bars and the outward force resulting from the twisting of the vertical bars was calculated. From the conservative approach, hoop tensile stresses in the #4@12circular ties were calculated to be 21.9 ksi which is much less than the ultimate strength of the ties.

The shortening of the reinforcing steel agrees well with the shortening of the vertical bars which would result from the assumed profile. Therefore, it is unlikely that there was a collapse or constriction in the rebar cage as a result of the twisting.

Conclusion

Based on the data provided by PSC and the above assumptions, the effect of the twisted reinforcing steel cage on the capacity of the caisson is negligible.

Please call if you have any questions or would like to discuss this matter further.

Yours very truly,

S. L. Wahlert

S. L. Wahlert
Structural Project Engineer

SLW:mk
Enclosure
Copies: Page 3

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BY HICKS
PAGE B67E
FORM NO. 372-30-2650

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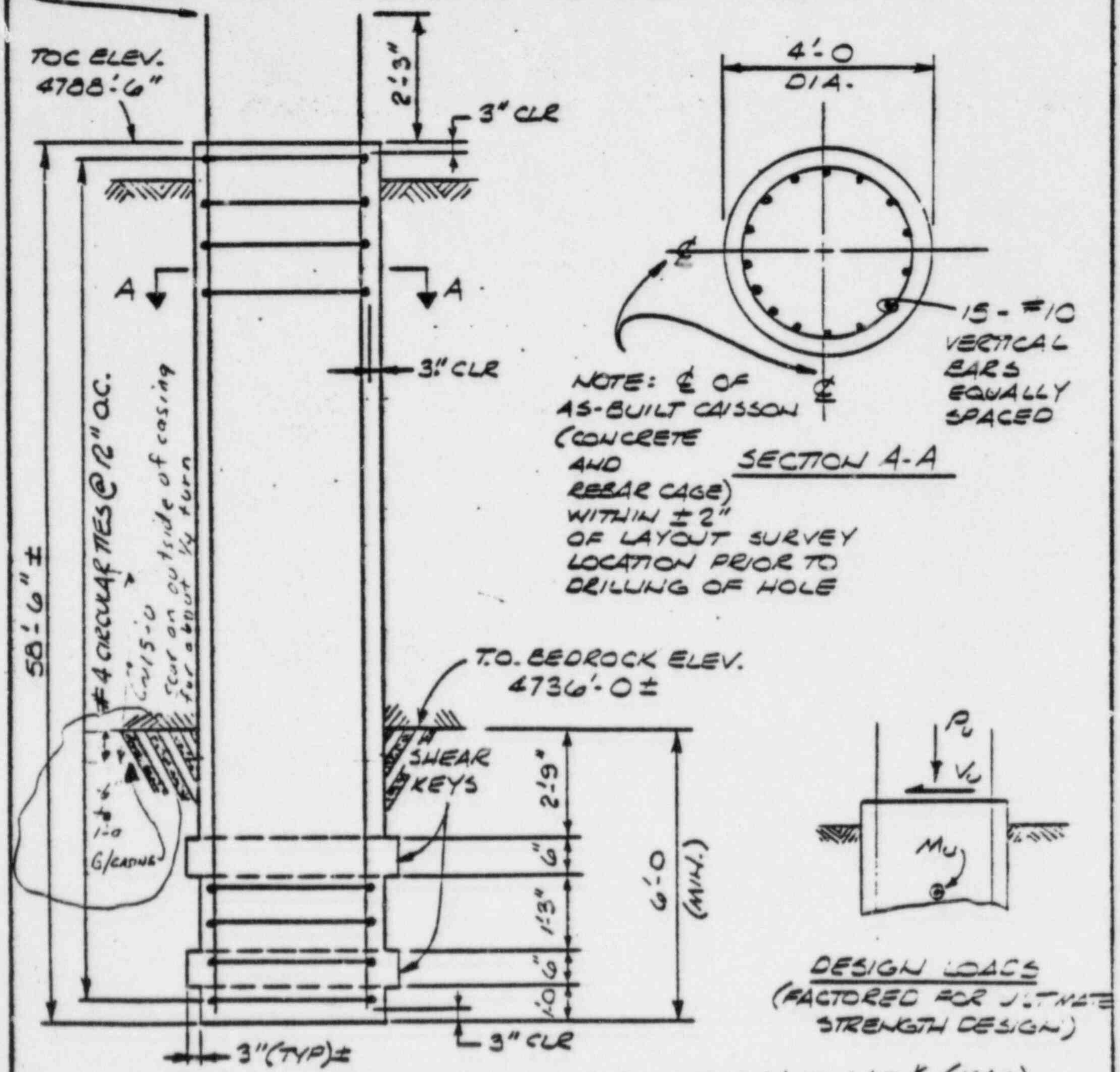
O. Zaben
N. Hingorani
C. Peterson

(ATTACHMENT 'A')

CN 1460
BY HICKS
PAGE 868 E
FORM NO. 372-30-2650

CALCULATIONS FOR		
		CALC. NO.
PREPARED BY	DATE	REF. DOCUMENTS:
REVIEWED BY	DATE	

NOTE: TOP ELEV. OF PROJECTED REBAR DROPPED 7" TO 8" FOR EACH BAR FROM TIME BAR CAGE WAS PLACED IN HOLE TO CASING REMOVAL



CAISSON SECTION

DESIGN LOADS
(FACTORED FOR ULTIMATE STRENGTH DESIGN)

HORIZ. SHEAR V_u = 140 k (MAX)
VERT. AXIAL P_u = 940 k ↓ (MAX)
= 66 k ↓ (MIN)
M_u = 1025 FT. K (MAX)
(THIS MOMENT FROM OUTPUT OF COMPUTER RUN, MOMENT DUE TO SOIL PRESSURE FROM LOAD V_u)

MATERIALS - CONCRETE: f'_c = 3500 PSI
STEEL: GRADE 60

M_u MAX @ 13'± BELOW GRADE

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	
13569.04-3-C1.2		CN 1460 BY HICKS PAGE B69E

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT RE
K Curtis 5-13-82	D.D. Kawamoto 5-19-82	

SUBJECT/TITLE: Caisson Design

QA CATEG

FORM NO. 372-30-2650

ATTACHMENT 'B

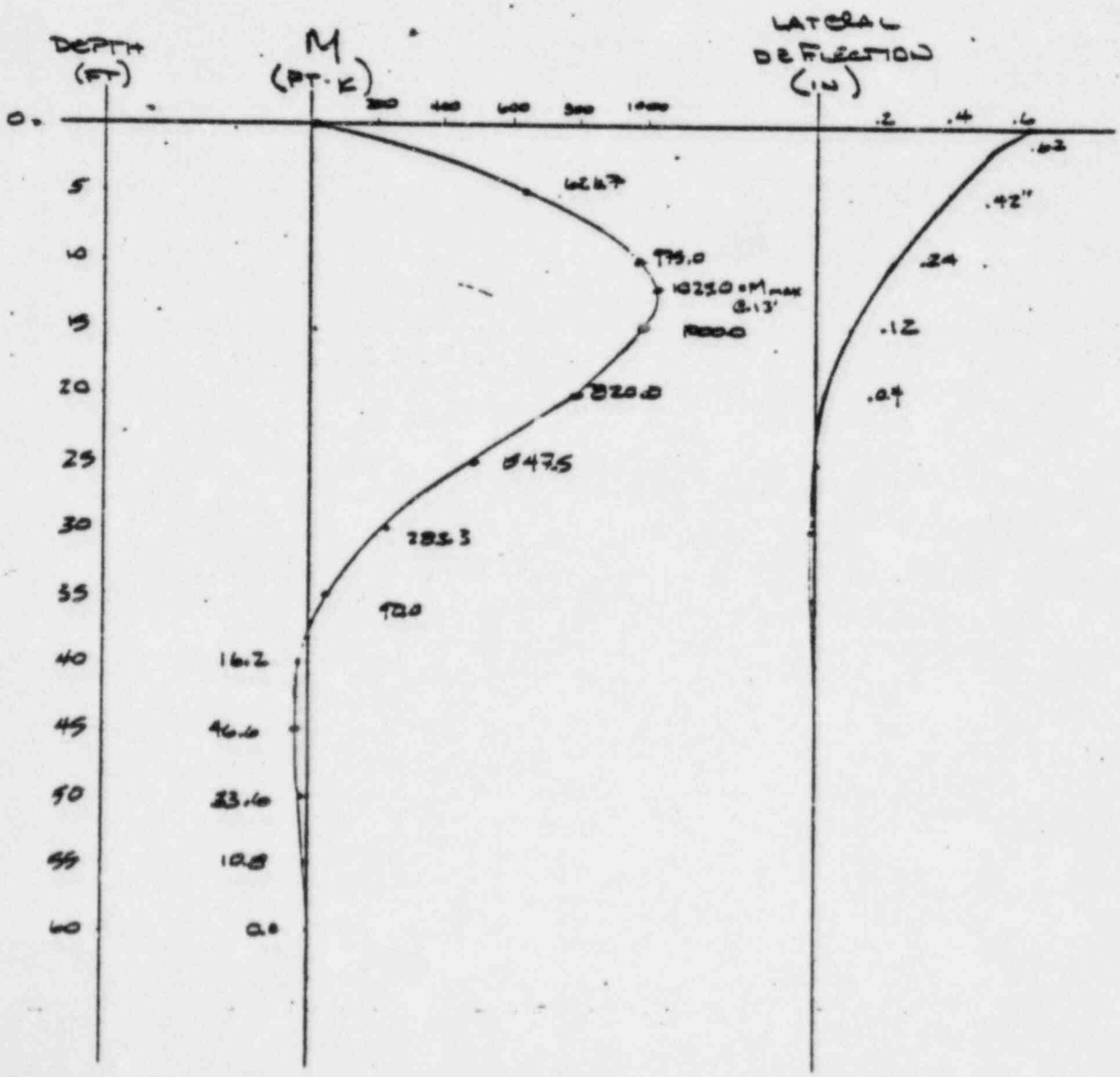
REF: ATTACHED LAT LOAD RUN JOB # 4147 05/14/82

FOR MOMENTS DUE TO SOIL PRESSURE,

'STRUCTURAL ENGINEERING HANDBOOK' 2nd ed BY GAYLORD & GAYLORD

FOR COL INTERACTION DIAGRAMS (p. 11-34)

CONSIDER CAISSON ESSENTIALLY CONTINUOUSLY LATERALLY SUPPORTED & SLENDERNESS EFFECTS NEED NOT BE CONSIDERED



FORM SAS 22.1 Rev. 0

SIGNATURE & DATE FOR REV__			SIGNATURE & DATE FOR REV__			SIGNATURE & DATE FOR REV__			SIGNATURE & DATE FOR REV.0		
APPROVER	REVIEWER	PREPARER	APPROVER	REVIEWER	PREPARER	APPROVER	REVIEWER	PREPARER	APPROVER	REVIEWER	PREPARER
									N.V. [illegible] 2-5-83	[illegible] 8-5-83	[illegible] 8-4-83

IDENTIFICATION OF PAGES PREPARED/REVISED/VOIDED & REVIEW METHOD

REVIEW METHOD	REVIEW METHOD	REVIEW METHOD	REVIEW METHOD DETAILED REVIEW
			PAGES 1 - 10

COMMENTS

QA SERIAL NUMBER

SARGENT & LUNDY ENGINEERS

DESIGN CONTROL SUMMARY

DESIGN VERIFICATION

PAGE 1

ATTACHMENT 'C'

PROJECT NAME FORT ST. VRAIN

PROJECT NO. 6117-32 UN

CLIENT PSC

CALC. NO. & DESCRIPTION ELDS10-FDN5

CALC. FOR 270° ROTATION OF REBAR IN CAISSON #5, BUILDING 10

☑ SAFETY RELATED ☐ NON SAFETY RELATED

CN 1460

BY HICKS

PAGE B70 E

FORM NO. 372-30-2650

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For 270° ROTATION OF REBAR IN CAISSON #5, BLDG. 10	CN 1460
✓ Safety-Related / Non-Safety-Related	BY HICKS
	PAGE 871E
	FORM NO. 372-30-2650

Client	PSC	Prepared by	[illegible] Date 8-3-83
Project	FORT ST. VRAIN	Reviewed by	[illegible] Date 8-5-83
Proj. No.	6117-32 Equip. No.	Approved by	[illegible] Date

PURPOSE OF CALCULATION

THE PURPOSE OF THIS CALCULATION IS TO DETERMINE THE EFFECTS OF A 270° ROTATION OF REINFORCING STEEL WITHIN CAISSON #5 OF BUILDING 10.

PSC HAS PROVIDED THE GEOMETRY AND LOAD (SEE PAGE 10). AT THE TOP THE BARS ARE 2° TO 3° FROM VERTICAL PER PSC'S LETTER OF 7-21-83.

METHOD OF CALCULATION

THIS CALCULATION WILL EXAMINE THE EFFECTS OF THE ROTATION BY ACCOMPLISHING THE FOLLOWING 3 ITEMS:

1. SHOW THAT THE DIAMETER OF THE REBAR CAGE HAS NOT SIGNIFICANTLY CHANGED. THIS WILL MEAN THAT THE GEOMETRY USED FOR THE ORIGINAL ANALYSIS IS STILL VALID.

2. SHOW THAT THE REBARS ARE ADEQUATE FOR THEIR TENSION LOADS IN THE ROTATED STATE.

3. SHOW THAT ADDITIONAL BURSTING FORCES DUE TO THE CURVATURE OF REBAR IN COMPRESSION ARE ADEQUATELY CONSTRAINED BY THE TIES.

Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For

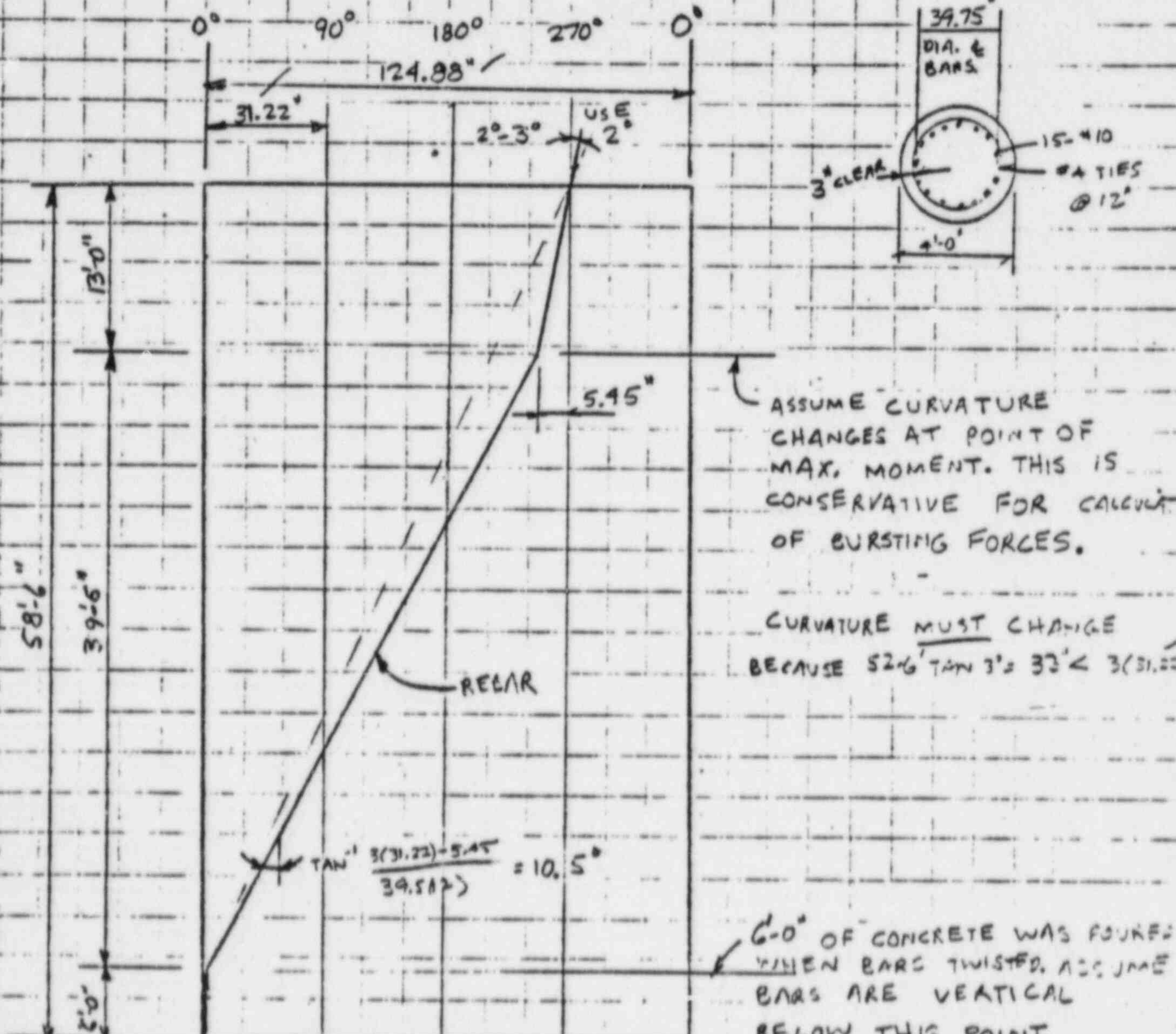
✓ Safety-Related | Non-Safety-Related

Calc. CN 1460 BY HICKS Rev. PAGE B72E Page FORM NO. 372-30-2650

Client PSC		Prepared by [signature]	Date 8-3-83
Project FORT ST. VRAIN		Reviewed by [signature]	Date 8-5-83
Proj. No. 6117-32	Equip. No.	Approved by [signature]	Date

CALCULATIONS

POSITION OF A SINGLE ROTATED VERTICAL REBAR



ASSUME CURVATURE CHANGES AT POINT OF MAX. MOMENT. THIS IS CONSERVATIVE FOR CALCULAT: OF BURSTING FORCES.

CURVATURE MUST CHANGE BECAUSE 52-6' TAN 3° = 33" < 3(31.22)

6'-0" OF CONCRETE WAS POURED WHEN BARS TWISTED. ASSUME BARS ARE VERTICAL BELOW THIS POINT.

DEVELOPED ELEVATION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For	Calc CN 1460
	✓ Safety–Related / Non–Safety–Related	Rev. BY HICKS
		Page PAGE 873 E
		FORM NO. 372-30-2650

Client PSC		Prepared by [signature]	Date 8-3-85
Project FORT ST. VRAIN		Reviewed by [signature]	Date 8-5-85
Proj. No. 6117-32	Equip. No.	Approved by	Date

ITEM #1

CALCULATE HEIGHT THAT THE TOP OF THE BARS SHOULD DROP IF CAGE DOES NOT CONSTRICT. ASSUME PROFILE SHOWN ON DEVELOPED ELEVATION. ACTUAL PROFILE IS NOT KNOWN EXACTLY.

$$\text{LENGTH OF PROFILE} = 6' + \sqrt{13^2 + (5.45/12)^2} + \sqrt{39.5^2 + \left([3(31.22) - 5.45]/12\right)^2}$$
$$= 59.186'$$

$$\text{HEIGHT OF DROP} = (59.186' - 58.5')(12) = 8.23 = 8\tfrac{1}{4}''$$

$$\text{MEASURED DROP} = 7'' \text{ TO } 8'' \cong 8\tfrac{1}{4}''$$

→ THEREFORE, THE CAGE DID NOT CONSTRICT. THE DIAMETER OF THE CAGE IS THE SAME AS BEFORE IT TWISTED.

SARGENT & LUNDY ENGINEERS CHICAGO

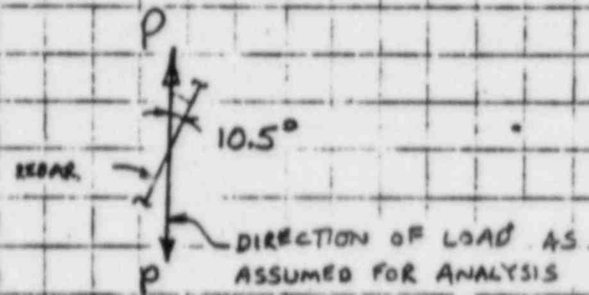
Calcs. For		Calc CN 1460
		Rev BY HICKS
✓ Safety-Related	Non-Safety-Related	Page PAGE 874E

FORM NO. 372-30-2650

Client PSC		Prepared by [signature]	Date 8-3-83
Project FORT ST. VRAIN		Reviewed by [signature]	Date 8-5-83
Proj. No. 6117-32	Equip. No.	Approved by [signature]	Date

ITEM #2

CHECK TENSION ON REBAR



LOAD REQUIRED IN BAR TO RESIST "P" = P/cos 10.5°

= 1.017 P

1.017 - 1.0 = .017

→ ANGULARITY INCREASES LOAD ON BAR < 2%. THEREFORE THE EFFECT ON THE ADEQUACY OF THE BAR IS NEGLIGABLE. ✓

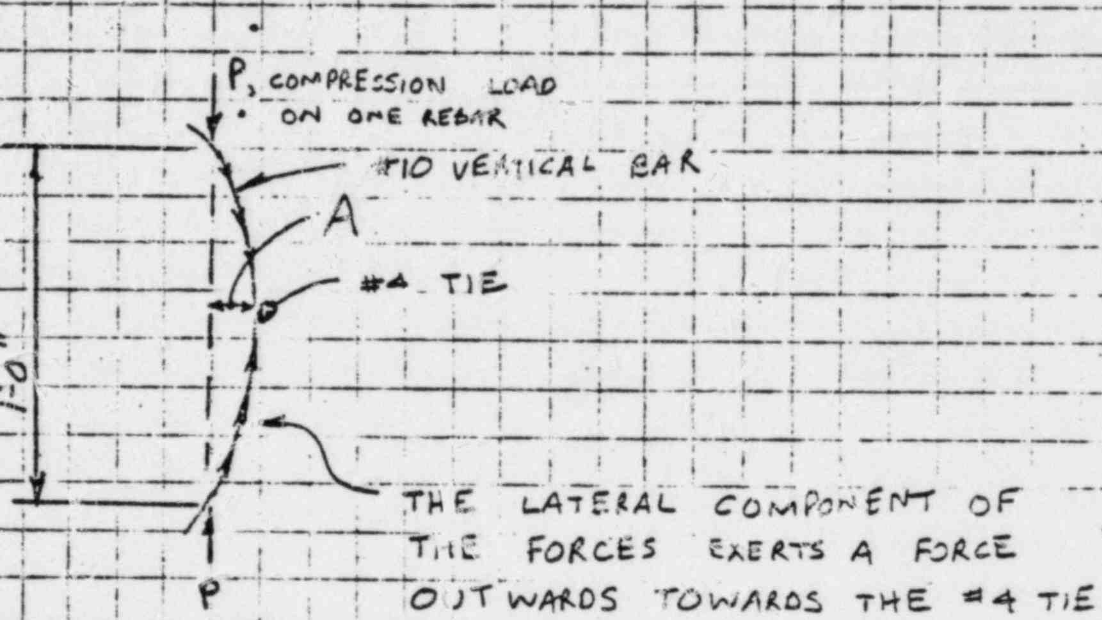
Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		CN 1460
	✓ Safety-Related	Non-Safety-Related	BY HICKS
			PAGE 875E
			FORM NO. 372-30-2650

Client	PSC	Prepared by	[signature]	Date 6-3-83
Project	FORT ST. VRAIN	Reviewed by	[signature]	Date 6-5-83
Proj. No. 6117-32	Equip. No.	Approved by		Date

ITEM #3

FOR REBARS IN COMPRESSION THE CURVATURE OF THE REBAR CAUSES BURSTING FORCES TO APPEAR. FOR A 1'-0" VERTICAL LENGTH:



TO ASSUME THE TIE TAKES ALL OF THE LOAD IS CONSERVATIVE BECAUSE THE CONCRETE WILL RESTRAIN THE VERTICAL BAR TO SOME DEGREE.

CALCULATION OF A DIM.

IN PLAN A 1'-0" VERTICAL SECTION WILL ARC

$$\left(\frac{1'}{39.5'}\right)\frac{[3(31.22)-5.45]''}{124.83''}(360^\circ) = 6.438'$$

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For	
✓ Safety-Related	Non-Safety-Related

CN 1460
BY HICKS
PAGE B76E

FORM NO. 372-30-2650

Client PSC		Prepared by [signature]	Date 3-4-3[illegible]
Project FORT ST. VRAIN		Reviewed by [signature]	Date 3-5-8[illegible]
Proj. No. 6117-32	Equip. No.	Approved by [signature]	Date

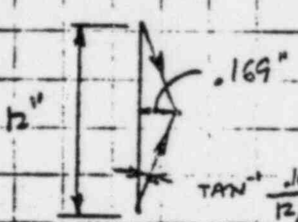
REF. AISC P. 6-18 ✓

$$\text{RISE, } A = \frac{\text{CHORD}}{2} \tan\left(\frac{\text{ARC}}{4}\right)$$ ✓

$$A = \frac{12''}{2} \tan\left(6.438°/4\right)$$ ✓

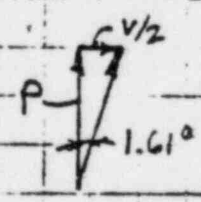
$$A = 0.169''$$

APPROXIMATE LOAD BY:



$$\tan^{-1}\frac{.169}{12/2} = 1.61°$$

V = TOTAL LATERAL LOAD



$$\tan 1.61° = \frac{V/2}{P}$$ ✓

$$V = .0563P$$ ✓

Form GO-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For	CN 1460 BY HICKS PAGE B77E FORM NO. 372-30-2650
	✓ Safety-Related / Non-Safety-Related	

Client	PSC	Prepared by	Date 3-4-83
Project	FORT ST. VRAIN	Reviewed by	Date 3-5-83
Proj. No.	6117-32 Equip. No.	Approved by	Date

TAKE "P" TO BE MAXIMUM POSSIBLE COMPRESSIVE FORCE

MAX. POSSIBLE STRESS = $n \phi f'_c$

$E_c = 57000\sqrt{3500} = 3.37 \times 10^6$ PSI — REF. ACI ~~318-77, SECT. 8.5~~ 318-80 § 8.5.1

$n \phi f'_c = \frac{29 \times 10^6}{3.37 \times 10^6}(.85)(3.5) = 25.6$ KSI

$P = 1.27 \text{ IN}^2 (25.6 \text{ KSI}) = 32.5^K$

$0.0563P = .0563(32.5) = 1.83^K$

TAKE 15 BARS @ 1.83^K. THIS IS VERY CONSERVATIVE BECAUSE WITH THE MOMENT ACTING ON THE SECTION THE MAXIMUM BAR FORCE WOULD NOT ACT ON ALL BARS.

TIE DIAMETER = 41.5"

UNIFORM PRESSURE = $\frac{15(1.83)}{\pi \, 41.5} = 0.211^K$/INCH DIAMETER

FORCE IN TIE = $\frac{1}{2}(41.5")(.211^K/")= 4.38^K$

STRESS IN #4 TIE = $\frac{4.38^K}{.201 \text{ IN}^2} = 21.9$ KSI < 60 KSI

$V_u = 140^K$ MAX.

SHEAR STRESS IN SECTION = $\frac{140{,}000\#}{\pi \, 21^2} = 101$ PSI AT TOP $< 2\sqrt{3500} = 118$ PSI.

SHEAR STRESS IS LOWER AT POINT OF MAXIMUM MOMENT.

#4 TIES ARE NOT REQUIRED FOR SHEAR. 21.9 KSI FOR TIE IS NOT COMBINED WITH SHEAR STRESS, 21.9 < 60 KSI, OK USING A VERY CONSERVATIVE APPROACH.

→ THEREFORE, THE TIES ARE ADEQUATE TO RESIST THE BURSTING FORCES THAT RESULT FROM THE CURVATURE OF COMPRESSION REBAR.

Form GQ-3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For		CN 1460
✓ Safety–Related	Non–Safety–Related	BY HICKS
		PAGE B78E
		FORM NO. 372-30-2650

Client	PSC	Prepared by	L. Hicks	Date 3-3-83
Project	FORT ST. VRAIN	Reviewed by	[illegible]	Date 3-5-83
Proj. No.	6117-32 Equip. No.	Approved by	" " "	Date

CONCLUSION

THE 270° ROTATION OF REINFORCING STEEL WITHIN CAISSON #5 OF BUILDING 10 DOES NOT HAVE ANY SIGNIFICANT EFFECT ON THE STRUCTURAL ADEQUACY OF THE CAISSON. THIS CONCLUSION IS BASED ON CALCULATIONS THAT DEMONSTRATE:

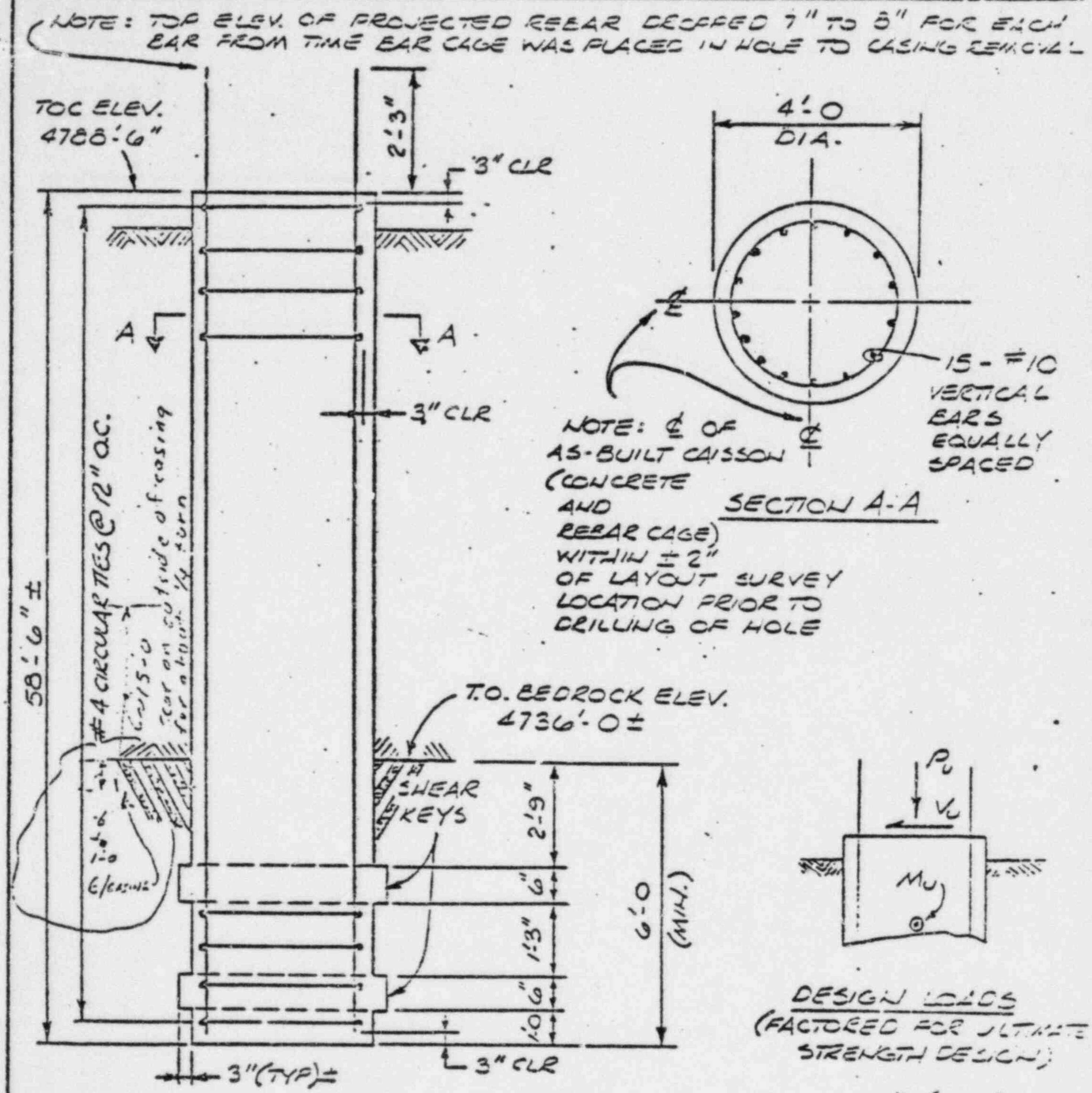
1. THE DIAMETER OF THE REBAR CAGE HAS NOT SIGNIFICANTLY CHANGED.

2. THE EFFECT ON THE CAPACITY OF THE REBARS IN TENSION IS NEGLIGABLE (<2%).

3. ADDITIONAL BURSTING FORCES DUE TO CURVATURE OF REBARS IN COMPRESSION ARE ADEQUATELY RESTRAINED BY THE TIES.

Form GQ-3.05.1 Rev. 2

CALCULATIONS FOR	Client PSC	CN 1460
	Project FORT ST. VRAIN	BY HICKS
PREPARED BY	Proj. No. 6117-32 Equip. No.	PAGE B79E
REVIEWED BY	✓ Safety-Related	FORM NO. 372-30-2650



HORIZ. SHEAR $V_U = 140^k$ (MAX)

VERT. AXIAL $P_U = 940^k \downarrow$ (MAX)

$= 66^k \downarrow$ (MIN)

$M_U = 1025$ FT.-K (MAX.)

(THIS MOMENT FROM OUTPUT OF COMPUTER RUN. MOMENT DUE TO SOIL PRESSURE FROM LOAD V_U)

MATERIALS - CONCRETE: $f'_c = 3500$ PSI

STEEL: GRADE 60

M_U MAX @ 13'-0 [illegible]

CN 1460
BY HICKS
PAGE 880 E
FORM NO. 372-30-2650

MARK FINTEL

1833A WILDBERRY DRIVE

GLENVIEW, IL. 60025

312/998-9822

August 8, 1983

Mr. Robert A. Gunnerson
Supervisor, Nuclear Projects
Public Service Co.
2420 W. 26th Ave., Suite 100D
Denver, Colorado 80211

Dear Mr. Gunnerson

Enclosed is my report on Rotation of Reinforcing Steel in Caisson #5 for Building 10.

It took several times more effort than initially anticipated to solve this seemingly simple problem.

Please let me know if you have some additional questions.

Sincerely,

Mark Fintel

Mark Fintel

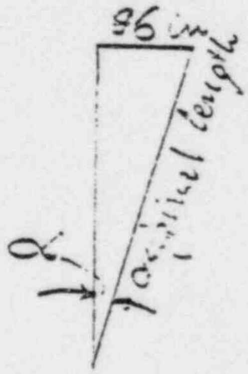
CN 1460
BY Hicks
PAGE 881E
FORM NO. 372-30-2650

MARK FINTEL
1833A Wildberry Drive
Glenview, Il. 60025
312/998-9822

INVESTIGATION OF EFFECTS OF ROTATION OF THE LONGITUDINAL REINFORCING STEEL IN A 58'-6" LONG DRILLED PIER

The longitudinal reinforcing cage consisting of 15 #10 bars distributed along the periphery of the 4'-0" diameter, 58'-6" long drilled pier (Fig. 1) of the Fort St. Vrain plant site has rotated as a unit approximately 270^0 clockwise about the longitudinal axis of the bar cage. This amount of cage rotation of the top relative to the base of the cage was noted by visual observation of the flags attached to some bars, and by measuring a difference of 7" to 8" in the elevations of the tops of the bars before and after casting of the pier.

1. Computation of drop of top of bar elevations to correspond to an assumed cage rotation of 270^0:



Periphery of the bar cage at bar centerlines:

Diameter 48" - 2 x 3" - 1.26" = 40.74 in

Periphery $2\pi r = \pi \times 40.74$ = 428.0 in

Length of periphery corresponding to 270^0

$$128 \frac{270}{360} = 96 \text{ in}$$

Expected drop of top of bar elevation for a horizontal displacement of 96 in along the periphery:

CN 1460
BY HICKS
PAGE B82 E
FORM NO. 372-30-2650

Original length of bar = 58'-6" + 2'-3" = 60'-9" = 729 i

height after rotation = $\sqrt{729^2 - 96^2}$ = 722.6 in.

drop of bar = 729 - 722.6 = 6.4 in.

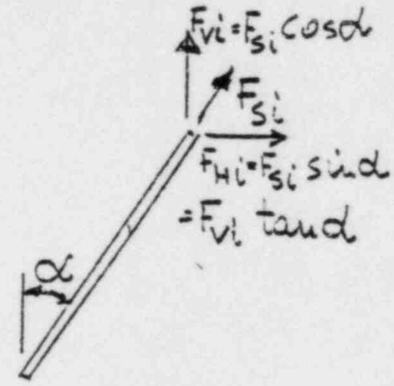
The observed flag rotation of 270^0 correlates reasonably well with the measured drop in the elevation of the tops of the bars. The angle of inclination of the bars from the vertical

$$\sin \alpha = \frac{96}{729} = .13169$$

$$\alpha = 7\tfrac{1}{2}^0$$

$$\cos \alpha = .9912913; \tan \alpha = .1328441$$

2. This angle of bar inclination corresponding to 270^0 cage rotation will be used for computation of the horizontal and vertical components of forces in the reinforcing bars. The individual bars are subjected to compression or tension due to the combined action of axial load and moment. Since the bars are inclined the horizontal component of the force in each bar is $F_{Hi} = F_{si} \times \sin \alpha = F_{vi} \times \tan \alpha$ These horizontal forces cause twisting of the pier. Compressive forces twist the pier clockwise. Tensile forces twist it counterclockwise. The torsional (twisting) moment of the forces in all bars



$$M_T = \sum_{i=1}^{n} F_{Hi} \times r_s$$ (r_s = radius to center of longitudinal reinforcement, n = number of bars)

causes a torsional stress in the pier:

$$\tau = \frac{M_T \times r}{J}$$

$$J = \text{polar moment of inertia} = \frac{\pi . r^4}{2} = \frac{\pi . 24^4}{2} = 521,152 \text{ in}^4$$

According to Section 11.6 of ACI 318-77, if the torsional stress τ due to factored torsional moment is less than $1.5\sqrt{f'_c}$, torsional effects can be neglected.

3. Computation of forces in the bars, torsional moments and torsional stresses.

Two load combinations were investigated:

$$\max P_U = 940 \text{ k}; \quad M_u = 1025 \text{ ft.k.}$$

$$\min P_U = 66 \text{ k}; \quad M_u = 1025 \text{ ft. k.}$$

Determining the forces in the reinforcing bars of the circular pier under either of the load combinations shown above requires the simultaneous solution of two integral equations, as shown in Fig. 2. A direct solution is extremely difficult to achieve. A numerical iterative solution is the logical choice. Such a solution was accomplished with the aid of an HP 9845 computer. The circular geometry was closely approximated by a polygon with 50 sides. For a given axial load, balance of forces was achieved for a number of given values of sectional curvature (ε_{cm}/c). The corresponding bending moments, as given by the moment equilibrium equation, were computed. After two curvature values that yielded moments just smaller than and just larger than the given moment were determined, computations were made for intermediate curvature values until the computed bending moment nearly coincided with the given bending moment on the section. Under both load combinations, both concrete and steel remained within the elastic range. The computer output is enclosed, and illustrates the iterative process of computation.

With the values of neutral axis depth and extreme compression fiber strain, as determined above, the stresses in the various layers of reinforcement were computed as shown in Tables 1 and 2. The horizontal components of forces in the various reinforcement layers were computed from the above stresses. The torsional moments caused by the horizontal forces and the resulting torsional stresses were also calculated as shown in Tables 1 and 2. The torsional stress produced by loading combination 1 is 6.18 psi, while that produced by load combination 2 is 36.09 psi. Both values are well within the allowable limit of $1.5\sqrt{f'_c}$.

CN 1460
BY HICKS
PAGE 884E
FORM NO. 372-30-2650

4. Conclusion:

The torsional stresses of 6.18 psi (clockwise) and 36.09 psi (counterclockwise) for the two load combinations are considerably below the level of $1.5\sqrt{f'_c}$ = 89 psi, thus allowing torsional effects to be neglected according to ACI 318-77. According to the ACI Committee 438 report "Tentative Recommendations for the Design of Reinforced Concrete Members to Resist Torsion", (ACI Journal Proceedings, V. 66, Jan. 1969, pp. 1-8), a torsional stress of $1.5\sqrt{f'_c}$ will not produce significant reduction in ultimate strength in either flexure or shear. Obviously, a stress of 36.0 psi, which is only 40% of that level, should be of no concern.

Mark Ptortel

CALCULATIONS FOR

CALC. NO.

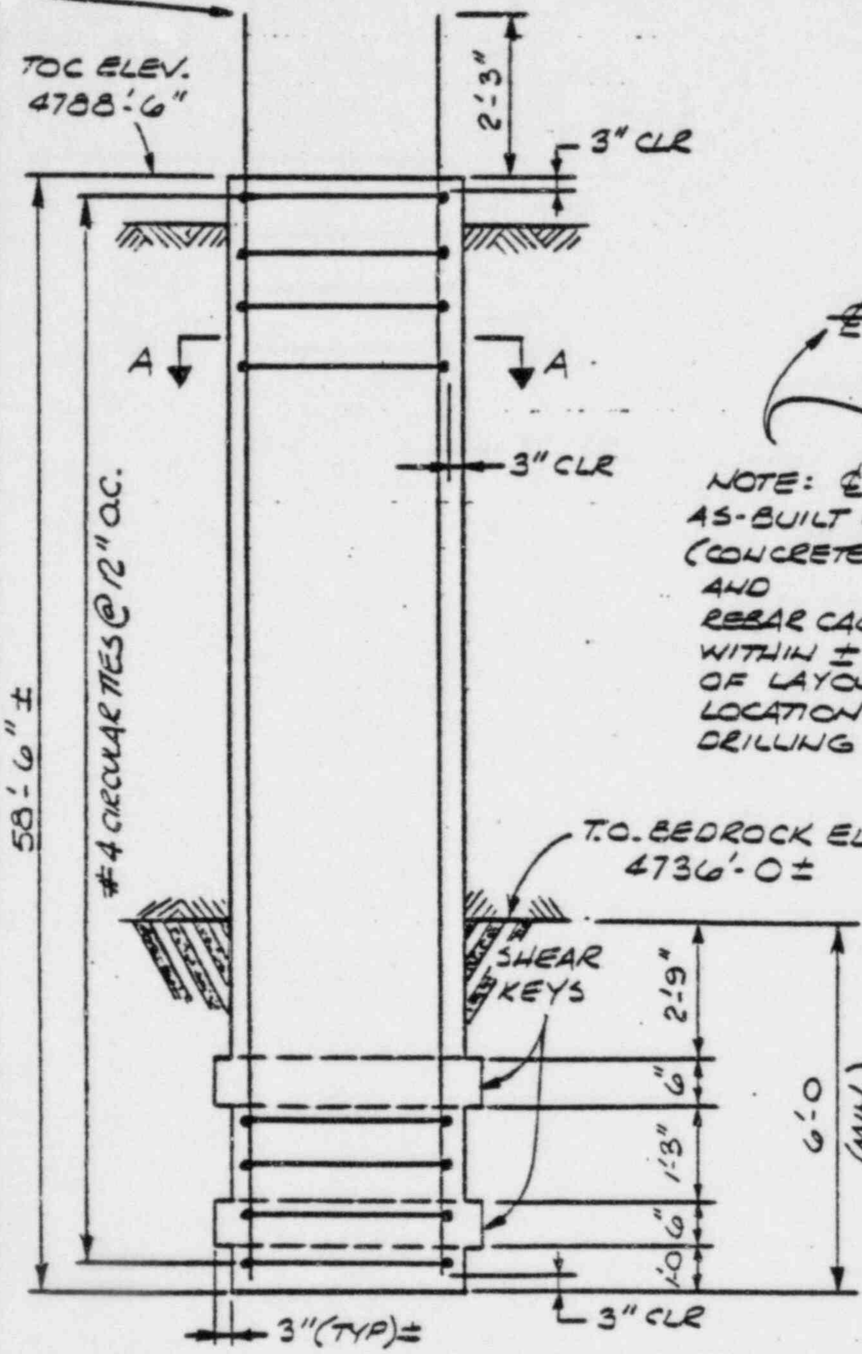
PREPARED BY | DATE

REVIEWED BY | DATE

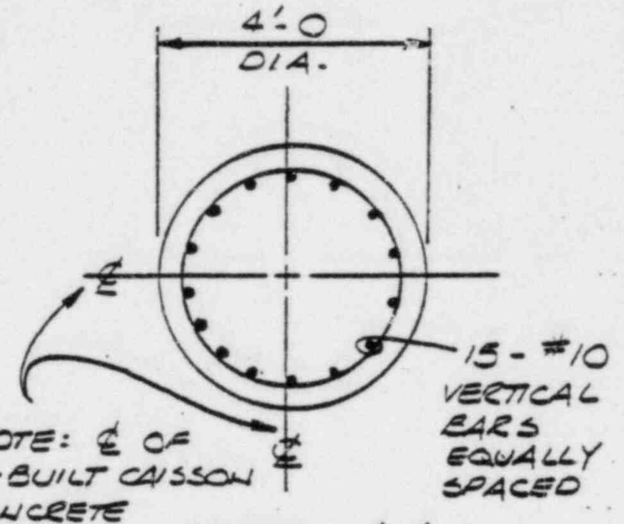
REF. DOCUMENTS:

CN 1460
BY HICKS
PAGE B85E
FORM NO. 372-30-2650

NOTE: TOP ELEV. OF PROJECTED REBAR DROPPED 7" TO 8" FOR EACH BAR FROM TIME BAR CAGE WAS PLACED IN HOLE TO CASING REMOVAL

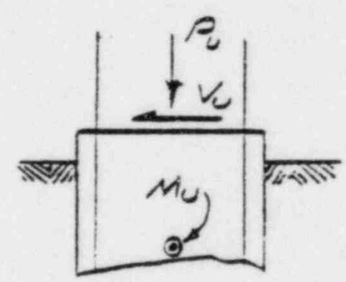


CAISSON SECTION



NOTE: ℄ OF AS-BUILT CAISSON (CONCRETE AND REBAR CAGE) WITHIN ± 2" OF LAYOUT SURVEY LOCATION PRIOR TO DRILLING OF HOLE

SECTION A-A



DESIGN LOADS
(FACTORED FOR ULTIMATE STRENGTH DESIGN)

HORIZ. SHEAR $V_u = 140^k$ (MAX)

VERT. AXIAL $P_u = 940^k \downarrow$ (MAX)

$= 66^k \downarrow$ (MIN)

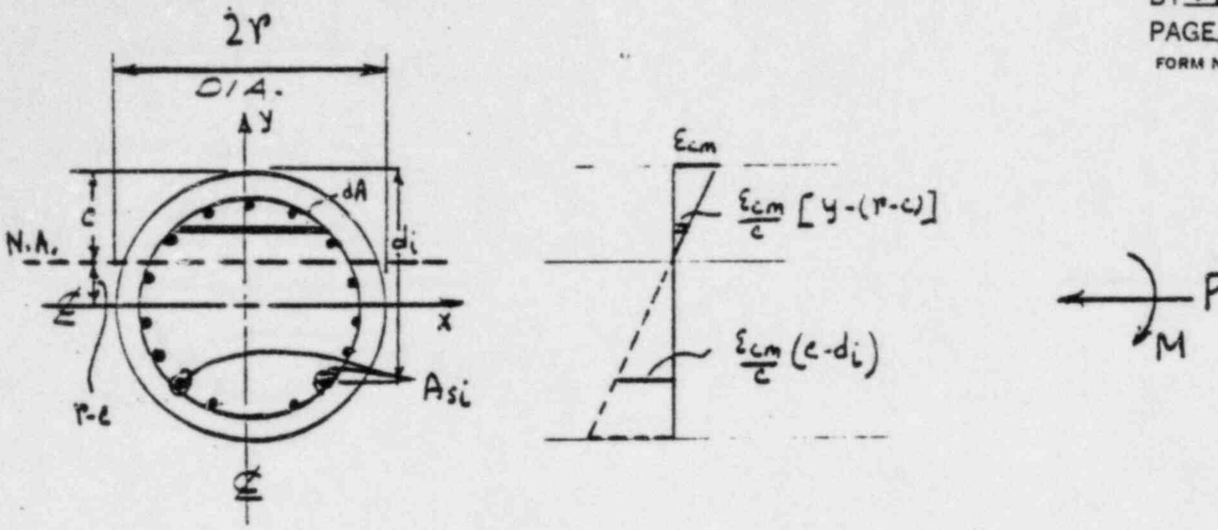
$M_u = 1025$ FT.-K (MAX)

(THIS MOMENT FROM OUTPUT OF COMPUTER RUN, MOMENT DUE TO SOIL PRESSURE FROM LOAD V_u)

MATERIALS - CONCRETE: $f'_c = 3500$ PSI

STEEL: GRADE 60

Fig. 1



$$dA = 2x\,dy = 2\sqrt{r^2-y^2}\,dy$$

$$P = \int_{r-c}^{r} 2\sqrt{r^2-y^2}\,dy \cdot \frac{\varepsilon_{cm}}{c}[y-(r-c)]E_c + \sum_{i=1}^{n}\frac{\varepsilon_{cm}}{c}(c-d_i)E_s A_{si}$$

(n = total no. of reinf. layers)

$$= 2\frac{\varepsilon_{cm}}{c}E_c\left[\int_{r-c}^{r}\sqrt{r^2-y^2}\cdot y\,dy - (r-c)\int_{r-c}^{r}\sqrt{r^2-y^2}\,dy\right] + \frac{\varepsilon_{cm}}{c}E_s\sum_{i=1}^{n}(c-d_i)A_{si}$$

$$M = \int_{r-c}^{r} 2\sqrt{r^2-y^2}\,dy \cdot \frac{\varepsilon_{cm}}{c}[y-(r-c)]E_c \cdot [y-(r-c)] + \sum_{i=1}^{n}\frac{\varepsilon_{cm}}{c}(c-d_i)E_s A_{si}(c-d_i)$$

$$= \frac{2\varepsilon_{cm}E_c}{c}\int_{r-c}^{r}\sqrt{r^2-y^2}\,dy\left[y^2-2y(r-c)+(r-c)^2\right] + \sum_{i=1}^{n}\frac{\varepsilon_{cm}}{c}E_s(c-d_i)^2A_{si}$$

$$= 2\frac{\varepsilon_{cm}}{c}E_c\left[\int_{r-c}^{r}\sqrt{r^2-y^2}\,y^2dy - 2(r-c)\int_{r-c}^{r}\sqrt{r^2-y^2}\,y\,dy + (r-c)^2\int_{r-c}^{r}\sqrt{r^2-y^2}\,dy\right] + \frac{\varepsilon_{cm}}{c}E_s\sum_{i=1}^{n}(c-d_i)^2A_{si}$$

Fig. 2

TABLE 1. Case 1: $P_u = 940$ k, $M_u = 1025$ ft-k

CN 1460
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PAGE B87E
FORM NO. 372-30-2650

$e = 29.81$ in., $\varepsilon_{cm} = 0.000459$

Reinf. Layer, i	Distance from Top, d_i, in.	$c-d_i$, in.	$\sigma_{si} = \frac{c-d_i}{c}\varepsilon_{cm}E_s$ ksi	Area of Reinf. Layer, A_{si}, in.^{2}	Vertical Force in Reinf. Layer $F_{Vi} = A_{si}\sigma_{si}$ kips	Horizontal Force in Reinf. Layer $F_{Hi} = F_{Vi}\tan\alpha$ kips
1	3.6	26.21	11.70	1.27	14.86	1.974
2	5.4	24.41	10.90	2.54	27.69	3.678
3	10.3	19.51	8.71	2.54	22.13	2.940
4	17.7	12.11	5.41	2.54	13.73	1.824
5	26.1	3.71	1.66	2.54	4.21	0.559
6	34.2	-4.39	-1.96	2.54	-4.97	-0.660
7	40.5	-10.69	-4.77	2.54	-12.12	-1.610
8	43.9	-14.09	-6.29	2.54	-15.98	-2.123

$\Sigma F_{Hi} = 6.582$

$M_t = \Sigma F_{Hi} \times r_s$

cover to center of reinf.

$= 6.582 \times (24 - 3.625) = 6.582 \times 20.375$

$= 134.108$ in-kips

$\tau = \frac{M_t \times r}{J} = \frac{134,108 \times 24}{521,152} = 6.18$ psi $< 1.5\sqrt{f_c'} = 89$ psi

TABLE 2. Case 2: $P_u = 66$ k, $M_u = 1025$ ft-k

$c = 12.96$ in. $\varepsilon_{cm} = 0.000616$

Reinf. Layer, i	Distance from Top, d_i, in.	$c-d_i$ in.	$\sigma_{si} = \frac{c-d_i}{c} \varepsilon_{cm} E_s$ ksi	Area of Reinf. Layer A_{si}, in.²	Vertical Force in Reinf. Layer $F_{Vi} = A_{si}\sigma_{si}$ kips	Horizontal Force in Reinf. Layer $F_{Hi} = F_{Vi} \tan\alpha$ kips
1	3.6	9.36	12.90	1.27	16.38	2.176
2	5.4	7.56	10.42	2.54	26.47	3.516
3	10.3	2.66	3.67	2.54	9.31	1.237
4	17.7	-4.74	-6.53	2.54	-16.60	-2.205
5	26.1	-13.14	-18.11	2.54	-46.00	-6.111
6	34.2	-21.24	-29.28	2.54	-74.36	-9.878
7	40.5	-27.54	-37.96	2.54	-96.42	-12.809
8	43.9	-30.94	-42.65	2.54	-108.32	-14.390

$\Sigma F_{Hi} = -38.464$

$M_t = \Sigma F_{Hi} \times r_s$

$= 38.464 \times 20.375 = 783.704$ in.-kips

$\tau = \frac{M_t \times r}{J} = \frac{783{,}704 \times 24}{521{,}152} = 36.09$ psi $< 1.5\sqrt{f_c'}$
$= 89$ psi

CN 1460
BY HICKS
PAGE B89E
FORM NO. 372-30-2650

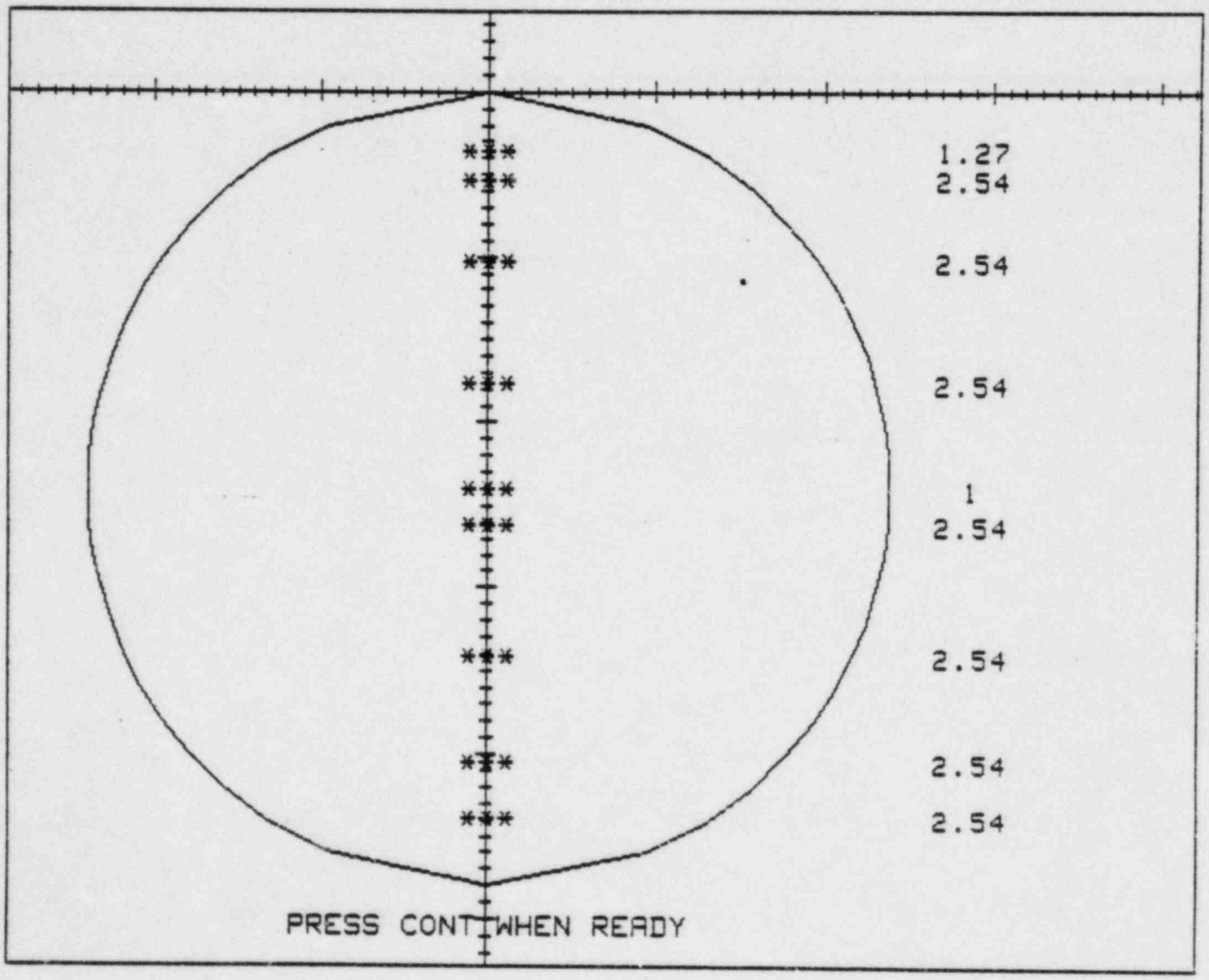
*** CONCRETE ***

WIDTH (IN)	DEPTH (IN)	TYPE
0.000	0.000	1
19.180	2.000	1
26.530	4.000	1
31.750	6.000	1
35.780	8.000	1
38.980	10.000	1
41.570	12.000	1
43.630	14.000	1
45.250	16.000	1
46.470	18.000	1
47.330	20.000	1
47.830	22.000	1
48.000	24.000	1
47.830	26.000	1
47.330	28.000	1
46.470	30.000	1
45.250	32.000	1
43.630	34.000	1
41.570	36.000	1
38.980	38.000	1
35.780	40.000	1
31.750	42.000	1
26.530	44.000	1
19.180	46.000	1
0.000	48.000	1

*** REINFORCEMENT ***

AREA (SQ. IN.)	DEPTH (IN.)	TYPE
1.2700	3.600	2
2.5400	5.400	2
2.5400	10.300	2
2.5400	17.700	2
2.5400	26.100	2
2.5400	34.200	2
2.5400	40.500	2
2.5400	43.900	2
1.0000	24.000	3

CN 1460
BY HICKS
PAGE B90 E
FORM NO. 372-30-2650



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PAGE B 91 E
FORM NO. 372-30-2650

*** MATERIAL STRESS-STRAIN RELATIONSHIPS ***

TYPE 1

STRAIN MILLIONTHS	STRESS PSI
-1000000	-3400
-2000	-3400
-887	-3400
0	0
1000000	0

*** MATERIAL STRESS-STRAIN RELATIONSHIPS ***

TYPE 2

STRAIN MILLIONTHS	STRESS PSI
-1000000	-60000
-2000	-60000
0	0
2000	60000
1000000	60000

*** MATERIAL STRESS-STRAIN RELATIONSHIPS ***

TYPE 3

STRAIN MILLIONTHS	STRESS PSI
-1000000	940000
1000000	940000

CN 1460
BY HICKS
PAGE B92E
FORM NO. 372-30-2650

Case 1: $P_u = 940$ k, $M_u = 1025$ ft-k

********** CROSS SECTION PROPERTIES **********

	TOP STRAIN MILLIONTHS	KD INCHES	MOMENT INCH-LBS	CURVATURE MILLIONTHS	STEEL STRESS PSI
1	-222	55.56	4349601	-4.00	940000
2	-357	35.71	9619751	-10.00	940000
3	-415	31.94	11239148	-13.00	940000
4	-433	30.95	11737544	-14.00	940000
5	-451	30.10	12171798	-15.00	940000
6	-454	30.04	12178763	-15.10	940000
7	-455	29.96	12219986	-15.20	940003
8	-457	29.88	12258100	-15.30	940000
9	-459	29.81	12300131	-15.40	940000
10	-461	29.73	12341741	-15.50	940000
11	-469	29.32	12585266	-16.00	940000
12	-487	28.62	12980456	-17.00	940000
13	-538	26.88	14048610	-20.00	940000
14	-693	23.11	17280681	-30.00	940000
15	-840	21.00	20028717	-40.00	940000
16	-980	19.60	22664966	-50.00	940000
17	-1122	18.69	25018416	-60.00	940000
18	-1416	17.70	28932610	-80.00	940000

CN 1460
BY HICKS
PAGE B 93 E
FORM NO. 372-30-2650

Case 2: $P_u = 66\ k$, $M_u = 1025\ ft\text{-}k$

*********** CROSS SECTION PROPERTIES ***********

	TOP STRAIN MILLIONTHS	KD INCHES	MOMENT INCH-LBS	CURVATURE MILLIONTHS	STEEL STRESS PSI
1	-89	17.76	1970077	-5.00	66000
2	-152	15.2[illegible]	3212367	-10.00	66000
3	-215	14.32	4435081	-15.00	66000
4	-277	13.83	5655682	-20.00	66000
5	-400	13.32	8097576	-30.00	66000
6	-523	13.07	10532215	-40.00	66000
7	-584	12.99	11744152	-45.00	66000
8	-597	12.99	11969934	-46.00	66000
9	-609	12.96	12228691	-47.00	66000
10	-616	12.96	12341932	-47.50	66000
11	-622	12.96	12455173	-48.00	66000
12	-634	12.93	12716134	-49.00	66000
13	-646	12.91	12967029	-50.00	66000
14	-768	12.81	15402333	-60.00	66000
15	-883	12.52	17392388	-70.00	66000
16	-983	12.29	18449834	-80.00	66000

STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

CN 1460
BY TESNER
PAGE 893.1E

A 5010.94 (FRONT)

FORM NO. 372-30-2650

CLIENT & PROJECT	PAGE 1
PUBLIC SERVICE CO. OF COLORADO / 3 ROOM COMPLEX - FORT ST. VRAIN	8

CALCULATION TITLE (Indicative of the Objective):	QA CATEGORY (✓)
CHECK OF CAISSON CAPACITY FOR BUILDING 10	☒ I - NUCLEAR SAFETY RELATED ☐ II ☐ III ☐ ___ OTHER

CALCULATION IDENTIFICATION NUMBER

J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
13569.04	S	C1.9	N/A	N/A

*APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO. OR NEW CALC NO.	SUPERSEDES *CALC. NO. OR REV. NO.	CONFIRMATION *REQUIRED (✓) YES	NO
R.C. STINNETT R.C. Stinnett 7-14-83	C. M. DeFrice [signature] 7-14-83	TL TURNOCK Terry L. Turnock 7-14-83	0			✓

DISTRIBUTION *

GROUP	NAME & LOCATION	COPY SENT (✓)	GROUP	NAME & LOCATION	COPY SENT (✓)
RECORDS MGT. FILES (OR FIRE FILE IF NONE)					

CN 1460
BY TESNER
PAGE 893.2 E
FORM NO. 372-30-2650

CALCULATION SHEET

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	
13569.04 - SC1.9	0	2

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
R. Stinnott / 7-14-83	NOTED C.M. DE FRIEZ JUL 14 1983	TL TURNOCK 7.14.83

SUBJECT/TITLE	QA CATEGORY / CODE CLASS
Check of Caisson Capacity	I

TABLE OF CONTENTS AND HISTORIC DATA
(Revisions, Additions, Deletions, Etc.)

PAGE NO.	DESCRIPTION	ORIG. REVIEW	REVISION NO.	REVISION DATE	REMARKS
1	Title Page				
2	Table of Contents				
3	Calculation Summary				
4-5	Moment Capacity neglecting Concrete Strength				
6-8	Moment Capacity including Concrete Strength				

CALCULATION SUMMARY

A5010.62

STONE & WEBSTER ENGINEERING CORPORATION

J.O./W.O./CALCULATION NO.	REVISION	
13569.04 - SC1.9	0	CN 1460 / BY TESNER
CLIENT/PROJECT	**QA CATEGORY**	PAGE 898.3E
PUBLIC SERVICE CO. OF COLORADO / 3 ROOM COMPLEX FOR FORT ST. VRAIN	I	FORM NO. 372-30-2650

SUBJECT/TITLE

CHECK OF CAISSON CAPACITY

OBJECTIVE OF CALCULATION

To determine the moment carrying capacity of the 4' caissons, and to determine the reserve capacity for the caissons.

CALCULATION METHOD/ASSUMPTIONS

Basic statics are employed to find the cassion's capacity using the "strain compatibility" method. Assumptions concerning the ultimate stresses and strains are given in ACI 318-77, Sec. 10.2.

SOURCES OF DATA/EQUATIONS

SWEC Calc. 13569.04-S-C1.7 (Rev. 0)
SWEC Dwg. 13569.04-FY-1A-0
ACI 318-77 Building Code
Reinforced Concrete Design, 2nd Ed., by Wang & Salmon, 1973.

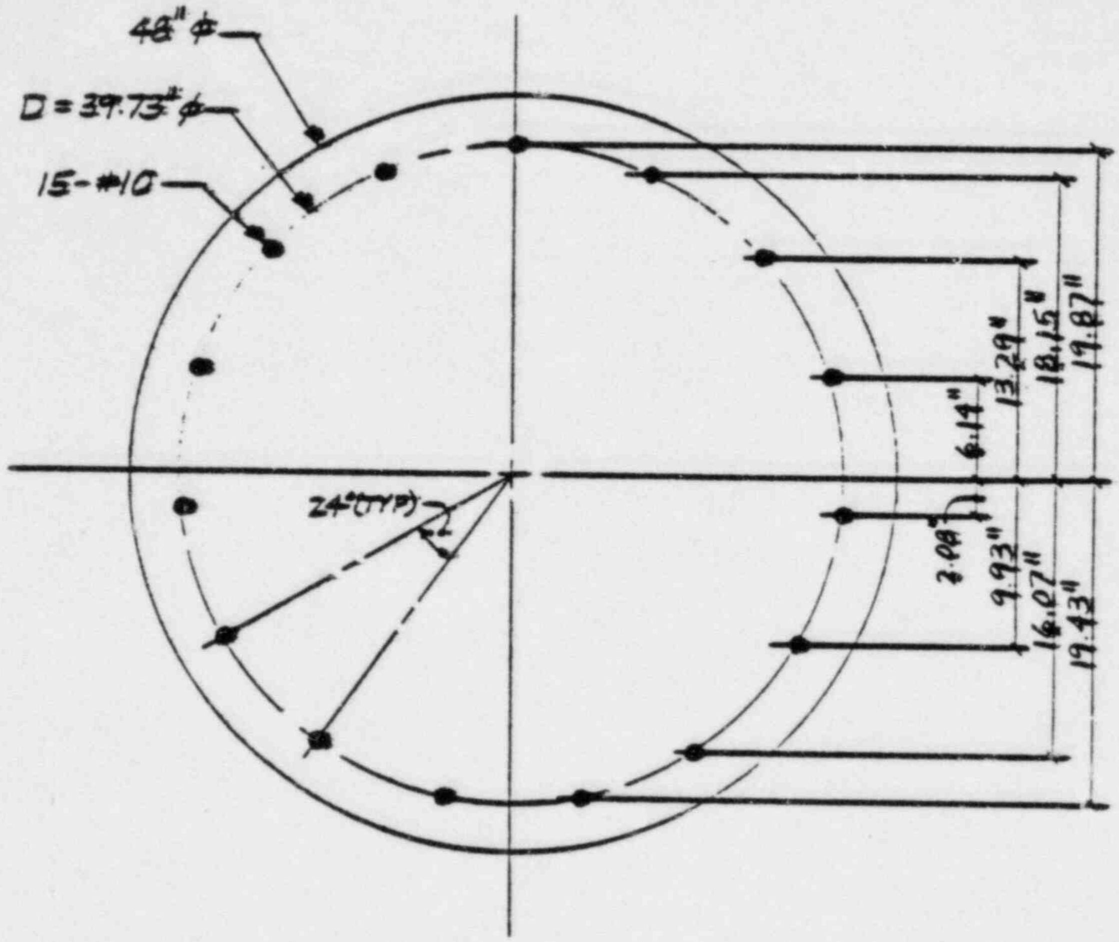
CONCLUSIONS

The capacity of the 4' caissons was found to be $M_u = 1560^{k'}$ when $P_u = 0^k$.

REVIEWER(S) COMMENTS		
	PREPARER R. Stinnett	**DATE** 7-14-83
	REVIEWER/CHECKER NOTED C.A. DEFRIEZ JUL 14 1983	**DATE**
	INDEPENDENT REVIEWER T L TURNOCK	**DATE** 7-14-83

CAISSON REINFORCEMENT

$D = 48 - 2 \times \text{clearance} - 2 \times \text{tie dia.} - d_b = 48 - 2(3) - 2(0.5) - 1.27 = 39.73''$



CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION	
13569.04 - SC 1.9		CN 1460

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R. Stinnett / 7-13-83	NOTED C.M. DE FRIEZ JUL 14 1983	T.L. TUCK	BY TESNER

PAGE 893.5E

SUBJECT / TITLE	QA CATE
Caisson Crack	I

FORM NO. 372-30-2650

STRESSES IN RESTEEL NEGLECTING CONCRETE

Calculate max. stress in the resteel neglecting the strength of the concrete. Assume the concrete and ties prevent any buckling of the bars.

$$I_{STEEL} = \Sigma A d^2$$

$$I_{STEEL} = 1.27\{19.87^2 + 2(19.43)^2 + 2(18.15)^2 + 2(16.07)^2 + 2(13.29)^2 + 2(9.93)^2 + 2(6.14)^2 + 2(2.08)^2\}$$

$$I_{STEEL} = 3759 \text{ in}^4$$

$$c = \frac{39.73}{2} = 19.86''$$

$M_u = 1025^{k'} = 12,300^{k''}$ [REF: SWEC Calc. 13569.04-S-C1.7 (Rev. 0)]

$$f_{max} = \frac{M_u c}{I_{STEEL}} = \frac{12,300(19.86)}{3759} = 64.98 \text{ ksi}$$

$f_{max} = 64.98 \text{ ksi} > f_y = 60 \text{ ksi}$ N.G.

$\therefore$ MUST CONSIDER CONCRETE STRENGTH

CALCULATION SHEET

J.O./W.O./CALCULATION NO.	REVISION
13569.04 - SC1.9	

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT RE
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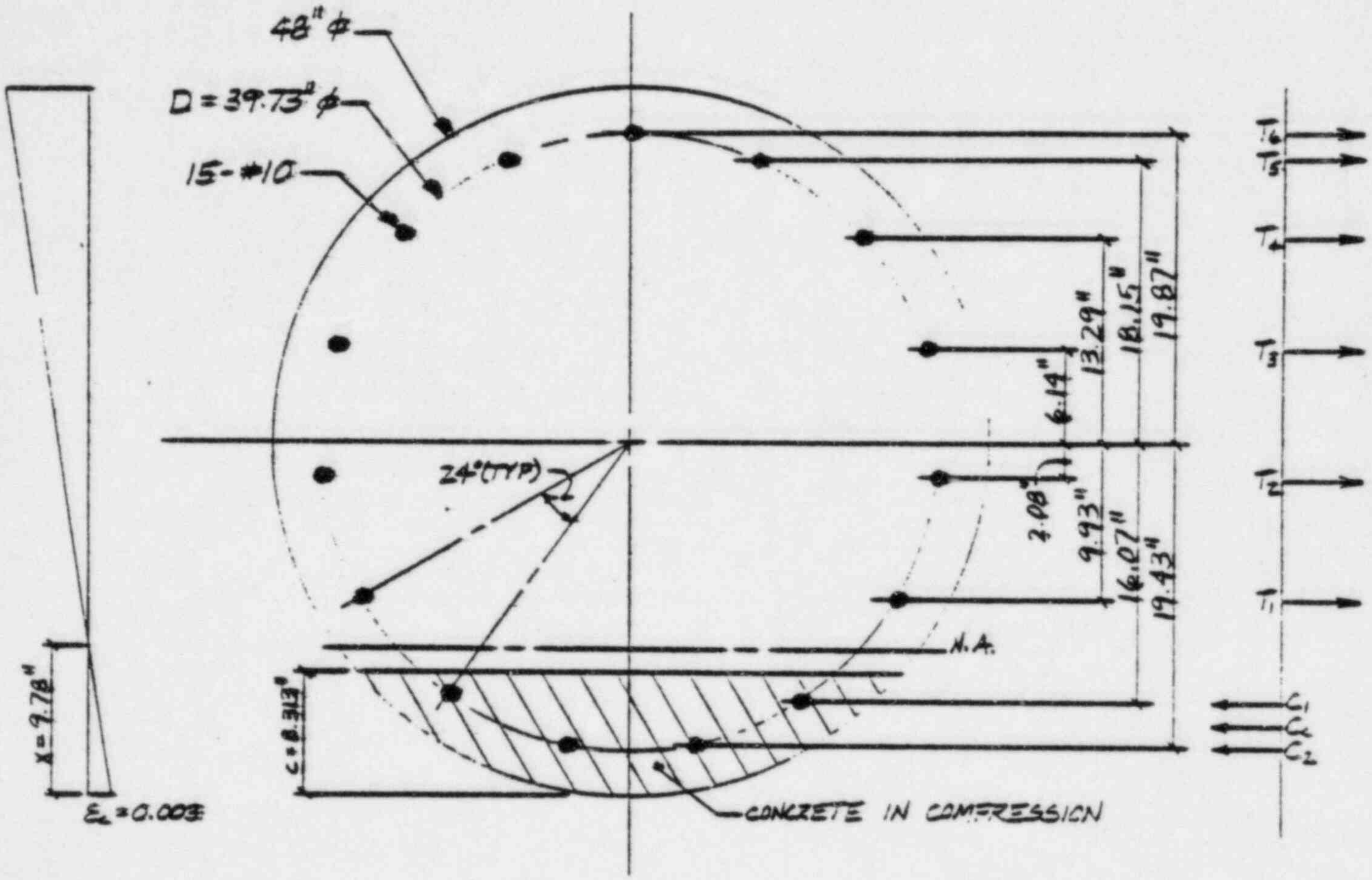
SUBJECT/TITLE	QA CATEG
Caisson Check	I

CN 1460
BY TESNER
PAGE 893.6E
FORM NO. 372-30-2650

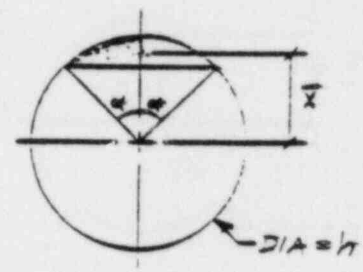
CAISSON REINFORCEMENT - ULTIMATE STRAINS & STRESSES

$D = 48 - 2\times\text{clearance} - 2\times\text{tie dia.} - d_b = 48 - 2(3) - 2(0.5) - 1.27 = 39.73''$



ULTIMATE MOMENT CAPACITY ($P_u = 0^k$)

[REF: Reinforced Concrete Design, 2nd Ed., p. 412]



A = Area of Segment $= \frac{h^2}{4}[\alpha - \sin\alpha \cos\alpha]$

M = First Moment of Area $= \frac{h^3}{12}[\sin^3 \alpha]$

$\bar{x}$ = Centroidal Distance $= \frac{M}{A}$

Assume $x = 9.78''$. (Determined by trial and error.)

$c = \beta_1 x = 0.85(9.78) = 8.313''$

$\alpha = \cos^{-1}\left[\frac{24 - 8.313}{24}\right] = 0.858$ rad.

$A = \frac{48^2}{4}[0.858 - \sin 0.858 \cos 0.858] = 209.5\ in^2$

$M = \frac{48^3}{12}[\sin^3 0.858] = 3995\ in^3$

$\bar{x} = \frac{3995}{209.5} = 19.07''$

$C_c = 0.85 f'_c A = 0.85(3.5)(209.5) = 623.3^k$

$\varepsilon_y = \frac{f_y}{E_s} = \frac{60}{29{,}000} = 0.00207$ (Yield Strain for Steel)

Force	ε_s	Does Steel Yield?	$f_s = \varepsilon_s E_s \leq 60ksi$	A_b	$F = f_s A_b$	Arm	F x Arm
T_1	.00132	No	38.16	2.54	96.9	4.29	416
T_2	.00372	Yes	60.00	2.54	152.4	12.14	1850
T_3	.00625	Yes	60.00	2.54	152.4	20.36	3103
T_4	.00844	Yes	60.00	2.54	152.4	27.51	4193
T_5	.00993	Yes	60.00	2.54	152.4	32.37	4933
T_6	.01046	Yes	60.00	1.27	76.2	34.09	2598
C_1	.00057	No	16.46	2.54	-41.8	1.85	77
C_2	.00160	No	46.35	2.54	-117.7	5.21	613
C_c	—	—	—	—	-623.3	4.85	3023
					-0.1^k		$20{,}806^k$

$P_n = \Sigma F \approx 0^k$ (As assumed.) $\longrightarrow P_u = \phi P_n = 0^k$

$M_n = \Sigma(F \times Arm) = 20{,}806^{k''} = 1734^{k'} \longrightarrow M_u = \phi M_n = 0.9(1734) = 1560^{k'}$

$M_u = 1560^{k'}$ (for $P_u = 0^k$)

CALCULATION SHEET

A5010.61

J.O./W.O./CALCULATION NO.	REVISION
13569.04 - SC1.9	

CN 1460
BY TESNER
PAGE 893.8E
FORM NO. 372-30-2650

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R. Stinnett / 7-14-83	NOTED C.M. DE FRUEZ JUL 14 1983	T L Turn

SUBJECT / TITLE	QA CATEG
Caisson Check	I

COMPARISON OF ACTUAL LOADS WITH CALCULATED CAPACITIES

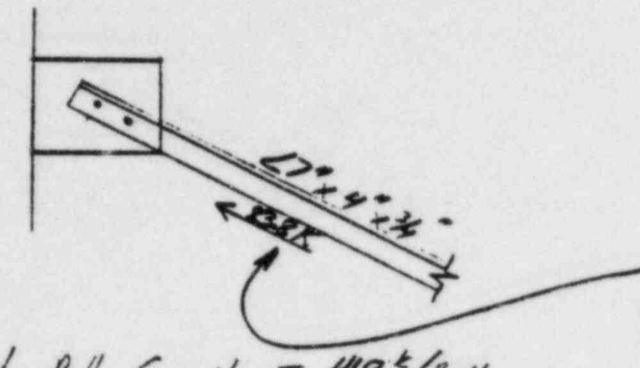
$(M_u)_{ACTUAL} = 1025^{k'}$ [REF: SWEC Calc. 13569.04-S-C1.7 (Rev. 0)]

$(M_u)_{CAPACITY} = 1560^{k'}$

Reserve Moment Capacity $= 535^{k'}$ (34%)

Connections — [illegible]

A) Diagonal bracing in X-Y Plane, Connection to Column Gusset Pl.



MAXIMUM AXIAL LOAD IN TRUSS MEMBERS T1/T2/T9/T10 (REF: STRUDL McAUTO RUN DATED 2/15/83, TIME 09:44:43) *got*

Req'd Bolt Capacity = 41.9^k/Bolt

∴ Use 1" Φ Bolts

F_v all = 47.1^k > 41.5^k (AISC Table 1-D)

Check Bearing: $R_B = 1.5 F_u D t$
$= 1.5(70)(1)(5/8)$
$= 65.6^k > 41.5^k$

F_u = 58 KSI FOR A-36 Pl SEE BELOW

O.k. *got*

Min. Edge Dist. = 1¼" (AISC TABLE 1.16.5.1, 8TH EDITION)

NOTES:

1) ALL CHECKS OF BOLTED CONNECTIONS BASED ON USE OF A-325 BOLT MATERIAL IN BEARING-TYPE CONNECTION WITH THREADS EXCLUDED FROM SHEAR PLANE.
2) SINCE DIAGONAL COLUMN BRACING CONSISTS OF BACK-TO-BACK ANGLES SEPARATED BY A 5/8 IN. THICK GUSSET PLATE, SHEAR ALLOWABLES (F_V ALL.) LISTED ARE FOR DOUBLE SHEAR PLANE CONDITION.
3) FOR ALL DIMENSIONAL DATA REFER TO NORTHERN STEEL DRAWINGS E-4441-1, E-4441-2, E-4441-3 AND E-4441-4.

CHECK BEARING: $R_B = 1.5 F_U D t$
$= (1.5)(58\,KSI)(1.0\,IN)(5/8\,IN) = 54.4^k > 41.9^k$ OK

BEARING STRESS ON ANGLES IS MUCH LOWER, THEREFORE BEARING ON GUSSET GOVERNS

CHECK EDGE DISTANCE [AISC 1.16.5.2]
FOR GUSSET: $L_e = \frac{2P}{F_U t} = \frac{(2)(41.9^k)}{(58\,KSI)(5/8\,IN)} = 2.3$ IN. SEE EVALUATION NEXT PAGE

CHECK CENTER-TO-CENTER SPACING [AISC 1.16.4.2]
$L_e' = L_e + d/2 = 2.3 + 1\,IN/2 = 2.8$ IN; ACTUAL 3 IN OK

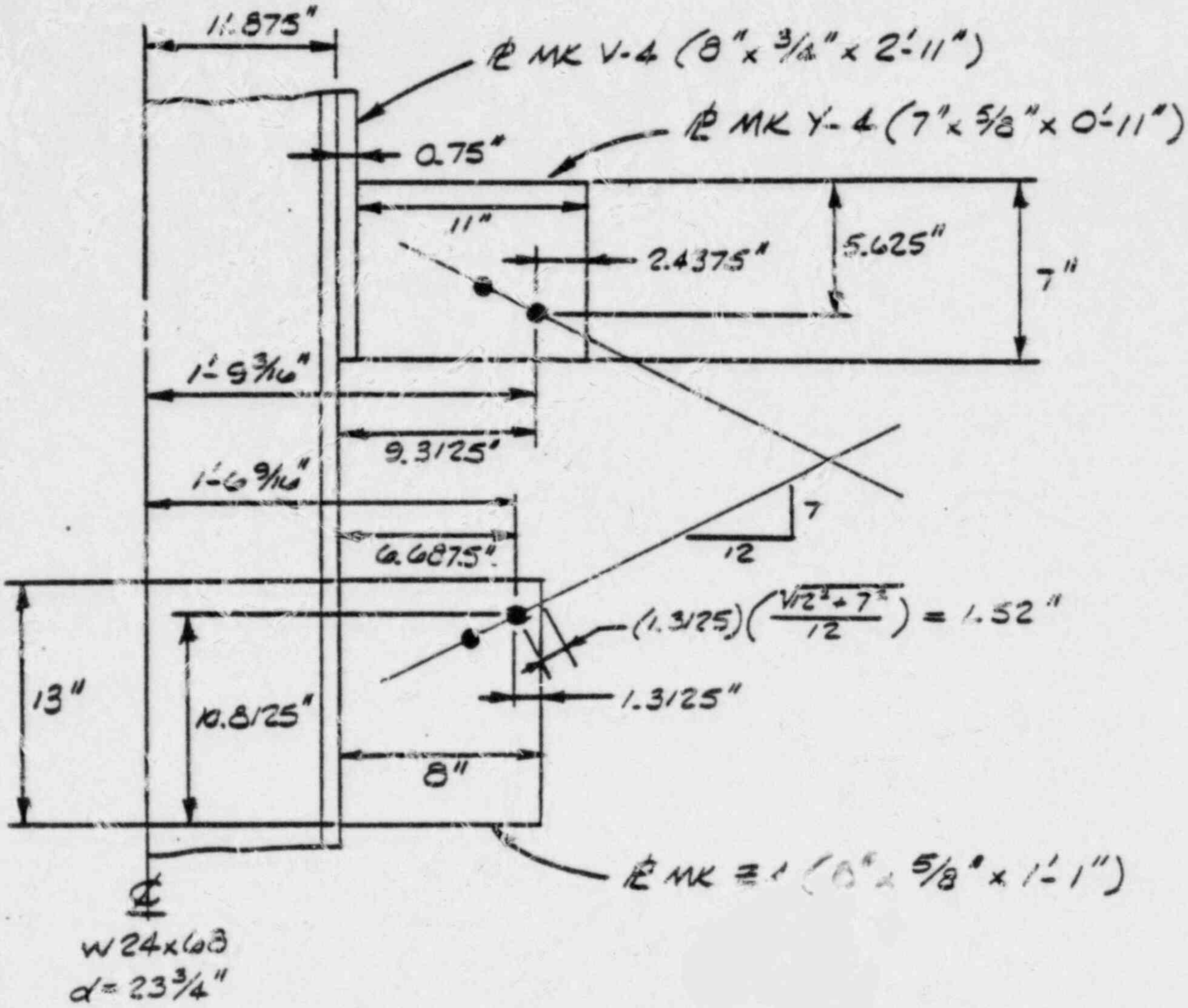
got

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

CN 1460
BY TESNER
PAGE 895E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/9/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF



GUSSETS FOR 2∠7 x 4 x 3/4

REQUIRED EDGE DISTANCE = 2.3 INCHES

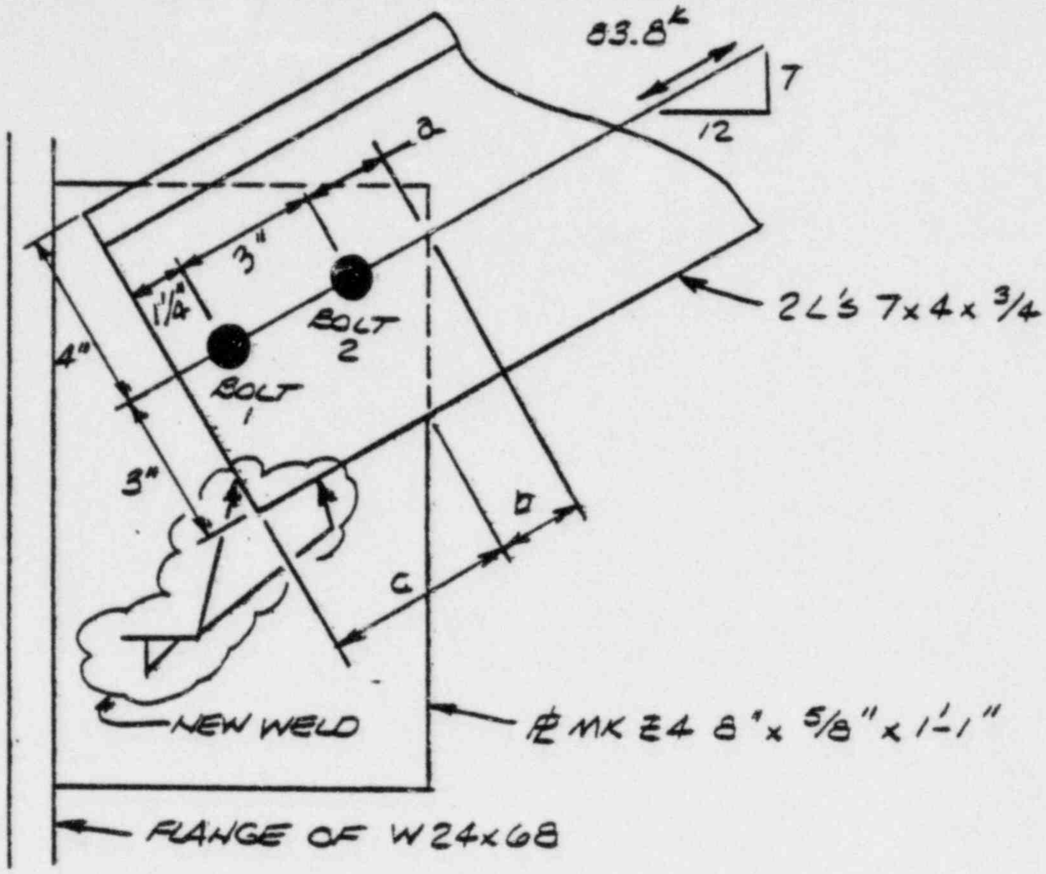
A. FOR PLATE MARK Y-4 ACTUAL EDGE DISTANCE IS APPROXIMATELY 2.44 IN > 2.3 IN. OK

B. FOR PLATE MARK Z-4 AVERAGE EDGE DISTANCE IS APPROX. 1.52 IN < 2.3 IN - REINFORCE CONNECTION WITH FILLET WELDS (SEE NEXT 3 PAGES)

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

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/14/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF



$a = 1.52$ in. (PREVIOUS PAGE)
$b = (3\text{ in})(7/12) = 1.75\text{ in}$
$c = (1.25 + 3) - (1.75 - 1.52) = 4.02\text{ in}$ SAY 4 in

CHECK EDGE DISTANCE ON ANGLES FOR BOLT 1:

$$L_e = \left(\frac{2P}{F_u t}\right)\left(\frac{1}{2}\right)^* = \frac{41.9^k}{(58\text{ ksi})(3/4\text{ in})} = 0.96\text{ in} < 1.25\text{ in OK}$$

MAXIMUM LOAD ON BOLT 2 IS GOVERNED BY TEAR OUT OF GUSSET PLATE:

$$P = \frac{(L_{ACT})(F_u)(t)}{2} = \frac{(1.52\text{ in})(58\text{ ksi})(5/8\text{ in})}{2} = 27.6^k$$

* BOLT LOAD IS DISTRIBUTED TO TWO ANGLES OF EQUAL EDGE DISTANCE

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

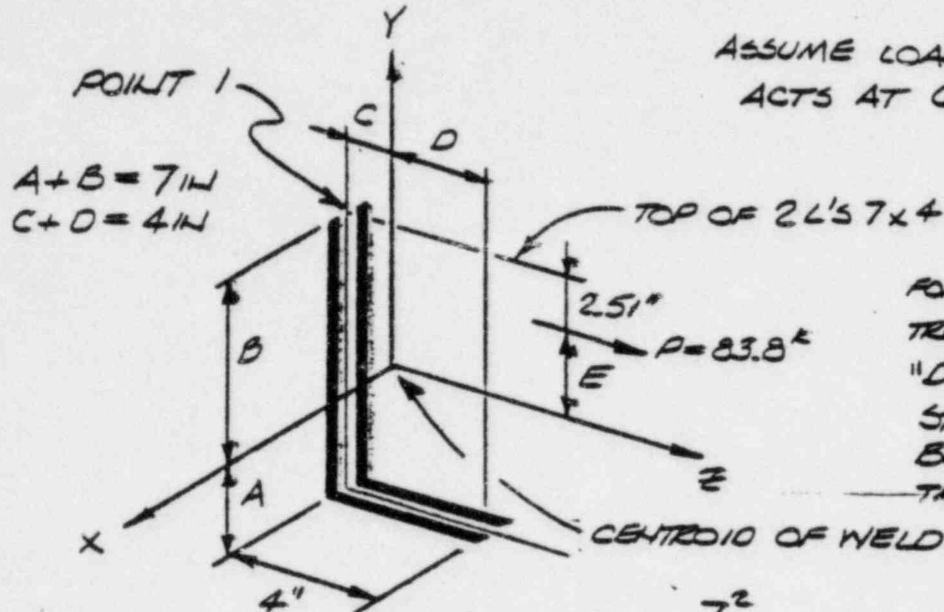
CN 1460
BY TESNER
PAGE 895.2 E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/14/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF

TRY TO DESIGN WELD AT CONNECTION TO CARRY TOTAL LOAD

ASSUME LOAD IN 2∠'S 7x4x3/4 ACTS AT CENTROID OF SECTION



FOR PROPERTIES OF WELD TREATED AS A LINE, SEE "DESIGN OF WELDED STRUCTURES" BY O.W. BLODGETT, PAGE 7.4-7, TABLE 5.

$A = \frac{7^2}{2(7+4)} = 2.23$ IN

$L_w = (2)(7+4)$
$= 22$ IN

$B = 7 - A = 7 - 2.23 = 4.77$ IN

$J_w = \left[\frac{(b+d)^4 - 6b^2d^2}{12(b+d)}\right](2)^*$

$C = \frac{4^2}{2(4+7)} = 0.73$ IN

$= \left[\frac{(4+7)^4 - 6(4^2)(7^2)}{12(4+7)}\right](2)$

$D = 4 - C = 4 - 0.73 = 3.27$ IN

$= \left[\frac{14641 - 4704}{132}\right](2)$

$E = B - 2.51 = 4.77 - 2.51 = 2.26$ IN

$= 150.6\ IN^3$

* DOUBLED FOR WELD ON EACH ∠7x4

REACTIONS ON WELD:

$F_z = 83.8^k$
$M_x = (83.8^k)(2.26\ IN) = 189$ IN-K

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

CN 1460
BY TESNER
PAGE 895.3 E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/14/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF

STRESS IN WELD = MAXIMUM STRESS OCCURS AT TIP POINT 1

$$f_{w_x} = 0$$

$$f_{w_Y} = \frac{(M_x)(C)}{J_w} = \frac{(189\text{ IN-K})(0.73\text{ IN})}{150.6\text{ IN}^3} = 0.92\text{ KIPS/IN}$$

$$f_{w_Z} = \frac{(M_x)(B)}{J_w} + \frac{F_Z}{L_W} = \frac{(189\text{ IN-K})(4.77\text{ IN})}{150.6\text{ IN}^3} + \frac{83.8^k}{22\text{ IN}}$$

$$= 5.99 + 3.81 = 9.80\text{ KIPS/IN}$$

$$f_{w_{RES}} = \sqrt{(0.92)^2 + (9.80)^2} = 9.84\text{ KIPS/IN}$$

LOAD IN TRUSS MEMBERS T1/T2/T9/T10 FROM STRUDL MCAUTO RUN DATED 2/15/83 (TIME 09:44:43) =

LOAD CASE 1 (WIND LOAD) = 81.8^k MAX
LOAD CASE 2 (DL + LL) = 1.9^k MAX
LOAD COMB. 3 (LC1 + LC2) = 83.8^k MAX

SINCE APPROX. 98% OF STRESS IS DUE TO WIND, INCREASE ALLOWABLE STRESS BY 1/3 PER AISC SECT. 1.5.6.

ALLOW. STRESS ON WELD THROAT = (0.3)(70 KSI)(4/3)
= 28 KSI [E70 ELECTRODE]

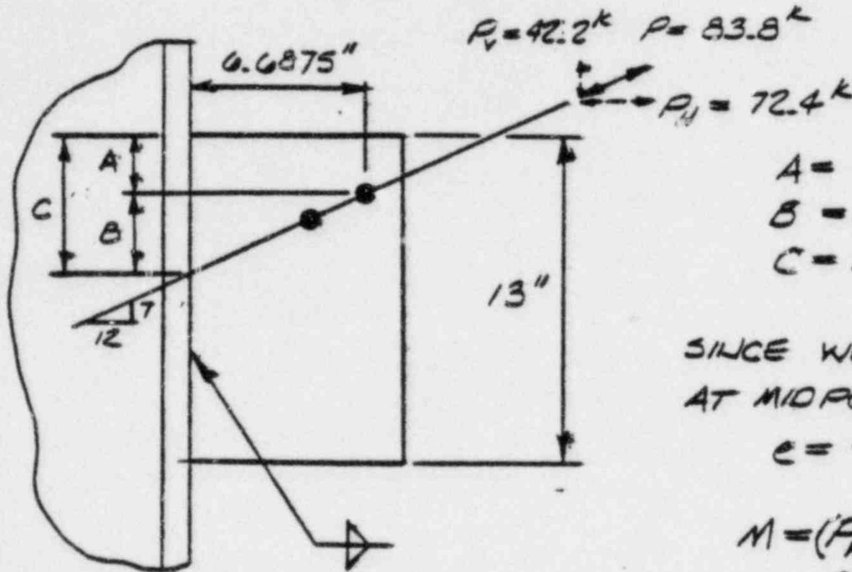
ALLOW. STRESS ON BASE METAL = (0.4)(36 KSI)(4/3)/0.707
= 27.2 KSI [A36 STEEL, STRESS CALCULATED ON WELD THROAT AREA]

$$\sigma_w = \frac{f_{w_{RES}}}{0.707t} ; \quad t = \frac{f_{w_{RES}}}{(0.707)(\sigma_{w_{ALL}})} = \frac{9.84\text{ KIPS/IN}}{(0.707)(27.2\text{ KSI})} = 0.51\text{ IN}$$

SPECIFY 1/2" FILLET, BOLTS PROVIDE ADDED FACTOR OF SAFETY FOR CONNECTION.

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY TESNER	DATE 9/14/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

CHECK WELD ON GUSSET ℄ Z4 TO COLUMN FLANGE



$A = 2.1875$ IN
$B = (6.6875)(7/12) = 3.90$ IN
$C = A + B = 6.09$ IN

SINCE WELD CENTROID IS LOCATED AT MIDPOINT OF PLATE DEPTH,

$e = \frac{13}{2} - 6.09 = 0.41$ IN

$M = (P_H)(e) = (72.4^k)(0.41\text{IN})$
$= 29.7$ IN-K

WELD PROPERTIES: $L_W = (2)(13\text{IN}) = 26\text{IN}$

$S_W = \frac{(13\text{IN})^2}{3} = 56.33\text{IN}^2$

STRESS IN WELD: $f_{WH} = \frac{P_H}{L_W} + \frac{M}{S_W} = \frac{72.4^k}{26\text{IN}} + \frac{29.7\text{IN-K}}{56.33\text{IN}^2}$

$= 2.79 + 0.53 = 3.32$ KIPS/IN

$f_{WV} = \frac{P_V}{L_W} = \frac{42.2^k}{26\text{IN}} = 1.62$ KIPS/IN

$f_{WRES} = \sqrt{(3.32)^2 + (1.62)^2} = 3.69$ KIPS/IN

$t = \frac{f_{WRES}}{(0.707)(\sigma_{ALL.})} = \frac{3.69\text{KIPS/IN}}{(0.707)(27.2\text{KSI})} = 0.19$ IN   3/8" FILLET BOTH SIDES OK

CHECK PLATE STRESS: $A_{net} = 0.85 A_{gross}$ [AISC 1.14.2.3]
$= (0.85)(13\text{IN})(0.625\text{IN}) = 6.91$ SQ IN

TENSION (AXIAL) $\sigma = \frac{72.4^k}{6.91\text{SQIN}} = 10.5$ KSI $< 0.60F_Y$ [AISC 1.5.1.1] CONSERVATIVE

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY TESNER	DATE 9/14/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

CHECK PLATE STRESS (CONT'D)

SHEAR – $\tau = \frac{(42.2^k)(0.85)}{6.91 \text{ SQ IN}} = 5.2 \text{ KSI} < 0.40 F_Y$ [AISC 1.5.1.2.1]

COMPRESSION (AXIAL) – $\sigma = \frac{72.4^k}{(13\text{IN})(0.625\text{IN})} = 8.91 \text{ KSI}$

ALLOWABLE STRESS (AXIAL COMPRESSION)

$k = 2.1 \quad l = 8 \text{ IN (CONSV.)}$

$I = \frac{(13\text{IN})(0.625\text{IN})^3}{12} = 0.264 \text{ IN}^4$

$A = (13\text{IN})(0.625\text{IN}) = 8.125 \text{ SQ IN}$

$r = \sqrt{I/A} = \sqrt{0.264/8.125} = 0.180 \text{ IN}$

$\frac{kl}{r} = \frac{(2.1)(8\text{IN})}{0.180\text{IN}} = 93.3 \qquad F_a = 13.8 \text{ KSI FOR A-36}$

$F_a' = 1.67 F_a = 23 \text{ KSI}$ [DC-70 TABLE 70.4] OK

BENDING – $M = 29.7 \text{ IN-K} \qquad S = \frac{(0.625\text{IN})(13\text{IN})^2}{6} = 17.6 \text{ IN}^3$

$\sigma = \frac{M}{S} = \frac{29.7 \text{ IN-K}}{17.6 \text{ IN}^3} = 1.7 \text{ KSI}$

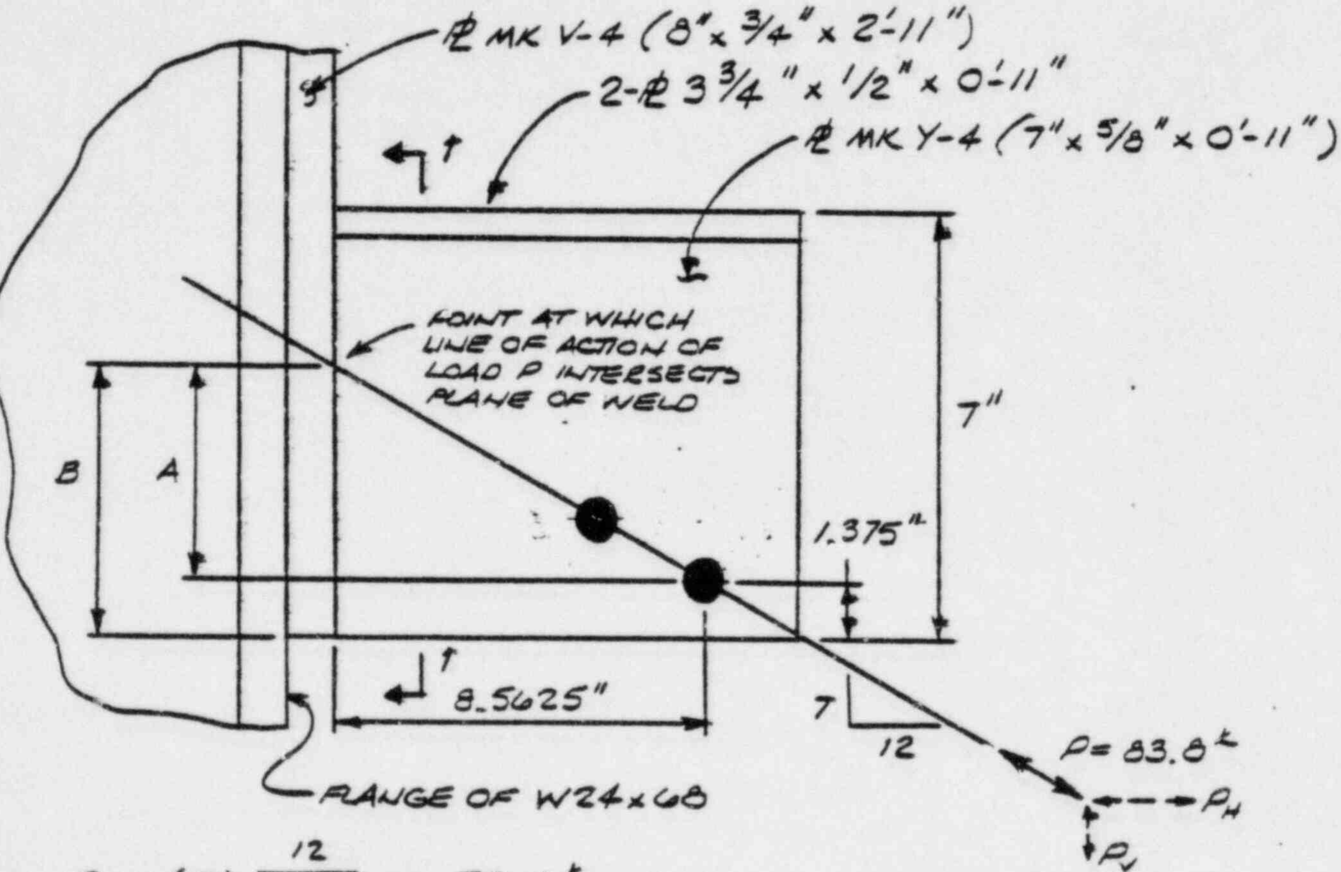
AXIAL COMPRESSION AND BENDING STRESSES ARE SUFFICIENTLY SMALL TO PRECLUDE ANY BUCKLING OF PLATE

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY TESNER	DATE 9/14/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

BY INSPECTION (LARGE LOAD AND HIGH ECCENTRICITY) 5/8" x 7" PL CROSS-SECTION WELDED ON BOTH SIDES OF 7" EDGE WITH 3/8" FILLET IS INADEQUATE. TRY THE FOLLOWING FIX.

EVALUATE WELDS AT GUSSET PL Y-4 TO SPLICE PL V-4 (COLUMN)



$$P_H = (P)\frac{12}{\sqrt{12^2+7^2}} = 72.4^k$$

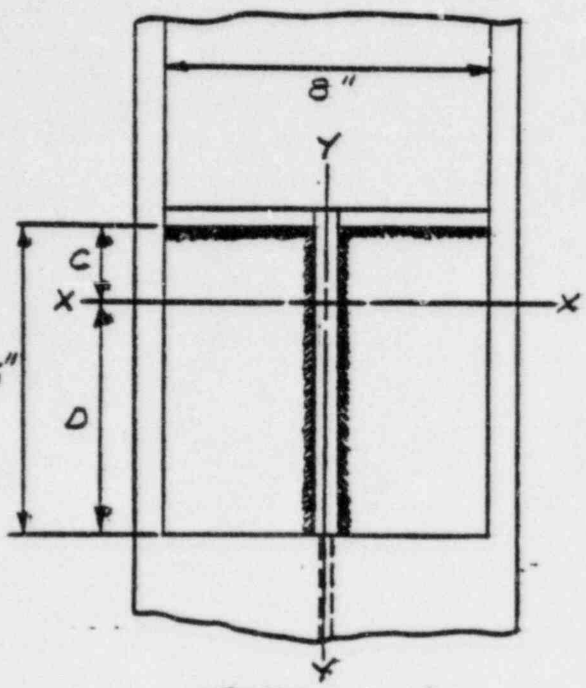
$$P_V = (P)\frac{7}{\sqrt{12^2+7^2}} = 42.2^k$$

$$A = (8.5625)\left(\frac{7}{12}\right) = 4.99 \text{ IN}$$

$$B = A + 1.375 = 6.37 \text{ IN}$$

Form 344-24-4308

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/14/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF



SECTION 1-1

LOCATE CENTROID OF WELD

$$C = \frac{(6.5)^2}{8+(2)(6.5)} = 2.01\text{ IN}$$

$$D = 6.5 - C = 4.49\text{ IN}$$

SINCE LINE OF ACTION OF LOAD P INTERSECTS PLANE OF WELD AT A DISTANCE OF 6.37 IN FROM BOTTOM OF PLATE Y-4, ECCENTRICITY THROUGH WHICH P_H ACTS IS $6.37 - 4.49 = 1.88$ IN

REACTIONS ON WELD:

$F_z = P_H = 72.4^k$

$F_Y = P_V = 42.2^k$

$M_x = (72.4^k)(1.88\text{ IN})$

$= 136$ IN-K

PROPERTIES OF WELD:

$$L_w = 8 + (2)(6.5) = 21\text{ IN}$$

$$S_w = \frac{(6.5^2)((2)(8)+6.5)}{(3)(8+6.5)} = 21.9\text{ IN}^2$$ TO HIGH POINT OF STRESS AT BOTTOM OF WELD

STRESS IN WELD (MAXIMUM) =

$$f_{w_x} = 0$$

$$f_{w_Y} = \frac{F_Y}{L_W} = \frac{42.2^k}{21\text{ IN}} = 2.01\text{ KIPS/IN}$$

$$f_{w_z} = \frac{F_z}{L_W} + \frac{M_x}{S_W} = \frac{72.4^k}{21\text{ IN}} + \frac{136\text{ IN-K}}{21.9\text{ IN}^2} = 3.45 + 6.21 = 9.66\text{ K/IN}$$

$$f_{w_{RES}} = \sqrt{(2.01)^2+(9.66)^2} = 9.87\text{ KIPS/IN}$$

$$t = \frac{f_{w_{RES}}}{(0.707)(27.2\text{ KSI})} = \frac{9.87\text{ KIPS/IN}}{19.23\text{ KSI}} = 0.51\text{ IN} \rightarrow$$ USE 1/2" FILLET

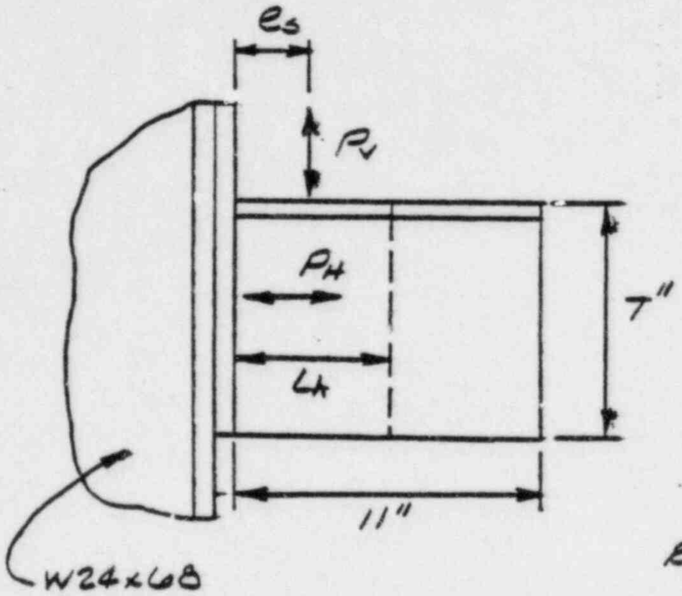
PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE 895.8E
FORM NO. 3 '2-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY TESNER	DATE 9/14/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

DESIGN T - SECTION AS STIFFENED BEAM SEAT



AXIAL LOAD IN TRUSS 2L'S 7x4x 3/4 (83.8^k) IS REDUCED TO VERTICAL AND HORIZONTAL FORCE WITH VERTICAL REACTION ACTING THROUGH AN EFFECTIVE ECCENTRICITY e_s OF

$$e_s = (1.88\text{ IN})\frac{P_H}{P_V} = (1.88\text{ IN})\left(\frac{72.4}{42.2}\right) = 3.23\text{ IN}$$

REF. DESIGN OF WELDED STRUCTURES BY O.W. BLODGETT, SECTION 5.3.1

ASSUME ONE HALF OF TOTAL LENGTH OF BRACKET IS EFFECTIVE IN RESISTING LOAD. THEREFORE $L_h = 5.5$ IN, $R = P_v = 42.2^k$, $e_s = 3.23$ IN, $\phi = 90°$ AND $\sigma_{ALLOW} = 22$ KSI (ASSUMED; TO BE CHECKED LATER). REQUIRED THICKNESS FOR VERTICAL PLATE (MK Y-4) IS

$$t = \frac{R(6e_s - 2L_h)}{\sigma L_h^2 \sin^2\phi} = \frac{(42.2^k)((6)(3.23\text{ IN})-(2)(5.5\text{ IN}))}{(22\text{KSI})(5.5\text{ IN})^2\sin^2 90°} = 0.53\text{ IN}$$

ACTUAL PLATE IS 5/8" THICK OK

FOR AXIAL TENSION/COMPRESSION, $P = 72.4^k$

$$A = (8\text{ IN})(0.5\text{ IN}) + (6.5\text{ IN})(0.625\text{ IN}) = 8.06\text{ SQ IN}$$

FOR TOTAL T CROSS-SECTION

$$\sigma = \frac{P}{A} = \frac{72.4^k}{8.06\text{ SQ IN}} = 9.0\text{ KSI}$$

THIS VALUE IS ACCEPTABLE BY JUDGEMENT SINCE $\frac{K\ell}{r}$ WILL BE RELATIVELY LOW AND ALLOWABLE CAN BE INCREASED BY 1.67 FOR TORNADO

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

CN 1460
BY TESNER
PAGE 895.9E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY TESNER	DATE 9/14/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF

CHECK WIDTH-TO-THICKNESS RATIOS [AISC 1.9.1.2]

FOR WEB PLATE, WORST CASE $b/t = 11in/0.625in = 17.6 < 127/\sqrt{F_y}$ (21.2)

FOR FLANGE PLATES, $b/t = 4in/0.5in = 8.0 < 95/\sqrt{F_y}$ (15.8)

THEREFORE ASSUMPTION FOR ALLOWABLE BENDING = 22KSI OK SINCE UNSTIFFENED ELEMENTS FULLY EFFECTIVE FOR COMPRESSION

FOR SHEAR, $\tau = \frac{42.2^k}{(7in)(0.625in)} = 9.65\ ksi < 0.4 F_y$ OK

USE 2 PL $3\frac{3}{4}" \times \frac{1}{2}" \times 0'-11$ FOR FLANGE, ONE EACH ON EITHER SIDE OF PL MK-Y4.

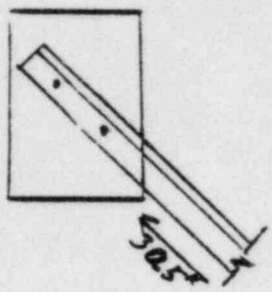
WELD BETWEEN FLANGE PL'S AND WEB TO HAVE EQUAL STRENGTH TO HORIZONTAL WELD BETWEEN FLANGE PL'S AND COLUMN (APPROX. 8 IN. OF 1/2" FILLET); SEE AISC 8TH ED. PAGE 4-48.

MINIMUM WELD SIZE FOR 5/8" MATERIAL = 1/4 [AISC 1.17.2]

22 LINEAR INCHES OF WELD IS POSSIBLE AT THIS JOINT SO 1/4 IN FILLET IS SATISFACTORY

CN 1460
BY TESHER
PAGE 896 E
FORM NO. 372-30-2650

B) Diagonal Bracing ∠ 4x3x5/16 , Connection @ Column Gusset ℘



Required Bolt Capacity = 15.25^k

∴ Use 5/8" Φ Bolts $F_{v\,all} = 18.4\ ^k/_{Bolt} > 15.25\ ^k/_{Bolt}$

$F_u = 58$ KSI FOR A-36 ℘ -
MINOR DECREASE ACCEPTABLE BY INSPECTION

check Bearing $= 1.5(F_u)(D)t$
$= 1.5(70)(5/8)(5/8) = 41.0\ ^k/_{Bolt} > 15.25\ ^k/_{Bolt}$ O.k.

Min. Edge Dist. = 7/8" (AISC TABLE 1.16.5.1, 8TH EDITION)

CHECK EDGE DISTANCE [AISC 1.16.5.2]

$$L_e = \frac{2P}{F_u t} = \frac{(2)(15.25)}{(58\,KSI)(5/8\,IN)} = 0.84\ IN$$

MIN. EDGE DISTANCE PER AISC TABLE 1.16.5.1 GOVERNS

ACTUAL EDGE DISTANCE (MINIMUM) = 1.32 IN (PLATE D-4) OK
SEE NEXT 5 PAGES

ALL CENTER-TO-CENTER ACTUAL DIMENSIONS = 3" OK BY INSPECTION

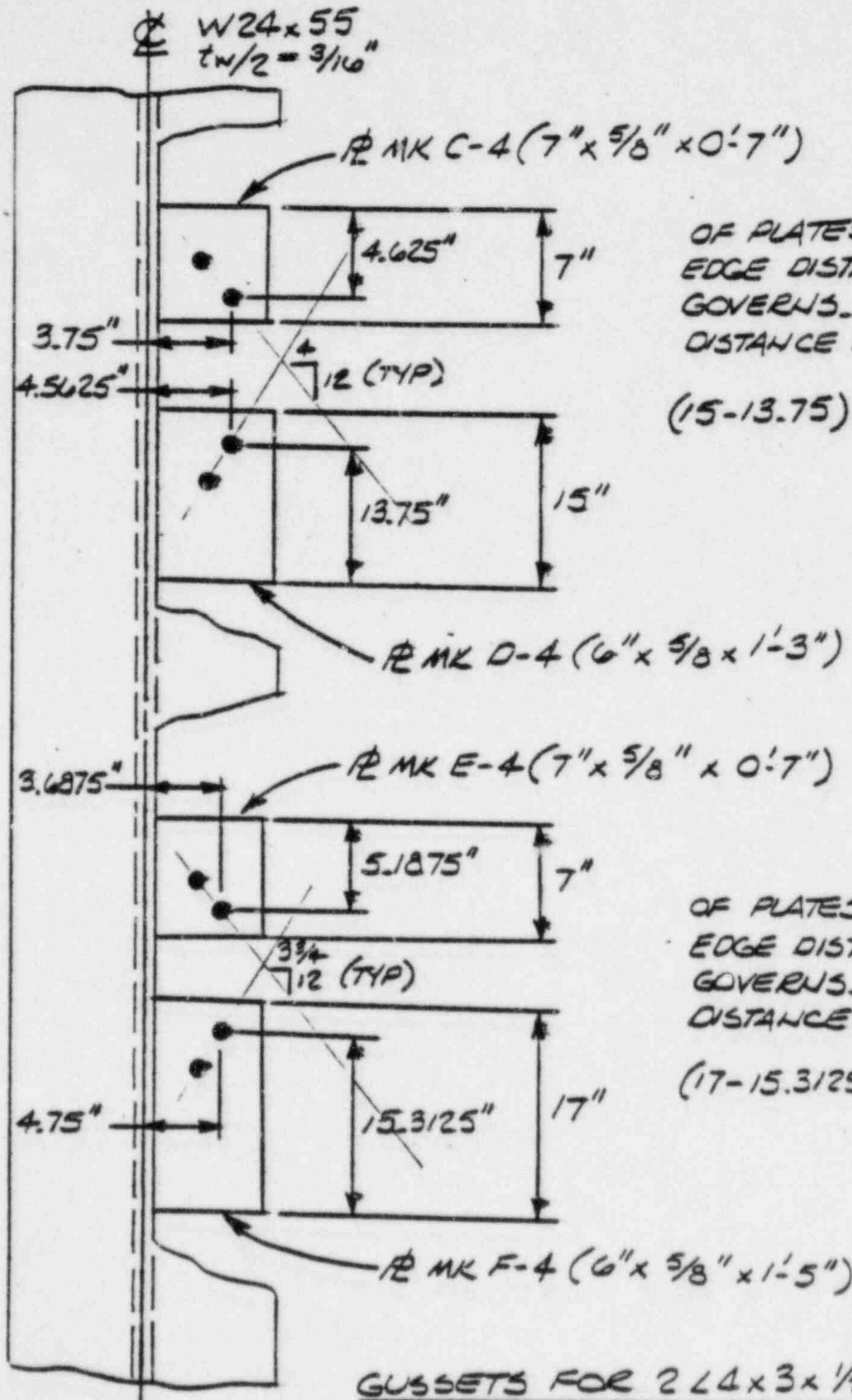
JAT

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

CN 1460
BY TESNER
PAGE 896.1E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY J. TESNER	DATE 9/9/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF



OF PLATES C-4 AND D-4, EDGE DISTANCE ON D-4 GOVERNS. AVERAGE EDGE DISTANCE FOR D-4 IS

$$(15-13.75)\frac{\sqrt{4^2+12^2}}{12} = 1.32 \text{ IN}$$

OF PLATES E-4 AND F-4, EDGE DISTANCE ON F-4 GOVERNS. AVERAGE EDGE DISTANCE FOR F-4 IS

$$(17-15.3125)\frac{\sqrt{3.75^2+12^2}}{12} = 1.77 \text{ IN}$$

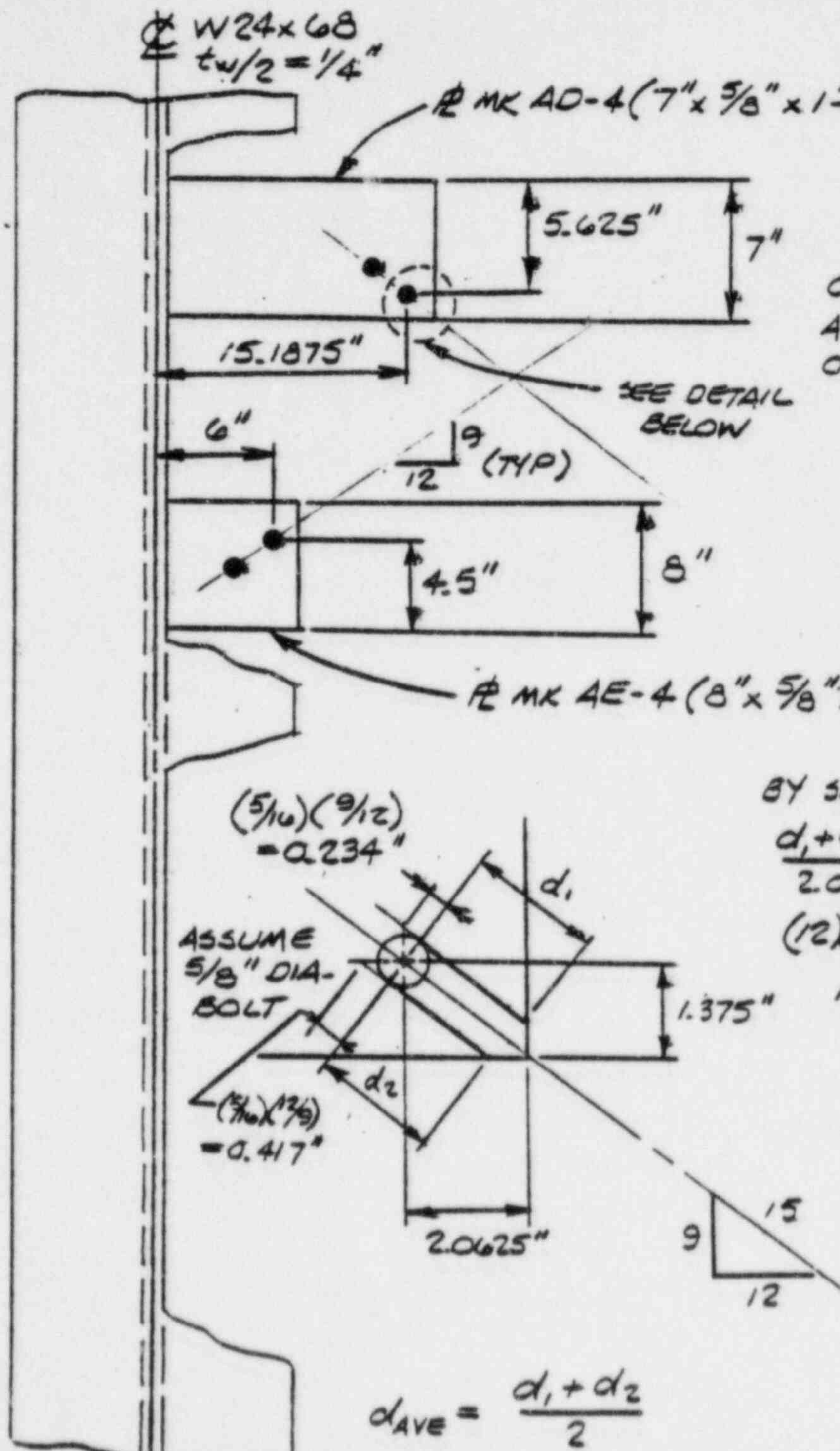
GUSSETS FOR 2∠4x3x½

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

CN 1460
BY TESNER
PAGE B96.2E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY J. TESNER	DATE 9/9/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF



OF PLATES AD-4 AND AE-4, EDGE DISTANCE ON AD-4 GOVERNS.

BY SIMILAR TRIANGLES,

$$\frac{d_1 + 0.234}{2.0625} = \frac{15}{12}$$

$$(12)(d_1 + 0.234) = (15)(2.0625)$$

$$12 d_1 = 28.13$$

$$d_1 = 2.34 \text{ IN}$$

ALSO,

$$\frac{d_2 + 0.417}{1.375} = \frac{15}{9}$$

$$(9)(d_2 + 0.417) = (15)(1.375)$$

$$9 d_2 = 16.872$$

$$d_2 = 1.875 \text{ IN}$$

$$d_{AVE} = \frac{d_1 + d_2}{2}$$

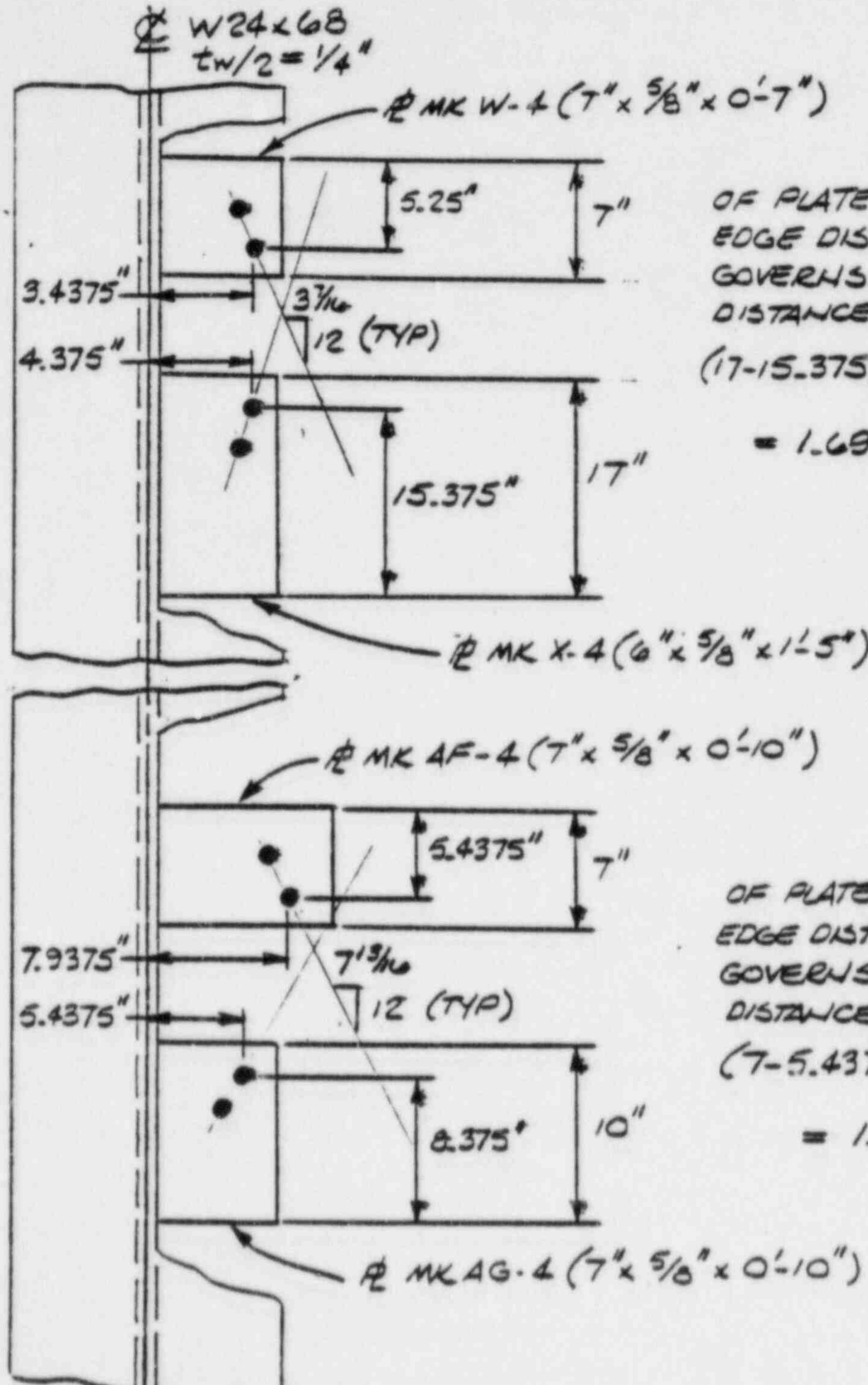
$$= \frac{2.34 + 1.875}{2} = 2.11 \text{ IN}$$

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

CN 1460
BY TESNER
PAGE 896.3E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY J. TESNER	DATE 9/9/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF



OF PLATES W-4 AND X-4, EDGE DISTANCE ON X-4 GOVERNS. AVERAGE EDGE DISTANCE FOR X-4 IS

$$(17-15.375)\frac{\sqrt{3.4375^2+12^2}}{12}$$

$= 1.69$ in

OF PLATES AF-4 AND AG-4, EDGE DISTANCE ON AF-4 GOVERNS. AVERAGE EDGE DISTANCE FOR AF-4 IS

$$(7-5.4375)\frac{\sqrt{7.8125^2+12^2}}{12}$$

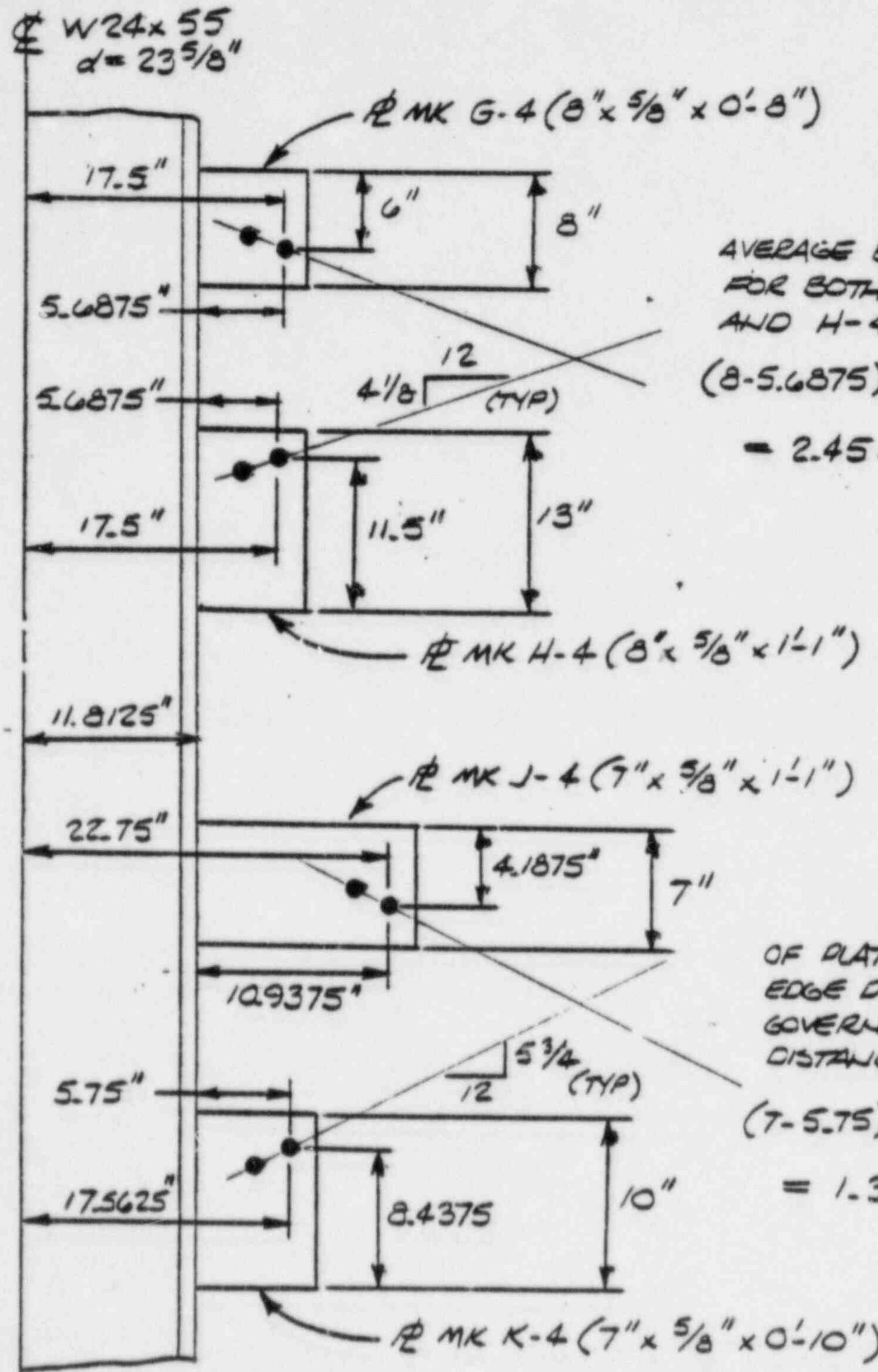
$= 1.86$ IN

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

CN 1460
BY TESHER
PAGE 896.4E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY J. TESHER	DATE 9/9/83			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF



AVERAGE EDGE DISTANCE FOR BOTH PLATES G-4 AND H-4:

$$(8-5.6875)\frac{\sqrt{4.125^2+12^2}}{12}$$

$= 2.45$ IN

OF PLATES J-4 AND K-4, EDGE DISTANCE ON K-4 GOVERNS. AVERAGE EDGE DISTANCE FOR K-4 IS

$$(7-5.75)\frac{\sqrt{5.75^2+12^2}}{12}$$

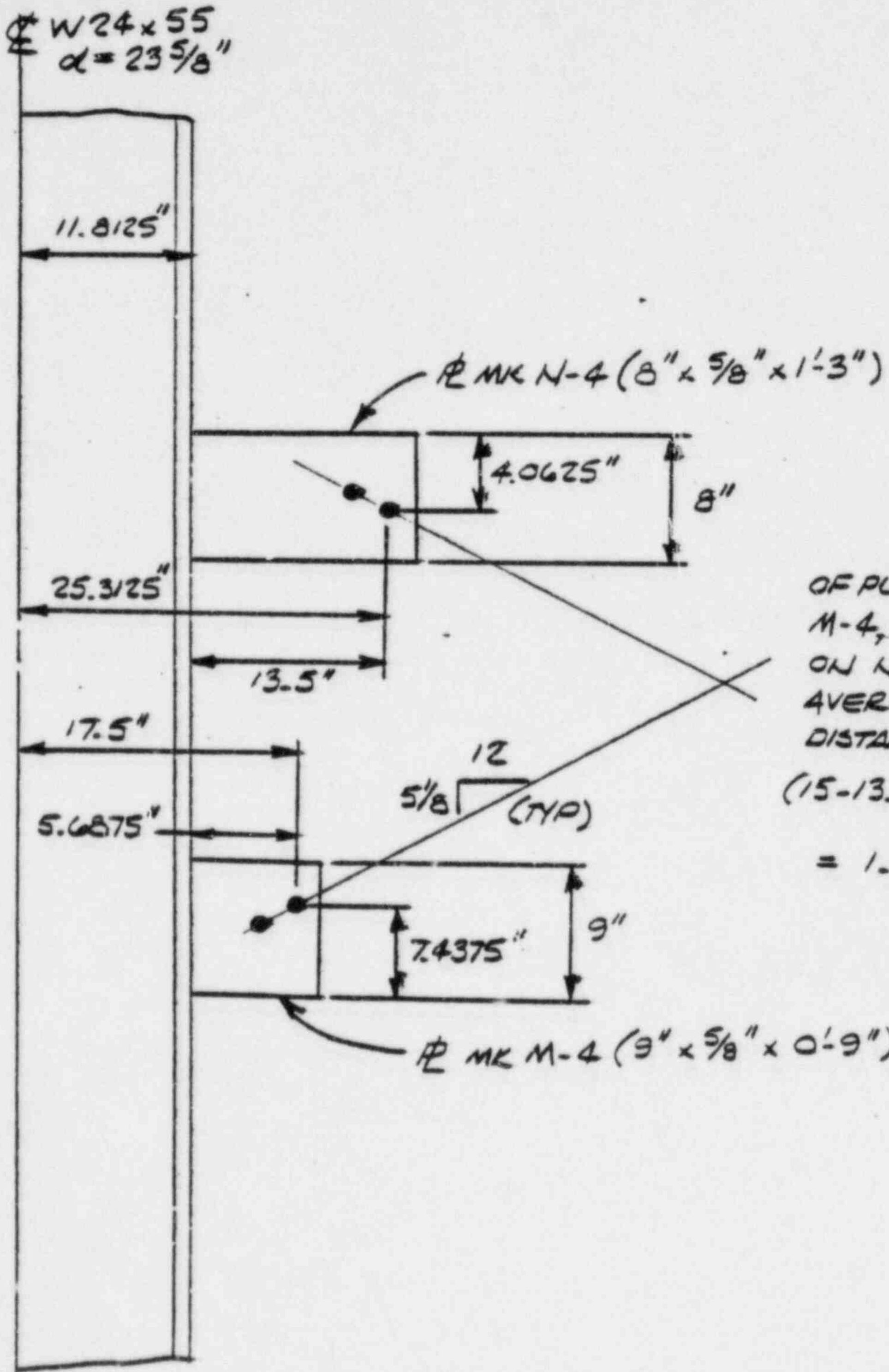
$= 1.39$ IN

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

CN 1460
BY TESNER
PAGE 896.5E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY J. TESNER	DATE 9/9/83		
REVIEWED BY	DATE	CALC. REV.	PAGE OF



OF PLATES N-4 AND M-4, EDGE DISTANCE ON N-4 GOVERNS. AVERAGE EDGE DISTANCE FOR N-4 IS

$$(15-13.5)\frac{\sqrt{5.125^2+12^2}}{12}$$

$= 1.63$ IN

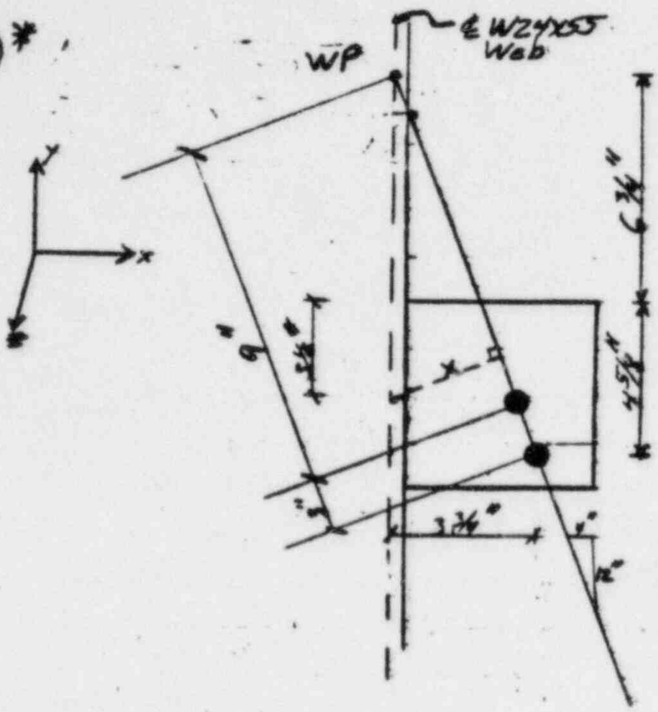
PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE B96.6E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR Analysis of Column-Gusset Welds for walk over Structure.			CALCULATION NUMBER
PREPARED BY Mullen	DATE 8-12-83		
REVIEWED BY	DATE	CALC. REV.	PAGE 1 OF

A)*



Note: By inspection, PL C4 will control analysis.

Max. Axial Force = 1.45^k
Gussets Mk #'s = C4, D4
Members: T15, T16, T7, T8

$X = \frac{4}{12.65}(10.25) = 3.24$ in (conservative)

$M_z = (3.24\text{ in})(1.45^k) = 4.70$ in-k

$F_x = 1.45^k\left(\frac{4}{12.65}\right) = .46^k$
$F_y = 1.45^k\left(\frac{12}{12.65}\right) = 1.38^k$

Check Weld Stress:

Weld Length $= \ell_w = 14$ in
$S_w = \frac{7^2}{3} = 16.33$ in

$(S_w)_x = \frac{F_x}{\ell_w} + \frac{M_z}{S_w} = \frac{.46^k}{14\text{ in}} + \frac{4.70\text{ in-k}}{16.33\text{ in}^2} = .32^k/\text{in}$
$(S_w)_y = \frac{F_y}{\ell_w} = \frac{1.38^k}{14\text{ in}} = 0.1^k/\text{in}$
$(S_w)_z = 0$

By inspection of the component weld forces, it is apparent that that the resulting stress is much less than the allowable weld stress of 20.4 ksi.

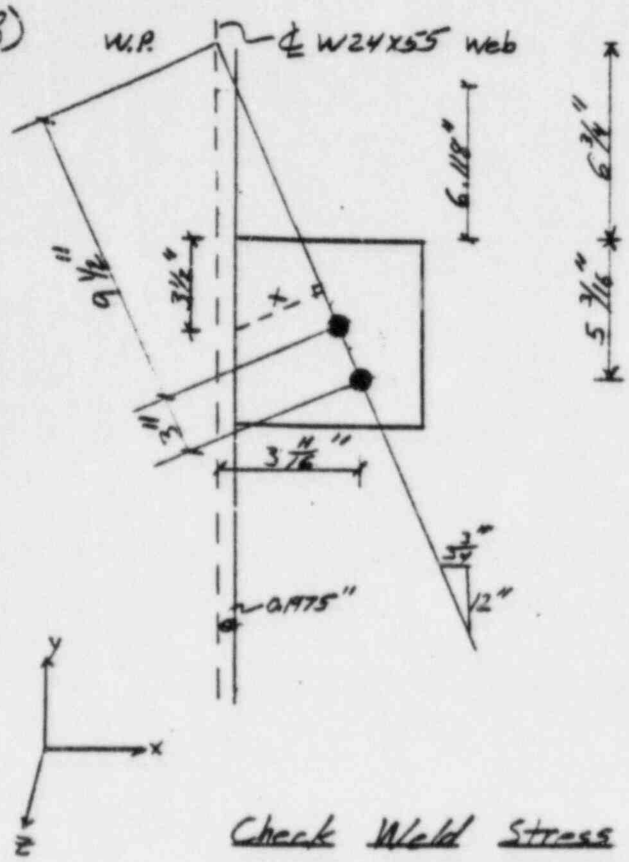
∴ Use 3/8" Fillet weld, both sides of Gusset.

*1) The following calculations reference Northern Steel Drawing NO E-4441-4 Sht. 4 of 4

2) Assume E70 Electrode Mat'l

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY Mullen	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE 2	OF

B)



Gussets MK # : E4, F4
Members : T21, T22, T23, T24
Max. Axial Force = 5.1^k

Note: By inspection, ℞ E4 will control analysis.

$X = 9.618\left(\frac{3.75}{12.572}\right) = 2.87$ in.

Reactions @ Web

$M_z = 5.1^k(2.87\text{ in}) = 14.6$ in-k

$F_x = 5.1^k\left(\frac{3.75}{12.572}\right) = 1.52^k$

$F_y = 5.1^k\left(\frac{12}{12.572}\right) = 4.87^k$

Weld Length = 14 in.

$S_w = \frac{49}{3} = 16.33\text{ in.}^2$

Check Weld Stress

$(f_w)_x = \frac{F_x}{\ell_w} + \frac{M_z}{S_w} = \frac{1.52^k}{14\text{ in}} + \frac{14.6\text{ in-k}}{16.33\text{ in}^2} = 1.0\ ^k/\text{in}$

$(f_w)_y = \frac{F_y}{\ell_w} = \frac{4.87^k}{14} = 0.35\ ^k/\text{in}$

$(f_w)_z = 0$

$(f_w)_R = \sqrt{(1)^2 + (.35)^2} = 1.06\ ^k/\text{in.}$

$\tau_w = \frac{1.06\ ^k/\text{in}}{(.707)(0.375\text{ in})} = 4.0\text{ KSI} < \frac{.4(36)}{.707} = 20.4\text{ KSI}$

∴ Use 3/8" Fillet Weld, both sides of Gusset.

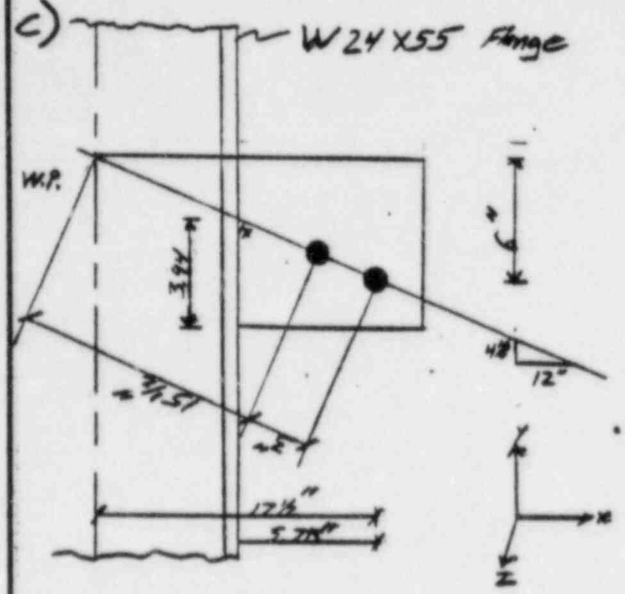
PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE 896.8E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY Muller	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE 3	OF

c)



Gusset Mk #: G4
Members : T11, T12
Max. Axial Force: 16.1^k

$x = .06 \left(\frac{12}{12.69}\right) \approx .06 \text{ in}$
$M_z = .06 \text{ in} (16.1^k) = 0.97 \text{ in-k}$
Negligable

$F_x = 16.1 \left(\frac{12}{12.69}\right) = 15.22^k$
$F_y = 16.1 \left(\frac{4.125}{12.69}\right) = 5.23^k$

$l_w = 16 \text{ in.}$

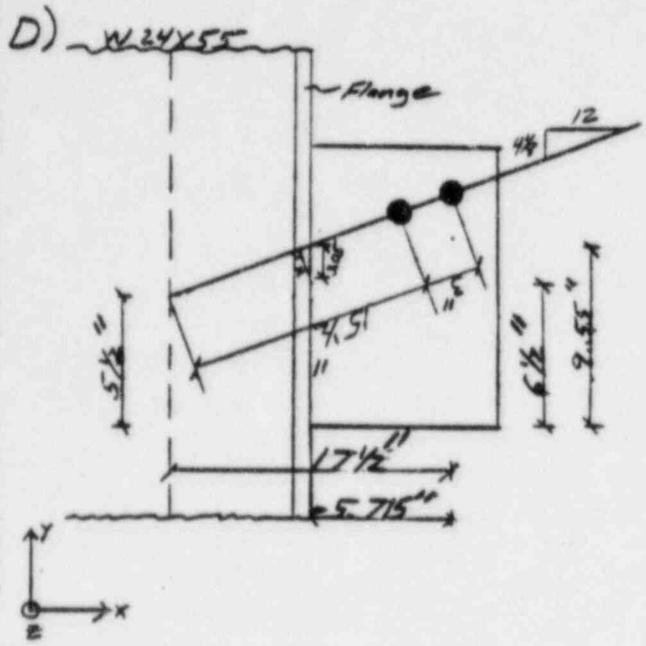
$(S_w)_x = \frac{F_x}{l_w} = \frac{15.22k}{16 \text{ in}} = .95 \text{ k/in}$
$(S_w)_y = \frac{F_y}{l_w} = \frac{5.23k}{16 \text{ in}} = .33 \text{ k/in}$

Weld is acceptable by inspection.

∴ Use 3/8" Fillet, both sides of Gusset.

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 4 OF

D)



Gusset Mk #: H4
Members : T11, T12
Max. Axial Force: 16.1^k

$X = \frac{12}{12.689}(3.05)$
$X = 2.88$ in.

$M_z = 16.1^k(2.88\text{ in.}) = 46.4$ in-k.
$F_x = 16.1^k\left(\frac{12}{12.689}\right) = 15.23^k$
$F_y = 16.1\left(\frac{4.125}{12.689}\right) = 5.23^k$

$l_w = 26$ in.
$S_w = \frac{13^2}{3} = 56.33\text{ in}^3$

$(f_w)_x = \frac{F_x}{l_w} + \frac{M_z}{S_w} = \frac{15.23^k}{26\text{ in}} + \frac{46.4\text{ in-k}}{56.33\text{ in}^3} = 1.41\ ^k/\text{in}$
$(f_w)_y = \frac{F_y}{l_w} = \frac{5.23^k}{26\text{ in}} = 0.2\ ^k/\text{in}$
$(f_w)_z = 0$

$(f_w)_R = \sqrt{(1.41)^2 + (0.2)^2} = 1.43\ ^k/\text{in}$

$\tau_w = \frac{1.43\ ^k/\text{in}}{(.707)(0.375\text{ in})} = 5.4\text{ KSI} < 20.4\text{ KSI}$ O.k.

∴ Use 3/8" Fillet, both sides of Gusset.

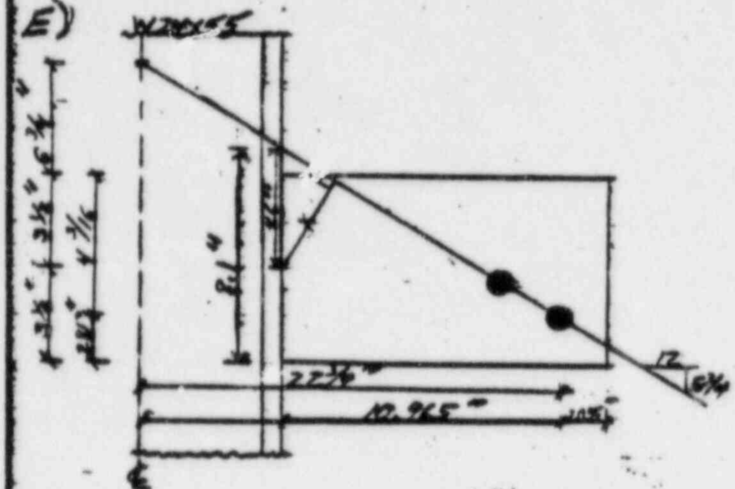
PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE 896.10E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 5 OF

E)



Gusset Mk # : J4
Members : T17, T18, T19, T20
Max. Axial Force : 30.5^k

$X = 4.6\left(\frac{12}{13.31}\right)$
$X = 4.15$ in

$M_z = 30.5^k(4.15in) = 126.60$ in-k
$F_x = 30.5^k\left(\frac{12}{13.31}\right) = 27.50^k$
$F_y = 30.5^k\left(\frac{5.75}{13.31}\right) = 13.18^k$
$l_w = 14$ in $S_w = \frac{l^2}{3} = 16.33 in^2$

$(S_w)_x = \frac{F_x}{l_w} + \frac{M_z}{S_w} = \frac{27.50^k}{14in} + \frac{126.6^{k-in}}{16.33in^2} = 9.72$ k/in
$(S_w)_y = \frac{F_y}{l_w} = \frac{13.18^k}{14in} = 0.94$ k/in
$(S_w)_z = 0$

$(S_w)_R = \sqrt{(9.72)^2 + (0.94)^2} = 9.77$ k/in

$\tau_w = \frac{9.77^k/in}{(0.375)(.707)} = 36.8$ ksi $> \frac{(.4)(36)}{.707} \times \frac{4}{3} = 27.2$ ksi

(~Fy Base Metal)
(Increase allowed for wind and AISC 1.5.6)

N.G.

Actual Weld Size - 1/2" Fillet (To be field verified)

$\therefore \tau_w = \frac{9.77}{(0.5)(.707)} = 27.6 \approx 27.2$ O.K. By Engineering Judgement

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

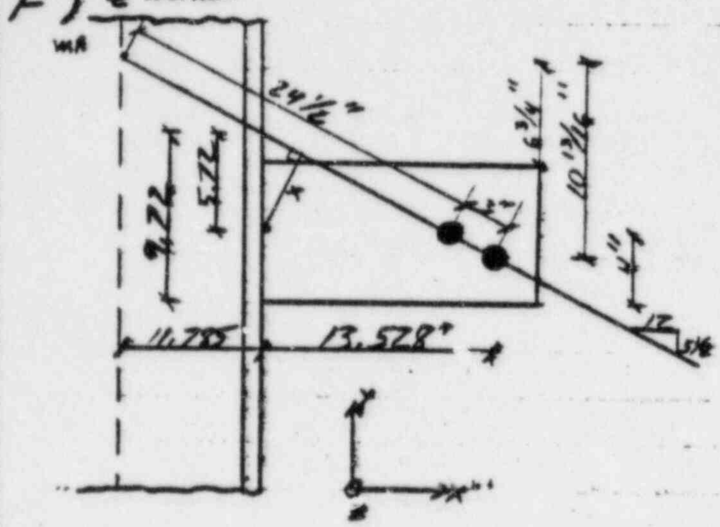
CN 1460
BY TESNER
PAGE 896.11E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 6 OF

By inspection, PL N-4 will control Analysis

F) ℄ W24X55



Gussets Mk #s : M4, N4
Members : T3, T4
Max. Axial Force : 9.8^k

$x = 5.72\left(\frac{12}{13.05}\right)$
$= 5.26\ in$

$M_z = 9.8^k(5.26\ in) = 51.6\ in\text{-}k$
$F_x = 9.8^k\left(\frac{12}{13.05}\right) = 9.01^k$
$F_y = 9.8^k\left(\frac{5.125}{13.05}\right) = 3.85^k$

$\ell_w = 16\ in.$
$S_w = \frac{8^2}{3} = 21.33\ in^2$

$(f_w)_x = \frac{F_x}{\ell_w} + \frac{M_z}{S_w} = \frac{9.01^k}{16\ in} + \frac{51.6\ in\text{-}k}{21.33\ in^2} = 2.98\ ^k/in.$
$(f_w)_y = \frac{F_y}{\ell_w} = \frac{3.85^k}{16\ in} = 0.24\ ^k/in$
$(f_w)_z = 0$

$(f_w)_R = \sqrt{(2.98)^2 + (0.24)^2} = 2.99\ ^k/in$

$\tau_w = \frac{2.99\ ^k/in}{(.707)(0.375\ in)} = 11.3\ ksi < \frac{.4(36)}{.707} = 20.4\ ksi$

∴ Use 3/8" Fillet, both sides of Gusset.

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

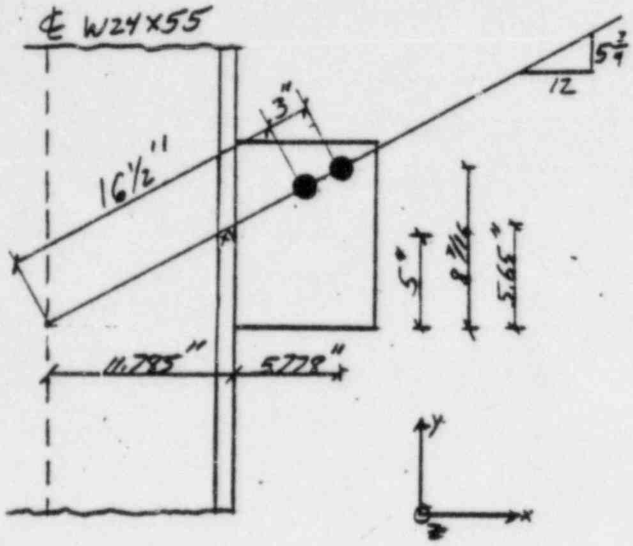
CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE 896.12E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY Mullen	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE 7	OF

G)



Gusset Mk # : K4

Members : T17, T18, T19, T20

Max. Axial Force: 30.5^k

$X = 0.65\left(\frac{12}{13.31}\right)$

$X = 0.59$

$M_z = 30.5^k (0.59\,in) = 18\ in\text{-}k$

$F_x = 30.5^k\left(\frac{12}{13.31}\right) = 27.5^k$

$F_y = 30.5^k\left(\frac{5.75}{13.31}\right) = 13.2^k$

$l_w = 20\ in$

$S_w = \frac{10^2}{3} = 33.33\ in^2$

$(f_w)_x = \frac{M_z}{S_w} + \frac{F_x}{l_w} = \frac{18\ in\text{-}k}{33.33\ in^2} + \frac{27.5^k}{20\ in} = 1.92^k/in$

$(f_w)_y = \frac{F_y}{l_w} = \frac{13.2^k}{20\ in} = 0.66^k/in$

$(f_w)_z = 0$

$(f_w)_R = \sqrt{(0.66)^2 + (1.92)^2} = 2.03^k/in.$

$\tau_w = \frac{2.03^k/in}{(.707)(0.375\ in)} = 7.66\ KSI < 20.4\ KSI$ O.K.

∴ Use 3/8" Fillet weld, both sides of Gusset.

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

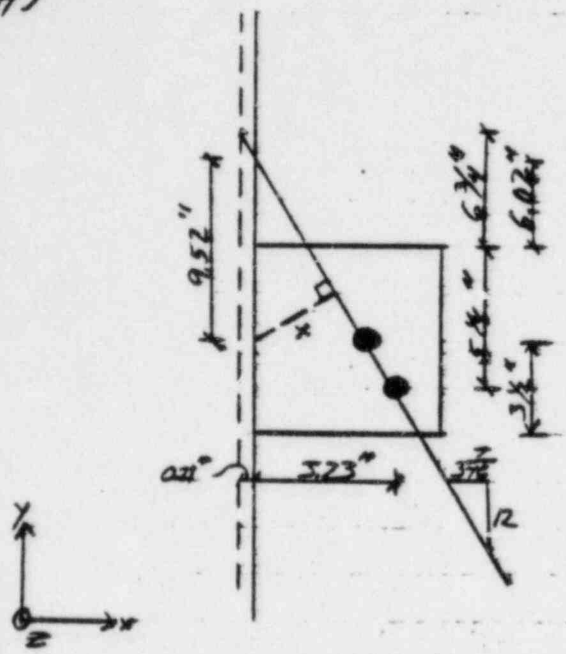
CN 1460
BY TESNER
PAGE 896.13E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 8 OF

By Inspection, PL W-4 will Control

H)



Gussets Mk #: W4, X4
Members : T5, T6
Max. Axial Force: 9.0^k

$x = 9.52\left(\frac{3\,7/16}{12.48}\right)$
$x = 2.62$ in.

$M_z = 9^k(2.62\text{in}) = 23.6^{\text{in-k}}$
$F_x = 9^k\left(\frac{3\,7/16}{12.48}\right) = 2.48^k$
$F_y = 9^k\left(\frac{12}{12.48}\right) = 8.65^k$

$l_w = 14$ in.
$S_w = \frac{l^2}{3} = \frac{14^2}{3} = 16.33\ \text{in}^2$

$(f_w)_x = \frac{M_z}{S_w} + \frac{F_x}{l_w} = \frac{23.6\text{in-k}}{16.33\text{in}^2} + \frac{2.48^k}{14\text{in}} = 1.62\ ^k/\text{in}$
$(f_w)_y = \frac{F_y}{l_w} = \frac{8.65^k}{14\text{ in}} = 0.62\ ^k/\text{in}$
$(f_w)_z = 0$

$(f_w)_R = \sqrt{(1.62)^2 + (0.62)^2} = 1.73\ ^k/\text{in}$

$\tau_w = \frac{1.73^k/\text{in}}{(.707)(0.375\text{in})} = 6.52$ KSI < 20.4 KSI   O.K.

∴ Use 3/8" Fillet Weld, both sides of Gusset.

Note:
Connections of PL's Mk AD4, AE4, AF4 and AG4 are adequate by inspection because of small loading.

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

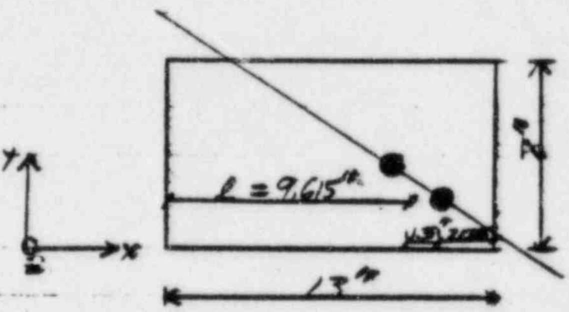
CN 1460
BY TESNER
PAGE B96.14E
FORM NO. 372-30-2650

Form 344-24-4308

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 9 OF

Examine PL Stress for Gusset J4:

$M = 126.6$ in-k
$F_x = 27.5^k$
$F_y = 13.18^k$
$A = (5/8")(7") = 4.375 \text{ in}^2$



Axial Compression:

$\therefore f_a = \frac{F_x}{A} = \frac{27.5^k}{4.375} = 6.29$ KSI

$k = 2.1$ $\quad I = \frac{bd^3}{12} = \frac{7(.625)^3}{12} = .142 \text{ in}^4$
$\ell = 9.625"$ $\quad r = \sqrt{I/A} = \sqrt{\frac{.142}{4.375}} = 0.18$

$\frac{k\ell}{r} = \frac{2.1(9.625)}{.18} = 112.2$

$\therefore F_a' = 11.37$ KSI [AISC Table 3-36]
$F_a = 11.37 \times 1.67$ [DC70, Issue F]
$= 19.0$ KSI

Bending:

$f_b = \frac{M}{S} = \frac{126.6 \text{ in-k}}{5.10 \text{ in}^3} = 24.83$ KSI $\quad S = \frac{bd^2}{6} = \frac{.625(7)^2}{6} = 5.10 \text{ in}^3$

$F_b = \frac{.60}{.66} F_y$
$= 33$ KSI

The PL is categorized per AISC 1.5.1.4.5 para. 2b w/ F.S. = 1.67. For members falling under AISC 1.5.1.4.1, w/ F.S. = 1.52, $F_b = F_y$ per DC-70. Therefore the above equation gives F_b by a F.S. ratio.

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 10 OF

Check Interaction:

$\frac{f_a}{F_a} = \frac{6.29 \text{ ksi}}{19.0 \text{ ksi}} = 0.33 > 0.15$ ∴ USE AISC Eq 1.6-1a + 1b

Eq 1.6-1a:

$$\frac{f_a}{F_a} + \frac{C_m f_b}{\left(1-\frac{f_a}{F'_e}\right)F_b} \leq 1.0$$

WHERE: $C_m = 0.6$

$F'_e = \frac{12\pi^2(29000 \text{ ksi})}{23(112.2)^2} = 11.86$

$$0.33 + \frac{0.6(24.8)}{\left(1-\frac{6.29}{11.86}\right)33} = 1.29 \geq 1.0$$ N.G.

Eq 1.6-1b:

$$\frac{f_a}{0.6F_y} + \frac{f_b}{F_b} \leq 1.0$$

$$\frac{6.29}{.6(36)} + \frac{24.8}{33} = 1.04 \geq 1.0$$ N.G.

Note: 1) Although AISC 1.5.1.4.5 Para. 2 requires lateral bracing @ intervals not exceeding $\frac{76 b_f}{\sqrt{F_y}}$, it is assumed that in this case the 4"x3"x5/16" double angles will provide adequate lateral support.

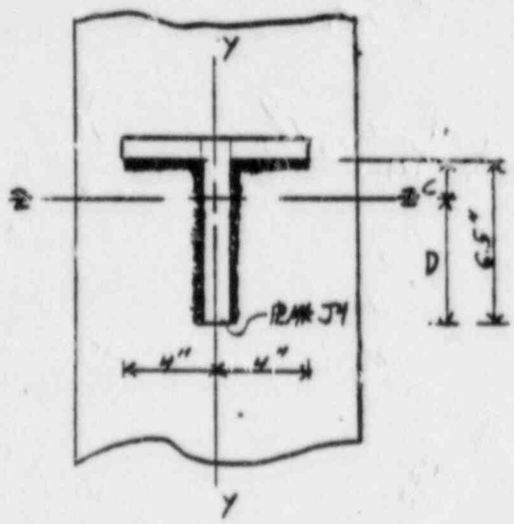
2) All other PL's are adequate by inspection, as indicated by low weld stresses.

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY Mullen	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE 11	OF

From Previous Pages
(P. B96.10)

$F_x = 27.5^k$
$F_y = 13.2^k$

Assume 2 PL's added to top of Gusset PL J-4,
2-PL $3\frac{3}{4}$" × $\frac{1}{2}$" × 1'-0", Similar to PL MK Y-4 Pgs. B95.6 THRU B95.9



Centroid of Weld:

$$C = \frac{(6.5)^2}{8 + 2(6.5)} = 2.01 \text{ in.}$$ Conservative

$$D = 6.5 - 2.01 = 4.49 \text{ in}$$

Line of action of load P intersects plane of weld at a distance of 8.1 in. from bottom of PL J-4, eccentricity through which F_x acts is:

$$8.1 - 4.49 = 3.61 \text{ in.}$$

Note: Weld as analyzed on previous pages O.k. – Conservative
(REF. P. B96.10)

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

CALCULATION WORKSHEET

CN 1460
BY TESNER
PAGE 896.17
FORM NO. 372-30-2650

Form 344-24-4309

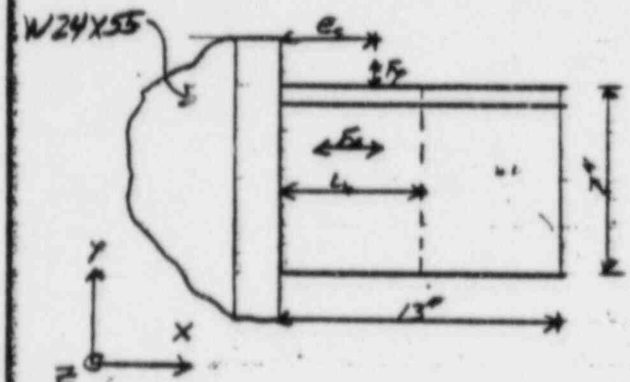
CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE 12 OF

From Previous Page:

$F_x = 27.5^k$

$F_y = 13.2^k$

Assume 2 - ℞ 3 3/8" × 1/2" × 1'-1 8" added to top of Gusset ℞ J-4, similar to ℞ Mk Y-4 Pg. 895.6



Effective eccentricity =

$$e_s = (3.61\ in)\frac{F_x}{F_y}$$

$$= (3.61)\frac{27.5}{13.2} = 7.52\ in.$$

Assume 1/2 of total length of Gusset is effective in resisting load. Therefore, $L_h = 6.5\ in$, $R = F_y = 13.2^k$, $e_s = 7.52\ in.$, $\phi = 90°$ & $\sigma_{all} = 22\ kSI$. Required thickness for ℞ J-4 is:

$$t = \frac{R(6e_s - 2L_h)}{\sigma L_h^2 \sin^2\phi} = \frac{13.2^k(6(7.52in) - 2(6.5in))}{(22\ kSI)(6.5in)^2 \sin^2 90} = 0.46\ in.$$

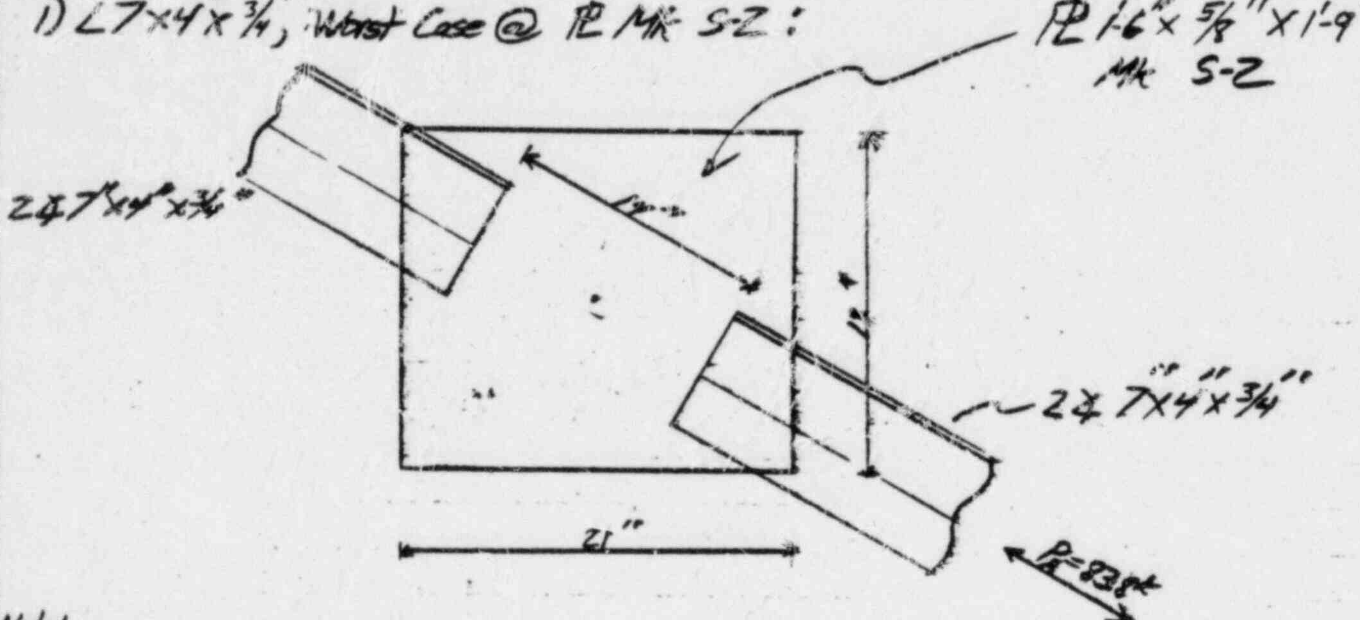
Actual ℞ thickness = 5/8" O.K.

Since F_x & F_y on ℞ Mk J4 are significantly less than on ℞ Mk-Y4 and the plate dimensions are approximately the same, the use of the same flange ℞'s as designed for ℞ Mk Y4 will be conservative. Refer to pages 895.8, 895.9 for a more detailed analysis

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY Mullen	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

Check Double Angle Brace Connection to Stitch PL:

1) ∠7"x4"x3/4", Worst Case @ PL Mk S-Z:



Note:

A) Spliced brace as shown above will control design
B) Assume 5/16" Fillet weld
C) Increase allowable stresses by 1/3 due to wind loading
D) Weld is designed to withstand shear caused by the axial load

Determine weld length required for axial load:

Allowable Weld Stress: $\frac{.4(F_y)}{.707}\left(\frac{4}{3}\right) = \frac{.4(36)}{.707}\left(\frac{4}{3}\right) = 27.2\ ksi$

$\therefore\ 27.2\ ksi = \frac{83.8^k}{(.707)(5/16)(l_w)}$

$l_w = \frac{83.8^k}{(.707)(5/16)(27.2\ ksi)}$

$l_w = 13.94$ in. Required

Since long leg of ∠ is 7 in. and welded to the PL, the l_w for both ∠'s on the 7 in. side will be 14 in. > 13.94 in

Cont'd →

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

CN 1460
BY TESNER
PAGE 896.19E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE OF

Since actual weld is all around the double ∠'s the actual lw will be significantly larger than 14 in. Therefore, the weld is adequate + conservative.

2) ∠ 4"x3" x 1/2", worst case @ PL Mk-E2:

$P_a = 30.5^k$
$E_2 = 1'\text{-}2" \times 5/8" \times 2'\text{-}0"$
Double ∠ 4"x3"x1/2"
Assume 5/16" Fillet

∴ lw required = lw(graph w/ Pa = 83.8^k) [Pa actual / Pa = 83.8^k]

$l_w = 13.94 \text{ in. } \left[\frac{30.5^k}{83.8^k}\right]$
$= 5.07$ in. req'd.

Since long leg of ∠ is 4 in + welded to the PL, the lw for both ∠'s on the 4 in. side will be 8 in. > 5.07 in. Actual weld is all around double ∠'s, therefore the actual lw will be significantly larger than 8 in.

∴ 5/16" Fillet is adequate and conservative.

3) Check Stitch PL Stress:

Note: 1) Effective PL width is assumed to equal the length of the angles attached to it. [Conservative]

2) The plate is assumed not to be laterally supported [Conservative]

REVIEWER'S COMMENT: K=1 IS USED FOR PL ANALYSIS, WHICH IMPLIES PINNED SUPPORTS AT BOTH ENDS (PROVIDED BY ANGLES). WITH CONTINUOUS ∠ WELDED FULL LENGTH ON BACK SIDE OF THIS DETAIL, FOLLOWING APPROACH IS VERY CONSERVATIVE. GOT

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

CN 1460
BY TESNER
PAGE B96.20E
FORM NO. 372-30-2650

Form 344-24-4309

CALCULATION FOR			CALCULATION NUMBER	
PREPARED BY	DATE			
REVIEWED BY	DATE	CALC. REV.	PAGE	OF

1) PL S-7 w/ 2 ⅄ 7"x4"x 3/4":

$P_a = 83.8^k$
$\ell = 14$ in.
$A = 7\text{in}(5/8\text{ in}) = 4.375 \text{ in}^2$
$k = 1$ (Ref. AISC Table C1.8.1)
$r = \sqrt{I/A}$
$= \sqrt{0.142/4.375}$
$= 0.18$ in

$I = \frac{bd^3}{12} = \frac{7(.625)^3}{12} = 0.142 \text{ in}^4$

$\therefore \frac{k\ell}{r} = \frac{1(14 \text{ in})}{.18 \text{ in}} = 77.8$

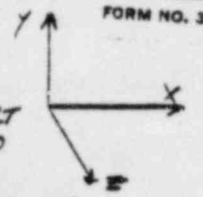
$F_a = 15.58 \times \frac{4}{3} = 20.77$ [AISC Table 3-36]

Increase for wind load. NOTE: CAN BE INCREASED BY 1.67 INSTEAD OF 4/3 BY TABLE 70.4 OF DC-70. got

$f_a = \frac{P}{A} = \frac{83.8^k}{4.375 \text{ in}^2}$
$= 19.15 \text{ ksi} < 20.77 \text{ ksi}$ O.k.

Tensile stress acceptable by Inspection

All other PL stresses are acceptable by inspection of the low axial loads and the effective plate areas.



Column Base ℙ Welds:

Controlling Forces: Axial $= -140.5^k$
$V_x = -40.3^k$
$V_z = 0.002^k$

BASED ON SUPPORT JOINTS MODELLED AS PINNED. FOR FIXED BASE REACTIONS SEE ANALYSIS NEXT PAGE. GOT

Column = W 24x68
$b = 8.965$, $d = 23.73$

Weld Stress: Assume 1/4" Fillet all around

$$S_w = bd + \frac{d^2}{3} = (8.965)(23.73) + \frac{23.73^2}{3} = 400.4$$

$$(f_w)_y = \frac{140.5k}{65.4in} = 2.15\ k/in$$

$$(f_w)_x = \frac{40.3k}{65.4in} = 0.62$$

$$(f_w)_z = \frac{.002}{65.4} = \text{Negligable}$$

$$(f_w)_R = \sqrt{(2.15)^2 + (.62)^2} = 2.24\ k/in$$

$$\tau_{fw} = \frac{2.24\ k/in}{(0.25)(.707)} = 12.7\ KSI < 20.4\ KSI^*$$

CONSERVATIVE - FOR ALL AROUND FILLET ON I-BEAM $S_w = 2bd + \frac{d^2}{3}$ PER BLODGETT'S DESIGN OF WELDED STRUCTURE: TABLE 5 P 7.4-7

ALSO LENGTH OF WELD $= (2)(23.73) + (4)(8.965) = 83.32$ IN, USE OF 65.4 IN IS CONSERVATIVE
GOT

∴ Use a 1/4" Fillet All Around

* 20.4 KSI = Allowable Stress $= \frac{(.40)F_y}{.707} = \frac{.4(36)}{.707}$

FOR W24x68, $t_w = 7/16"$, $t_f = 9/16"$
MINIMUM FILLET WELD SIZE PER AISC TABLE 1.17.2A FOR 9/16" THICK MATERIAL IS 1/4" OK
GOT

CALCULATION FOR			CALCULATION NUMBER
PREPARED BY Mullen	DATE		
REVIEWED BY	DATE	CALC. REV.	PAGE OF

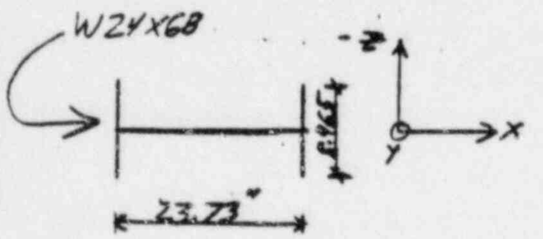
Column Base Pl Welds Continued:

Design weld w/ Fixed structure model per Mc Auto STRUDL run 5/07/82 Time 14.52.23.

Examine largest Jt. reactions in worst loading combination for conservatism.

∴ Controlling Reactions =

$F_x = -43.4^k$ $\quad M_x$ = Negligable
$F_y = +113.0^k$ $\quad M_y$ = Negligable
$F_z = +2.9^k$ $\quad M_z = 255$ ft-k $= 3060$ in-k



Properties of Weld Treated as a line:

$S_w = 2bd + \frac{d^2}{3}$
$= 2(8.965)(23.73) + \frac{(23.73)^2}{3}$
$= 613.2 \text{ in}^2$

$L_w = 83.3 \text{ in.}$

check Weld Stress:

$(f_w)_x = \frac{43.4k}{83.3in} = 0.521$ k/in
$(f_w)_y = \frac{113k}{83.3in} + \frac{3060 in\cdot k}{613.2 in^2} = 6.346$ k/in
$(f_w)_z = \frac{2.9k}{83.3in} = 0.035$ k/in

$(f_w)_R = \sqrt{(0.521)^2 + (6.346)^2 + (0.035)^2}$
$= 6.37$ k/in

* Allowable increased because of large stress induced by wind load

Assume 3/8" Fillet, All Around:

$\tau_w = \frac{6.37 \text{ k/in}}{(0.375 in)(.707)} = 24.0 \text{ KSI} < \frac{.4(36 \text{ KSI})}{.707}\frac{4}{3}^* = 27.2 \text{ KSI}$

∴ Use 3/8" Fillet Weld

NOTE: CALCULATIONS ON THIS PAGE HAVE BEEN SUPERCEDED BY A CASE-BY-CASE EXAMINATION OF GUSSET ℄ TO COLUMN WELD STRESS FOR EACH GUSSET, AS CONTAINED IN THIS CN ON PAGES 895.4E, 895.6E, 895.7E AND 896.6E THROUGH 896.13E, INCLUSIVE. JOT

CN 1460
BY Hicks
PAGE 898E
FORM NO. 372-30-2650

Gusset ℄ to Columns

Controlling Forces:

$V_y = 43.419^k$

$M_y = 0.0388$ ft-k $= 0.4656$ in-k

$V_z = 0.00178^k$

$M_z = 16.3165$ ft-k $= 195.798$ in-k

$V_x = 72.331^k$

$M_x = 0$

Assume 1/4" Fillet 2 edges, both sides:

$S_w = \frac{4bd + d^2}{6} = \frac{4(6)(6)+(6)^2}{6} = 30\ in^2 \times 2 = 60\ in^2$ (S&J pg. 234)

$(f_w)_y = \frac{43.419^k}{24\ in} + \frac{0.4656}{60} = 1.809 + 0.0078 = 1.817\ ^k/in$

$(f_w)_z = \frac{0.00178}{24} + \frac{195.798}{60} = 0.0001 + 3.263 = 3.263\ ^k/in$

$(f_w)_x = \frac{72.331}{24} = 3.014 = 3.014$

$(f_w)_R = \sqrt{(1.817)^2+(3.263)^2+(3.014)^2} = 4.80\ ^k/in$

$\tau_w = \frac{4.80\ ^k/in}{(.250)(.707)} = 27.16\ ksi > 20.4\ ksi$ **N.G.**

Try 3/8" Fillet:

$(f_w)_y = 1.817\ ^k/in$
$(f_w)_z = 3.263\ ^k/in$
$(f_w)_x = 3.014\ ^k/in$

} $(f_w)_R = 4.80\ ^k/in$

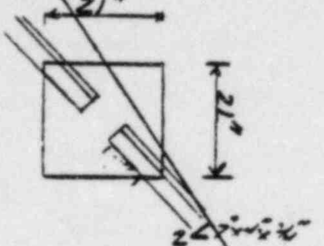
$\tau_w = \frac{4.80\ ^k/in}{(.375)(.707)} = 18.1\ ksi < 20.4\ ksi$ O.K.

∴ 3/8" Fillet

NOTE: CALCULATIONS ON THIS PAGE HAVE BEEN SUPERCEDED BY A DETAILED ANALYSIS OF STITCH PLATES/WELDS FOR BOTH ∠7x4 AND ∠4x3 BRACING CONNECTIONS, AS CONTAINED IN THIS CN ON PAGES B96.18 THRU B96.20.
GDT

CN 1060
BY HICKS
PAGE B99E
FORM NO. 372-30-2650

Stitch Pl. for Diagonal Bracing:



Use same Forces as Page 4.

$S_w = bd = 42 \times 2 = 84$

$(f_w)_y = \frac{43.419}{24} + \frac{0.4856}{84} = 1.82$ k/in

$(f_w)_x = \frac{72.331}{24} = 3.01$ k/in

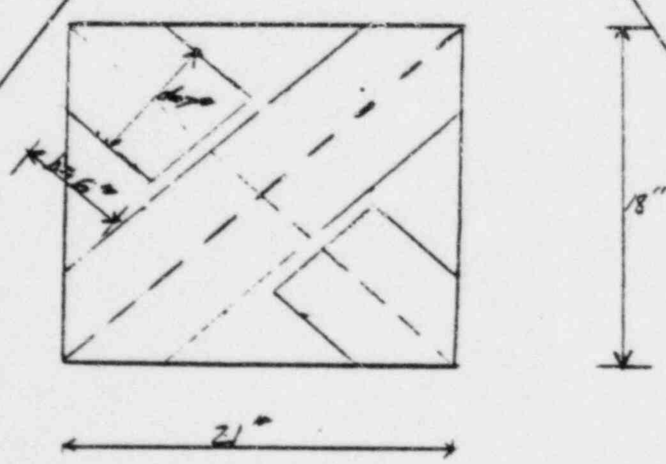
$(f_w)_z = \frac{[illegible]}{24} + \frac{195.709}{84} = 2.37$ k/in

$(f_w)_R = \sqrt{(1.82)^2 + (3.01)^2 + (2.33)^2} = 4.22$ k/in

$\tau_w = \frac{4.22}{(t)(.707)} < 20.4$ ksi

$\therefore t = \frac{4.22}{(.707)(20.4)} = 0.29$ use 5/16" Fillet

$\tau_w = \frac{4.22}{(.313)(.707)} = 19.1$ ksi < 20.4 ksi O.K.



COMMERCIAL TESTING LABORATORIES

A DIVISION OF CTL-THOMPSON

CN 1460
BY TESNER
PAGE 899.1E
FORM NO. 372-30-2650

September 14, 1983

G. E. Johnson Construction Company
P.O. Box 1497
Longmont, Colorado 80501

Attention: Mr. Jim Hanley

Subject: Ultrasonic Pulse Velocity Tests
South Wall of the Building 10 Addition
Fort St. Vrain Nuclear Power Plant
Platteville, Colorado
Job No. Q-3403

Gentlemen:

In accordance with your request, we have performed an investigation to evaluate the integrity of the first lift of the south wall of the Building 10 addition at the Fort St. Vrain power plant near Platteville, Colorado. Non-destructive, ultrasonic tests were performed to determine if the honeycombing observed on faces of four walls extended into the wall concrete. The initial portion of our field investigation was performed on August 2, 1983, but because of equipment failure, was not completed until August 17, 1983.

Tests were performed using V-Meter equipment consisting of an ultrasonic wave energy source, a receiver, and an electronic clock to record the time for the ultrasonic pulse to travel from the source to the receiver. Direct transmission testing of the south wall was performed by placing the source on the wall exterior and the receiver directly in line with the source on the interior of the wall to provide a direct velocity measurement between the two points. The wall thickness was measured at openings in the wall. Pulse velocity was then computed by dividing the wall thickness by the pulse travel time. The general test configuration was specified by Mr. Ed Hicks, Public Service Company of Colorado. Three-foot test grids were laid out on interior and exterior faces of the south wall by our personnel based on elevations provided by G.E. Johnson Construction Company. A total of 30 points were tested.

Ultrasonic Pulse Velocity Test Results

The ultrasonic pulse velocity generally varies directly with concrete compressive strength and density. The presence of voids, low strength concrete zones, cracks or discontinuities are indicated by low ultrasonic pulse velocities. Results of the ultrasonic pulse velocity measurements and the test configuration are presented on Fig. 1. An

CN 1460
BY TESNER
PAGE 899.2E
FORM NO. 372-30-2650

average pulse velocity of 13,110 feet per second (fps) and a standard deviation of 226 fps were calculated for the 30 measurement points. Pulse velocities ranged from a low of 12,560 fps to a high of 13,530 fps. Our test grid was located to minimize the effects of reinforcing steel in the wall on pulse velocity measurements.

Conclusions and Recommendations

1. Ultrasonic pulse velocity measurements indicate good concrete of normal strength and density at all test points tested for the first lift of the south wall of the addition to Building 10.

2. Velocities, in our opinion, do not indicate presence of voids or other discontinuities.

3. In our opinion, the honeycombing and void systems can be located by inspection of the interior and exterior wall surfaces.

Please advise us if we can be of further service in discussing the contents of this report, or in the analyses of the concrete quality of walls of this structure.

Very truly yours,

Commercial Testing Laboratories, Inc.

By ______________________
Larry D. Olson, Staff Engineer

Reviewed by
____
Carl J. Ray, Jr., P.E., President

C. J. RAY, JR. REGISTERED 3069 PROFESSIONAL ENGINEER STATE OF COLO

LDO:CJR:jc

(2 copies sent)

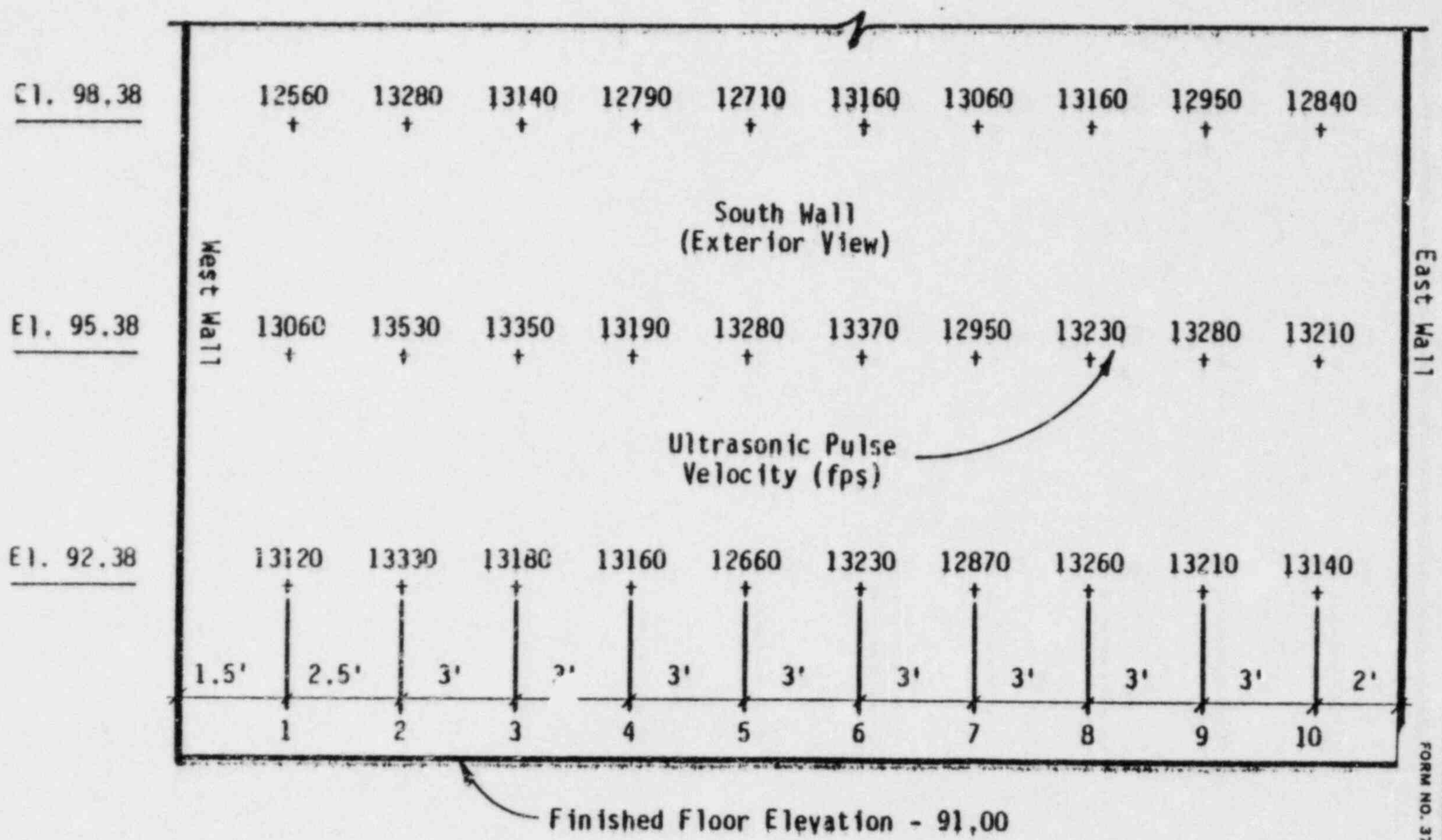
2cc: Public Service Company of Colorado
2420 West 26th Avenue
Suite 100B
Denver, Colorado 80211

Job No. Q-3403

Average Pulse Velocity: 13,110 feet per second (fps)

Standard Deviation: 226 fps

High: 13,530 fps Low: 12,560 fps



Ultrasonic Pulse Velocity Test Results for the South Wall of the Addition to Building 10

Fig. 1

CN 1460
BY Teswere
PAGE B99.3E
FORM NO. 372-30-2650

CN 1460
BY HICKS
PAGE B100E
FORM NO. 372-30-2650

This reissue incorporates all of the following deviation requests. All DRs have been approved by Engineering. The DRs do not compromise the requirements of the FSAR.

82-206-1-H	No changes in design intent.
82-206-1-J	See engineering evaluation [Pgs. B44D through B64D (Ref.), B101E]
82-206-1-K	No change in design intent.
82-206-1-L	See engineering evaluation (Pg. B102E)
82-206-1-N	No change in design intent.
82-206-1-O	
82-206-1-Q	
82-206-1-P	
82-206-1-S	
82-206-1-T	
82-206-1-U	
82-206-1-V	
82-206-1-W	
82-206-1-Y	
82-206-1-Z	
82-206-1-AA	
82-206-1-AC	
82-206-1-AE	
83-76-1-A	
83-76-1-B	
83-76-1-C	
83-76-1-D	
83-76-1-F	
83-76-1-G	
83-76-1-H	
83-76-1-I	
83-76-1-J	
83-76-1-K	
83-76-1-L	
83-76-1-M	
83-76-1-N	
83-76-1-O	
83-76-1-P	
83-76-1-Q	No change, the battery room is held by main structural steel not battery room roof.
83-76-1-R	No changes in design intent.

CN 1460
BY HICKS
PAGE B101E
FORM NO. 372-30-2650

GEJOHNSON
CONSTRUCTION COMPANY

P.O. Box 2139
Colorado Springs, Colora
Telephone 303 473 532.
Office and Yard 310 S. Fourteenth Street

Procedure For Excavating and Placing Lean Concrete

Backfill at Walkover Structure Foundation
Revision 1

1. Excavate and shore sections of the excavation on three (3) foot lifts down to elevation 4776.0. Properly shore all walls as lifts are excavated.

2. When the bottom of excavation is complete (El 4776'-0"±) the engineer will inspect and approve excavation before placement of lean concrete is made.

3. All dirt that is not shored shall be cut back to prevent dirt from falling into concrete.

3A See attached report from Consulting Geotechnical & Materials Engineer dated 6/3/83 for the soil bearing test.

4. Order lean concrete from Mobile Premix, 220 Mix Design, 3/4" aggregate, Type II L.A. Cement.

5. Discharge concrete directly from back of mixer trucks and layer concrete in (2) foot lifts.

6. No shoring shall be left in concrete.

7. Vibrate the concrete to be sure no voids are left.

8. Top of lean concrete backfill (Elevation 4785'-0"±1) shall be vibrated to form a smooth level top. (± ½") or as otherwise directed by the engineer.

9. Provide tests of lean concrete for Slump 4" ± 1", Air 5% ± 1%, Compressive strength 500 PSI at 28 days, Compression cylinders MIN OF 5, Temperature Max 90 degrees F.

10. Forming of walkover foundation may begin the next day. AFTER THE LEAN CONCRETE BACKFILL HAS BEEN COMPLETED

11. To prevent the backfill from filling the excavated cavity concrete backfill may be placed in retangular blocks (Min Volumn 240 C.F.) at the bottom of the excavation with a maximum height of 5'. A continuous concrete cap shall be placed across the top of the blocks. Thus cap shall be a height of 4'±.

82-206-1-5

CN 1460
BY Hicks
PAGE B102E
FORM NO. 372-30-2650

DRY-PACK GROUT PROCEDURE
(DR 82-206-1-L)

Material:

Cement, Type II
Sand, natural or manufactured
as approved by engineer
Proportioning

1 part Portland Cement to 3 parts sand by weight. Water content shall be such that a mass of mortar squeezed in the hand retains its shape.

Placing:

Place dry pack grout against soil. Packing shall be performed by ramming with paddles of suitable size, shape and length. The space between the base and grade beam shall be filled with dry pack grout.

Curing:

Cure edges of concrete in a manner similar to that used for concrete.

Before grout work is started be sure that all surfaces are clean to the satisfaction of the engineer.

Installer shall be careful in placing dry pack grout that existing dirt does not spall or cave in.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) / TCR / SCR / PC / TR
NO. 1461 E
PAGE 2

CATEGORY

TYPE:

- [X] CN OVERALL
- [ ] CN SUBMITTAL
- [ ] SETPOINT CHANGE REPORT
- [ ] TEST REQUEST
- [ ] TEMPORARY CONFIGURATION REPORT
- [ ] PROCEDURE CHANGE (FSAR)
- [ ] OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

CLASS I	[ ] YES	[X] NO	ENGINEERED SAFEGUARD	[ ] YES	[X] NO
SAFE SHUTDOWN	[ ] YES	[X] NO	PLANT PROTECTIVE SYSTEM	[ ] YES	[X] NO
SAFETY RELATED	[X] YES	[ ] NO	SECURITY SYSTEM	[ ] YES	[X] NO

REMARKS Design and analysis treated as safety related with respect to fire protection.

EVALUATION — USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE F S A R OR TECH SPEC? [X] YES [ ] NO

LIST THE APPLICABLE SECTIONS REVIEWED. This activity involves construction of HVAC and fire protection systems in a new facility (Building 10). As such, it is not identified in either the FSAR or Tech Specs. However, general criteria for fire protection are identified in FSAR Sections 1.4.1.2, 9.12 and App C, Crit. 3, and Tech Spec LCO 4.10 and SR 5.10 which are applicable to similar existing systems.

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE F S A R OR TECH SPEC? [X] YES [ ] NO

LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE. FSAR Sections 9.12, 10.2.7 should be changed to reflect installation of these systems. No changes are required to the Technical Specifications. (see attached pages 2.1, 2.2).

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE F S A R BEEN INCREASED? [ ] YES [X] NO STATE BASIS: see pages 2.1, 2.2

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE F S A R BEEN CREATED? [ ] YES [X] NO STATE BASIS: see pages 2.1, 2.2

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE F S A R BEEN REDUCED? [ ] YES [X] NO STATE BASIS: No defined margin of safety in the Tech Specs

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION [ ] YES [X] NO
BE SAFETY SIGNIFICANT [X] YES [ ] NO

BY Nancy Blichmann (SIGNATURE) 2/6/84 (DATE) *APPROVED J R [signature] (SIGNATURE) 2-6-84 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372 02 3382

SAFETY EVALUATION

2. continued...

No changes to the technical specifications are required as a result of the installation of these systems.

The Halon fire suppression system was not installed to meet regulatory requirements, but strictly for insurance purposes. A fire protection review of Building 10 (then named the Three Room Control Complex Addition) was performed by Proto-Power Management Corporation. The resulting report concluded that the fire protection meets the requirements of Branch Technical Position (BTP) 9.5-1, and 10CFR50, Appendix R, as it applies to Fort St. Vrain, without taking credit for the Halon fire suppression system. As such, no additions concerning Halon or fire dampers must be added to the Tech Specs.

The maximum temperature which could be reached as a result of HVAC system failure was evaluated in NDG-83-0297. Calculations show that the maximum temperature does not exceed the environmental qualification of the equipment. No Technical Specification change concerning the temperature limits of Building 10 is required.

Ionization type detectors installed in Building 10 do not require a Technical Specifications change. LCO 4.10.3 concerns smoke detectors and alarms for the Three Room Control Complex and congested cable areas. The control room is included because of its particular importance to safe plant operation. The other areas, including the auxilliary electric equipment room and the 480 V switchgear room, were included because they contain congested cable areas. The basis for LCO 4.10.3 states "The system alerts the operator to the possibility of a fire in congested cable areas and to the necessity of investigation of conditions in these areas." The redundant trains of cables in Building 10 will be

BY: Nancy Blichmann 2/6/84 APPROVED: JR Johns 2-6-84
DATE DATE

2. continued
wrapped to provide a one hour fire barrier, as required in 10CFR50, App. R 6.2(c) and as recommended by the Proto Power Fire Analysis shown on pages B53A - B69A of this CN.

3a). The probability of damage to safety related equipment has not increased. The Proto-Power Fire Analysis (pages B53A - B69A) states that the ionization detectors provide sufficient indication of fire. Mitigation is provided by dry chemical fire extinguishers, and by a Halon fire suppression system. The Fire Analysis mentioned above verified that portable dry chemical extinguishers are sufficient to meet the criteria in BTP 9.5-1, App. A and 10CFR50, App R as it applies to FSV. However, the Halon system does provide additional fire mitigation and increases safety.

Recommendations made by Proto-Power concerning wrapping redundant cables B1L1 and B2L2, and fixed emergency lighting have been included in the design. Because the design meets these criteria, possibility of damage to safety related equipment, which has been analyzed in the FSAR, has not been increased.

b) There are no cable spreading areas in Building 10, therefore existing fire protection systems are adequate. The possibility or consequence of an accident has not been increased by this addition, and effective protection systems have been installed.

BY Nancy Blichmann 2/6/84 APPROVED JR Johns 2-6-84
DATE DATE

CN 1461A
BY D. Combard
PAGE B-1A
FORM NO. 372-30-2650

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

Electrical ☐
Mechanical ☒
Structural ☐
Safety Related ☒☐
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS
Sheet 1 of 1

This CN will cover the mechanical portion of the construction of the Three Room Complex Addition. All mechanical work will be performed in accordance with section 15000 of specification 75-J-02. The work to be done by this CN is not safety related but will be treated as such as far as an independent design review is concerned. The Uniform Mechanical Code 1979 Edition and the Uniform Plumping Code 1976 Edition, will be used as guidelines for the ~~HVAC system installation.~~ Fire protection system will be designed and installed per NFPA 12A and UL Requirements.

A fire hazards analysis was performed by Proto-Power Management Corp. to verify that the proposed fire protection for Building 10 (New name for the Three Room Complex Addition) is in compliance with Branch Technical Position 9.5-1. This analysis is included as pages B-55A thru B-69A. Also see p. B-70A for a discussion of this analysis.

[signature] 12/10/82

Added by CN-1461A

Prepared By: /s/ [signature] Date

Approved By: /s/ F. Tilson 10-6-82 Date
F. Tilson 12-15-82

CN 1461
BY M. Lamcred
PAGE B-2.

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

Electrical ☐
Mechanical ☒
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN ANALYSIS
Sheet 1 of 51

As stated in the Design Input Requirements, all work will be done per specification 75-S-02, section 15000. Calculations are included here for HVAC unit and duct sizing and also for duct hanger sizing to insure that duct runs will not fall on safety related equipment during a seismic event.

HVAC calculations:

Note: All formulas and constants are taken from ANSRAE Fundamentals, 1977, Trane Air Conditioning Manual, 1981, and SMACNA Low Pressure Duct Construction Standards, 1976.

I. Calculations for U, overall heat transfer coefficient.

A. Walls

	R
Concrete, 12" thick	1.86
Fiberglass, 3" thick	9.5
Inside surface (still air)	0.68
Outside surface (15 mph wind)	0.17
Total	12.21 $\frac{hr \cdot ft^2 \cdot °F}{Btu}$

$U = \frac{1}{R}$ $\therefore U_w = \frac{1}{12.21} = .082 \frac{Btu}{hr \cdot ft^2 \cdot °F}$

B. Outside Doors

$U_{OD} = .29 \frac{Btu}{hr \cdot ft^2 \cdot °F}$ (from ASHRAE Handbook, 1977 Edition)

Prepared By: /s/ [signature] 9/15/82
Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 2 of 51

C. Roof

	R
Outside surface (15 mph wind)	0.17
2" insulation, outside	10.00
12" Concrete	1.86
6" insulation inside	19.00
Inside surface, still air	0.68
Total	31.71 $\frac{hr \cdot ft^2 \cdot °F}{Btu}$

$\therefore U_R = \frac{1}{R_R} = .032 \frac{Btu}{hr\, ft^2\, °F}$

D. Floor, grade level

	R
Concrete, 12" thick	1.86
Inside surface, still air	.68
Total	2.54 $\frac{hr \cdot ft^2 \cdot °F}{Btu}$

$\therefore U_{FGL} = \frac{1}{2.54} = .39 \frac{Btu}{hr \cdot ft^2 \cdot °F}$

E. 1'3" Floor/Ceiling

	R
Top surface, still air	.68
Concrete, 15" thick	2.33
Bottom surface, still air	.68
Total	3.69 $\frac{hr\, ft^2\, °F}{Btu}$

$U_{15" F/C} = \frac{1}{3.69} = .27 \frac{Btu}{hr\, ft^2\, °F}$

F. 6" Floor/Ceiling

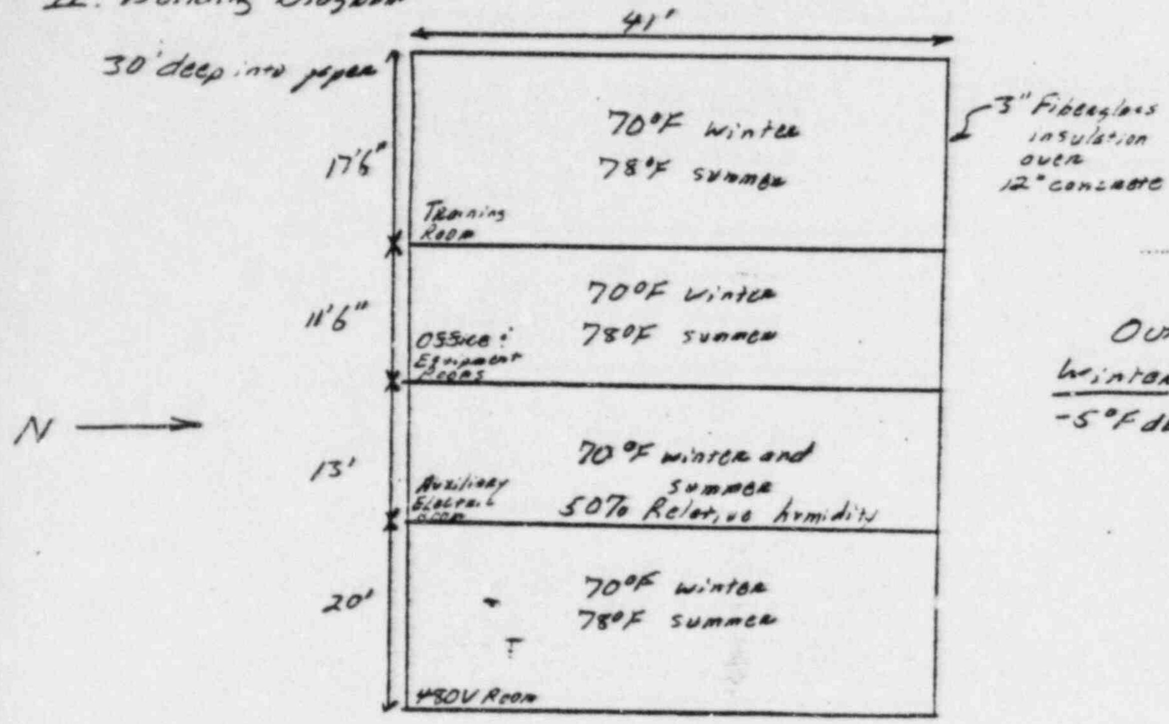
Top surface, still air	.68
6" Concrete	.93
Bottom surface, still air	.68
	2.29 $\frac{hr\, ft^2\, °F}{Btu}$

$U_{6" F/C} = \frac{1}{2.29} = .44 \frac{Btu}{hr\, ft^2\, °F}$

Prepared By: 1st [signature] 9/15/82
Date

SAFETY RELATED
DESIGN ANALYSIS

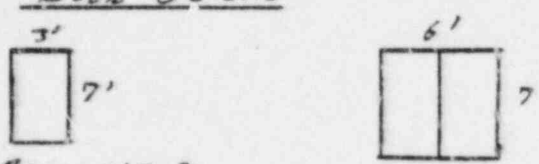
II. Building Diagram



Outdoor Conditions

Winter	Summer
-5°F db.	95°F d.b.

Door Details



Area = 21 ft^2
Perimeter = 20 ft

Area = 42 ft^2
Perimeter = 33 ft. (incl. crack down middle)

Prepared By: /s/ [signature] 9/15/82
Date

SAFETY RELATED

DESIGN ANALYSIS

III. Heat Loss Calculations

A. 480 V Room

1. Walls

$A_w = 2(20 \times 41) + 2(20 \times 30) = 2840 \text{ ft}^2$

$U_w = .082$

$\Delta T = 70 - (-5) = 75$

$q_w = UA\Delta T = .082(2840)(75)$

$q_w = 17,466$ Btuh

2 Floor

$A = 41 \times 30 = 1230 \text{ ft}^2$ (same for all floors and ceilings)

$U = .39$ $\Delta T = 75$

$q_F = .39(1230)(75) =$

$q_F = 35,980$ Btuh

3 Ceiling

$A = 1230$, $U = .44$, $\Delta T = 0$

$\therefore q = 0$

4 Exhaust from battery room, $V = 8 \times 15 \times 9 = 1080 \text{ ft}^3$; 3 air changes per hour = 3240 cfh = 54 cfm, say 100 cfm to be safe.

$Q = 100$ cfm, $\Delta T = 75$

$q_s = 1.08 Q \Delta T$ $q_L = .7 Q \Delta HR$

$q_s = 1.08(100)(75)$ $q_L = .7(100)(110.7 - 5.51)$

$q_s = 8100$ Btuh $q_L = 7360$ Btuh

$q_T = q_s + q_L = 15,460$ Btuh

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DESIGN ANALYSIS

B. Auxiliary Electric Room

1. Walls

$A_w = 2(13 \times 41) + 2(13 \times 30) = 1846\ ft^2$

$U_w = .082 \quad \Delta T = 70 - (-5) = 75$

$q_w = .082(1846)(75)$

$q_w = 11,350$ Btuh

2. Floor

$U = .44, \quad \Delta T = 0$

$\therefore q = 0$

3. Ceiling

$\Delta T = 0$

$\therefore q = 0$

C. Office and Equipment Room

1. Walls

$A_w = 2(11.5 \times 40) + 2(11.5 \times 30)$

$A_w = 1610\ ft^2$

$U = .082, \quad \Delta T = 75$

$q = .082(1610)(75)$

$q = 9900$ Btuh

2. Floor

$\Delta T = 0$

$q = 0$

3. Ceilings

$\Delta T = 0$

$q = 0$

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DESIGN ANALYSIS

D. Training Room

1. Walls

$A_w = 2(17.5 \times 41) + 2(17.5 \times 30)$

$A_w = 2485 \; ft^2$

$U = .082, \; \Delta T = 75$

$q_w = .082(2485)(75)$

$q_w = 15,280$ Btuh

2. Floor

$\Delta T = 0$

$q = 0$

3. Ceiling

$U = .032, \; \Delta T = 75, \; A = 1230$

$q = UA\Delta T$

$q = .032(1230)(75)$

$q = 2950$ Btuh

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 7 of 51

E. Exfiltration Through Door Cracks

Single door: $A = 21\ ft^2$; $P = 20\ ft$
Double door: $A = 42\ ft^2$, $P = 33\ ft$ (incl. crack down middle)

1. 480V Room

1 double door, 1 single door
$\Delta T = 75°F$

a. crack loss

assume 11 cfm per linear ft. of crack
$P_{Total} = 20 + 33 = 53\ ft$

$Q = 53(11) = 583\ cfm$

$q_{latent} = .7\,Q(\Delta HR)$ $\quad q_{sensible} = 1.08\,Q\,\Delta T$

$q_L = .7(583)(110.7 - 5.51)$ $\quad q_s = 1.08(583)(75)$

$q_L = 42,930\ Btuh$ $\quad q_s = 47,225\ Btuh$

$q_s + q_L = 90,155\ Btuh$

b. conduction

$U = .29,\ \Delta T = 75,\ A = 42 + 21 = 63\ ft^2$

$q_c = UA\Delta T$

$q_c = .29(63)(75)$

$q_c = 1370\ Btuh$

$\therefore q_{Total} = 90,155 + 1370 = 91,525\ Btuh$

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DESIGN ANALYSIS

2. Auxiliary Electric Room

same as 480V Room, $q_{Total} = 91,525$ Btuh

3. Office & Equipment Room

1 single door, A = 21 ft², P = 20 ft

a. crack loss

$Q = P(11) = 20(11) = 220$ cfm

$q_L = .7 Q \Delta HR$ | $q_s = 1.08 Q \Delta T$

$q_L = .7(220)(71.07-5.51)$ | $q_s = 1.08(220)(75)$

$q_L = 16,200$ Btuh | $q_s = 17,820$ Btuh

$q_s + q_L = 34,020$ Btuh

b. conduction loss

$U = .29$, $A = 21$, $\Delta T = 75$

$q_c = UA\Delta T$

$q_c = .29(21)(75)$

$q_c = 460$ Btuh

$q_{Total} = q_c + q_s + q_L = 460 + 34,020$

$q_{Total} = 34,480$ Btuh.

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 9 of 57

4. Training Room

same as 480V Room, q_{Total} = 91,325 Btuh

IV Summary of Heat Loss Calculations

A. 480V Room

Walls	17,466 Btuh
Floor	35,980
Ceiling	0
Battery Room Exhaust	15,460
Doors	91,525
Total	160,431 Btuh

B. Auxiliary Electric Room

Walls	11,350 Btuh
Floor	0
Ceiling	0
Doors	91,525
Total	102,875 Btuh

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Date

CN 1461
BY [illegible]
PAGE B-11

SAFETY RELATED
DESIGN ANALYSIS
Sheet 10 of 51

C. Office & Equipment Room

Walls	9900 Btuh
Floor	0
Ceiling	0
Doors	34,480
Total	44,380 Btuh

D. Training Room

Walls	15,280 Btuh
Floor	0
Ceiling	2950
Doors	91,525
Total	109,755 Btuh

Total heating load = 417,441 Btuh (entire building)

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SAFETY RELATED

DESIGN ANALYSIS

Sheet 11 of 51

IV. Cooling Load Calculations

1. 480V Room

a. Equipment

$45 kW = 45 \times 10^3 W (3.4121 \frac{Btuh}{W}) = 153,450$ Btuh

b. Walls

Conduction, U = .082, $\Delta T = 95 - 78 = 17°F$

$A = 2(20 \times 41) + 2(20 \times 30) = 2840 ft^2$

$q = UA\Delta T$

$q = .082(2840)(17)$

$q = 4000$ Btuh

Solar gain on walls

$A_N = 20(30) = 600 ft^2$

$A_S = A_N = 600 ft^2$

$A_E = 20(41) = 820 ft^2$

$A_W = A_E = 820 ft^2$

Temp. Differentials (Trane book, Tables 3-41 & 3-43)

$TD_N = 10$

$TD_S = 27$

$TD_E = 20$

$TD_W = 16$

$q = UATD$

$q_N = (.082)(600)(10)$

$q_N = 500$ Btuh

$q_E = .082(820)(20)$

$q_E = 1350$ Btuh

$q_S = (.082)(600)(27)$

$q_S = 1330$ Btuh

$q_W = .082(820)(16)$

$q_W = 1100$ Btuh

$q_N + q_S + q_W + q_E = 500 + 1330 + 1100 + 1350 = 4300$ Btuh

$\therefore q_{total} = 4000 + 4300 =$ <u>8300 Btuh</u>

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SAFETY RELATED
DESIGN ANALYSIS
Sheet 12 of 51

c. Floor

$U = .39$, $A = 1230$, $\Delta T = 17$

$q = UA\Delta T =$

$q = .39(1230)(17)$

$q = 8160$ Btuh

d. Ceiling

$U = .44$, $A = 1230$, $\Delta T = 70 - 78 = -8°F$

$q = UA\Delta T$

$q = .44(1230)(-8)$

$q = -4330$ Btuh

e. Doors, 1 double door, 1 single door

$P = 53$ ft $Q = 53(11) = 583$ cfm $U = .29$

$A = 63$ ft² $\Delta T = 95 - 78 = 17°F$

infiltration

$q_s = 1.08\ Q\Delta T$ $q_L = .7\ Q\Delta HR$

$q_s = 1.08(583)(17)$ $q_L = .7(583)(257.1 - 146)$

$q_s = 10,710$ Btuh $q_L = 45,340$ Btuh

$q_s + q_L = 56,050$ Btuh

conduction

$q = UA\Delta T$

$q = .29(63)(17)$

$q = 310$ Btuh

$q_{Total} = 56,050 + 310 = 56,360$ Btuh

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Date

SAFETY RELATED

DESIGN ANALYSIS

Sheet 13 of 51

f. Lighting

4 W/ft² average

A = 30(41) + 30(23) = 1920

4(1920) = 7680 W

q = W(3.4)(1.2) (Trane book, p. 31)

q = 7680 (3.4)(1.2)

q = 31,335 Btuh

g. People

assume 5 people maximum

q_s = 5(240) = 1200 Btuh (Trane Handbook)

q_L = 5(510) = 2550

3750 Btuh

5 cfm/person = 25 cfm — 25 cfm

q_s = 1.08 (25)(17)

q_s = 460 Btuh

q_L = .7(25)(111.1)

q_L = 1950 Btuh

$q_s + q_L$ = 2410 Btuh

q_{total} = 3750 + 2410 = 6160 Btuh

h. Battery Room Ventilation — 100 cfm

Q = 100 cfm

q_s = 1.08(100)(17) q_L = .7(100)(111.1) $q_s + q_L$ = 9640 Btuh

q_s = 1840 Btuh q_L = 7800 Btuh

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DESIGN ANALYSIS

2. Auxiliary Electric Room

a. Equipment

$20 kW = 20 \times 10^3 W (3.4121) = 68,240$ Btuh

b. Walls

conduction

$U = .082$, $\Delta T = 95 - 70 = 25$

$A = 2(13 \times 40) + 2(13 \times 30) = 1846$ ft²

$q = UA\Delta T$

$q = .082(1846)(25)$

$q = 3790$ Btuh

Solar gain

$A_N = 13(30) = 260$ ft² — $TD_N = 10$

$A_S = A_N = 260$ ft² — $TD_S = 27$

$A_E = 13(40) = 520$ ft² — $TD_E = 20$

$A_W = A_E = 520$ ft² — $TD_W = 16$

$q_N = .082(260)(10)$

$q_N = 215$ Btuh

$q_E = .082(520)(20)$

$q_E = 855$ Btuh

$q_S = .082(260)(27)$

$q_S = 580$ Btuh

$q_W = .082(520)(16)$

$q_W = 685$ Btuh

$q_N + q_S + q_E + q_W = 215 + 580 + 855 + 685 = $ 2335 Btuh

$\therefore q_{total} = 3790 + 2335 = $ 6125 Btuh

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 15 of 51

c. Floor

$\Delta T = 78-70 = 8°F$ $U = .44$, $A = 1230$

$q = UA\Delta T$

$q = .44(1230)(8)$

$q = 4330$ Btuh

d. Ceiling

$\Delta T = 78-70 = 8$, $U = .44$, $A = 1230$

$q = 4330$ Btuh

e. Doors, $Q = 583$ cfm, $\Delta T = 25$

$q_s = 1.08(583)(25)$ $q_L = .7(583)(25.21-11.07)$

$q_s = 15,745$ Btuh $q_L = 59,745$ Btuh

$q_s + q_L = 75,490$ Btuh

Conduction

$q = .29(63)(25) = 460$ Btuh

$\therefore q_{TOTAL} = 75,950$ Btuh

f. Lighting

$A = 41(30) = 1230$ ft², 4 w/ft²

$4(1230) = 4920$ W

$q = W(3.4)(1.2)$

$q = 4920(3.4)(1.2)$

$q = 20,075$ Btuh

g. People

This room will not be permanently occupied, therefore $q = 0$.

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 16 of 51

3. Office and Equipment Room

a. Equipment

10kW = 10×10³W (3.4121) = 34,125 Btuh

b. Walls

Conduction

A = 2(11.5×41) + 2(11.5×30) = 1635 ft²

U = .082, ΔT = 95-78 = 17°F

q = UAΔT

q = .082(1635)(17)

q = 2,280 Btuh

Solar gain

A_N = 11.5(30) = 345 ft² TD_N = 10

A_S = A_N = 345 ft² TD_S = 27

A_E = 11.5(41) = 472 ft² TD_E = 20

A_W = A_E = 472 ft² TD_W = 16

q_N = .082(345)(10)
q_N = 285 Btuh

q_E = .082(472)(20)
q_E = 775 Btuh

q_S = .082(345)(27)
q_S = 765 ft²

q_W = .082(472)(16)
q_W = 620 Btuh

$q_N + q_S + q_E + q_W$ = 285 + 765 + 775 + 620 = 2445 Btuh

c. q_{total} = 2280 + 2445 = 4725 Btuh

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 17 of 51

c. Floor
$\Delta T = 70-78 = -8°F$, $U = .44$, $A = 1230$
$q = UA\Delta T$
$q = .44(1230)(-8)$
$q = -4330$ Btuh

d. Ceiling
$\Delta T = 0, q = 0$

e. Doors
1 single door
$A = 21$ ft², $P = 20$ ft, $Q = 11(20) = 220$ cfm, $U = .29$, $\Delta T = 17$, $\Delta HR = 111.1$
infiltration
$q_s = 1.08 Q \Delta T$ — $q_L = .7 Q \Delta HR$
$q_s = 1.08(220)(17)$ — $q_L = .7(220)(111.1)$
$q_s = 4040$ Btuh — $q_L = 17,110$ Btuh

$q_s + q_L = 21,150$ Btuh

Conduction
$q = UA\Delta T$
$q = .29(21)(17)$
$q = 105$ Btuh

$q_{total} = 105 + 21,150 = 21,255$ Btuh

5. Lighting
same as Auxiliary Electric Room
$q = 20,075$ Btuh

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 18 of 57

g. People
10 max (OSSiCE only)

$q_s = 10(240) = 2400$
$q_L = 10(510) = 5100$
7500 Btuh

5 cfm/person · 100 cfm
$q_s = 1.08Q\Delta T$
$q_s = 1.08(100)(17)$
$q_s = 1840$ Btuh

$q_L = .7Q\Delta W$
$q_L = .7(100)(111)$
$q_L = 7780$ Btuh

$q_{total} = 7500 + 1840 + 7780$
$q_{total} = 17{,}120$ Btuh

4. Training Room

a. Equipment
10 kW (simulator estimated load), same as OSSiCE & Equipment Room
$q = 34{,}125$ Btuh

b. Walls
conduction
$A = 2(17.5 \times 41) + 2(17.5 \times 30) = 2485\ ft^2$
$U = .082,\ \Delta T = 17$
$q = UA\Delta T$
$q = .082(2485)(17)$
$q = 3465$ Btuh

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SAFETY RELATED

DESIGN ANALYSIS

Solar gain, U=.082

$A_N = 17.5(30) = 525$ ft^2

$A_S = A_N = 525$ ft^2

$A_E = 17.5(41) = 720$ ft^2

$A_W = A_E = 720$ ft^2

$TD_N = 10$

$TD_S = 27$

$TD_E = 20$

$TD_W = 16$

$q_N = .082(525)(10)$

$q_N = 435$ Btuh

$q_S = .082(525)(27)$

$q_S = 1165$ Btuh

$q_E = .082(720)(20)$

$q_E = 1185$ Btuh

$q_W = .082(720)(16)$

$q_W = 945$ Btuh

$q_S + q_N + q_E + q_W = 1165 + 435 + 1185 + 945 = 3730$ Btuh

$\therefore q_{total} = 3465 + 3730 = \underline{7195 \text{ Btuh}}$

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Date

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DESIGN ANALYSIS

c. Floor
$\Delta T = 0,\ q = 0$

d. Ceiling
$\Delta T = 17,\ U = .032,\ A = 1230$

$q = UA\Delta T$
$q = .032(1230)(17)$
$q = 670$ Btuh

e. Doors
Same as 480V Room

$q = 56,360$ Btuh

f. Lighting
Same as Auxiliary Electric Room
$q = 20,075$ Btuh

g. People
25 max
$q_s = 25(240) = 6000$
$q_L = 25(510) = 12,750$
18,750 Btuh

5 cfm/person = 125 cfm

$q_s = 1.08(125)(17)$ $q_L = .7(125)(111.1)$
$q_s = 2295$ Btuh $q_L = 9,725$ Btuh
$q_s + q_L = 2295 + 9725 = 12,020$ Btuh

$q_{Total} = 12,020 + 18,750 = 30,770$ Btuh

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CN 1461
BY [illegible]
PAGE B-22

SAFETY RELATED

DESIGN ANALYSIS

VI Summary of Cooling Load Calculations

1. 480 V Room

Equipment	153,450 Btuh
Walls	8300
Floor	8160
Ceiling	-4330
Doors	56,360
Lighting	31,335
People	6160
Ventilation-Battery Room	9640
	269,075 Btuh

2. Auxiliary Electric Room

Equipment	68,240 Btuh
Walls	6,125
Floor	4,330
Ceiling	4,330
Doors	75,950
Lighting	20,075
People	0
Total	179,050 Btuh (to be supplied by computer room units)

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Date

SAFETY RELATED
DESIGN ANALYSIS
Sheet 22 of 51

3. Office and Equipment Room

Equipment	34,125 Btuh
Walls	4,725
Floor	-4,330
Ceiling	0
Doors	21,255
Lighting	20,075
People	17,120
Total	92,970 Btuh

4. Training Room

Equipment	34,125 Btuh
Walls	7195
Floor	0
Ceiling	670
Doors	56,360
Lighting	20,075
People	30,770
Total	149,195 Btuh

Total Cooling Load 690,290 Btuh, of this load, 179,050 Btuh (14.9 tons) is to be supplied by the computer room HVAC system and the remainder, 511,240 Btuh (42.6 tons) will be supplied by the rooftop HVAC unit.

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Date

SAFETY RELATED DESIGN ANALYSIS

VII Room air flow requirements

$\Delta T = \frac{q}{1.08Q}$ ∴ $Q = \frac{q}{1.08\Delta T}$

A. 480V Room, $\Delta T = 23$
$q = 269{,}075$ Btuh

$Q = \frac{269{,}075}{1.08(23)} = 10{,}832$ cfm

(11,955 used to allow for expansion and error)

B. Auxiliary Electric Room
$q = 179{,}050$ Btuh, $\Delta T = 20$

$Q = \frac{179{,}050}{1.08(20)} = 8290$ cfm

(8290 cfm will be delivered by each unit for redundancy)

C. Office and Equipment Room
$q = 92{,}970$ Btuh, $\Delta T = 23$

$Q = \frac{92{,}970}{1.08(23)} = 3750$ cfm

(4000 cfm used for expansion and error)

D. Training Room
$q = 149{,}150$ Btuh, $\Delta T = 23$

$Q = \frac{149{,}150}{(1.08)(23)} = 6000$ cfm

(6000 cfm used due to fact that load was included for simulator)

Total for rooftop unit = 20,450 cfm, unit will supply 22,000 cfm to allow for expansion and error.

Total for computer room units 16,580 cfm for both.

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SAFETY RELATED DESIGN ANALYSIS
Sheet 24 of 51

VIII Unit Fan Sizing

A. Roof top

Supply - from computer run data for supply system, static pressure loss through duct is 2.12" not including roof top unit and roof curb losses.

Return - 55 ft. of duct @ 1"/100ft. .06"
single elbow .12"
double elbow .34"
insulated duct, .6"/100ft for 40 ft = .24"
total → .76"

Roof top unit roof curb losses are approximately .12" for both supply and return, therefore required fan capacities are:

Supply 2.12"+.12" = 2.24"
Return .76"+.12" = .88"

B. Computer Room

static pressure loss through the raised computer room floor is assumed to be constant at .5". (from floor vendor data)

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Date

SAFETY RELATED

DESIGN ANALYSIS

Sheet 25 of 51

IX. HVAC Final Design Considerations

In order to insure complete redundancy in the computer rooms, there will be one HVAC unit on each side and each unit will be sized to supply the total cooling for both sides should one unit fail completely. There will be an emergency damper installed under the raised floor to direct airflow from one side to the other should this situation arise.

The supply air system is of the variable air volume type which modulates the airflow to each zone as needed to keep up with load demand. Airflow control boxes in the training room and office area will be supplied with electric reheat coils to insure comfort during the winter months. All others areas will be supplied with cooling only control boxes due to the fact that cooling loads in these areas far surpass heating loads throughout the year. Supply system ductwork was designed using the Trane Company supply duct design computer program, a copy of which is included as part of this blue package. Supply duct system will be supplied and installed as detailed in specification 75-J-02 and as shown on drawings M-435 and M-436.

The return duct system was designed using a Trane Ductulator, and will be made of rectangular duct. Return system will be supplied and installed per specification 75-J-02 and drawings M-435 and M-436. A constant friction loss of .1"/100ft. duct was used for the return duct sizing.

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SAFETY RELATED

DESIGN ANALYSIS

Sheet 26 of 51

HVAC equipment will be supplied and installed as detailed in spec. 75-J-02 and as shown on drawing M-437. The rooftop HVAC unit will supply 511,240 Btuh which translates to a 42.3 ton capacity, therefore a 50 ton unit will be used. (45 ton units are not generally available, especially with a variable air delivery system). All HVAC electrical work will be done per CN-1462 and section 16000 of spec. 75-J-02.

HVAC in the computer rooms will be supplied by two units, one on each side, to be supplied and installed per spec. 75-J-02. Each computer room unit shall have the capability of supplying the cooling load for the entire floor, or 179,050 Btuh (14.9 tons). Two 15 ton units will be used for this floor. Each will be connected to a separate condenser to maintain redundancy. Condenser units will be mounted on the roof of the building. All HVAC installations will comply with the Uniform Mechanical Code, 1979 Edition, and spec. 75-J-02.

Supply water piping will be routed to the computer room HVAC units per spec. 75-J-02 and drawings M-437 and B-445. Drain and vent lines will be run per the same spec. and drawings. Drain line from the computer room floor drains was routed to drain through the wall of the new building per Ed Hicks instructions. Piping installation will comply with the Uniform Plumbing Code, '78 Edition.

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Date

SAFETY RELATED DESIGN ANALYSIS
Sheet 27 of 51

Refrigeration piping from the computer room HVAC units to the rooftop condensing units will be installed per spec. 75-J-02, drawing M-437, and Uniform Mechanical Code '79 Edition requirements.

X. Hanger Design - Seismic

Hangers for horizontal duct runs must be designed to withstand a vertical seismic loading so as not to fall on safety related equipment. There will not be any safety related equipment above the equipment room at El. 4824'0", so hangers will be analyzed at this elevation as a worst case to make sure spans, supports and bolting as called out in 75-J-02 will be sufficient. HVAC hangers will be just below El. 4835'6", so the vertical seismic acceleration at this elevation will be used and is equal to 1.1g. It is assumed that, due to their configuration, hangers will not support loading in the horizontal direction, therefore they will only be checked for strength in the vertical direction. Equations from "Mechanical Engineering Design" by Shigley, acceleration and static coefficient from Stone and Websters 3RCR design calculations.

A. Rectangular Duct

1. 22"x13" duct

6 ft²/ft of run, 26 gauge, .75 lb/ft²

W = 4.5 lb/ft of run = distributed load

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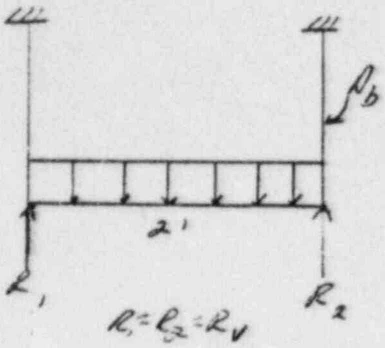


SAFETY RELATED DESIGN ANALYSIS
Sheet 28 of 51

a. Vertical Loading

$w = 4.5\#/ft$, span $= 6$ ft. $= l$

$R_V = \frac{wl}{2} = \frac{(4.5)(6)}{2} = 13.5$ lb. = vertical reaction

seismic loading, $R_s = R\,a_V\,(S.C.)$ a_V = dead weight acceleration plus given seismic acceleration

$a_V = 1.0 + 1.1 = 2.1g$, S.C. = 1.5 (static coefficient)

$R_s = (13.5)(2.1)(1.5) = 42.5$ lb. = seismic reaction

$\sigma = 20{,}000$ psi $d = ?$

$A_b = \frac{R_s}{\sigma} = \frac{42.5\ lb}{20{,}000\ \#/in^2} = .0021\ in^2$ = bolt area σ = conservative allowable steel stress

$d = .052$ in = bolt diameter

will use $d = .375"$, safety factor $= 7.2$

Maximum Moment $= M_{max}$ will be at $x = l/2$, $F = 2R_s$.

$$M_{max} = \frac{Fx}{2} = \frac{2R_s(l/2)}{2} = \frac{R_s l}{2} = \frac{(42.5)(2)}{2} = 42.5\ ft\,lb$$

section modulus $= Z_{max} = \frac{M_{max}}{\sigma} = \frac{42.5\ ft\,lb\,(12\ in/ft)}{20{,}000\ lb/in^2} = .0255\ in^3$

Z for 1"x1"x1/4" angle (as called out in spec. 75-J-02) is .05, so safety factor is 2.0

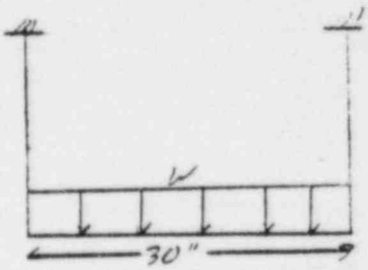
2. 28"x18" duct

27 ft²/ft of run, 26 ga., .125 lb/ft²

5.8 lb/ft run, span = 6 ft

$R_V = \frac{wl}{2} = \frac{(5.8)(6)}{2} = 17.4$ lb

$R_s = 17.4(2.1)(1.5) = 54.8$ lb



Prepared By: /s/ [signature] 9/16/82
Date

SAFETY RELATED DESIGN ANALYSIS
Sheet 29 of 51

$\sigma = 20{,}000$

$A_b = \frac{R_s}{\sigma} = \frac{54.8}{20{,}000} = .0027\ in^2$ $\quad A = \pi R^2 \quad R = \sqrt{A/\pi} \rightarrow d = 2\sqrt{A/\pi}$

$\therefore d = .059\ in$

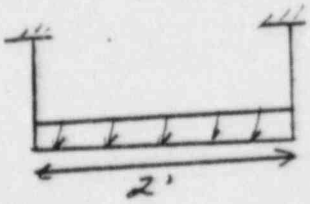
will use $d = .375"$, $\therefore$ Safety Factor $= 6.4$

$M_{max} = \frac{R_s l}{2} = \frac{(54.8)(2.5)}{2} = 68.5\ ft \cdot lb$

$Z_{max} = \frac{(68.5)(12)}{20{,}000} = .041\ in^3$

$\therefore$ safety factor $= 1.2$

3. 22"x8" duct



6.7 ft²/ft run, .75 lb/ft², 26 ga., l = 6

$w = 5.0\ lb/ft\ run$

$R_v = \frac{wl}{2} = \frac{(5.0)(6)}{2} = 15.0\ lb$

$R_s = (15)(2.1)(1.5) = 47.3\ lb$

$A_b = \frac{47.3}{20{,}000} = .0024\ in^2$ $\quad d = .055\ in$

$\therefore$ bolt safety factor $= 6.8$

$M_{max} = \frac{47.3(2)}{2} = 47.3\ ft \cdot lb$

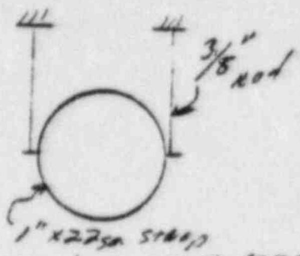
$Z_{max} = \frac{47.3(12)}{20{,}000} = .028\ in^3$

$\therefore$ angle iron safety factor $= 1.8$

Prepared By: /s/ [signature] 9/10/82
Date

SAFETY RELATED DESIGN ANALYSIS

B. Round Duct



1. 24" round duct and smaller
Span = 8 ft, 7.8 lb/ft run, 24 ga.

$W = 7.8$ lb/ft run

$R_V = \frac{7.8(8)}{2} = 31.2$ lb

$R_S = 31.2(2.1)(1.5) = 98.3$ lb

$A_b = \frac{98.3}{20,000} = .0049\ in^2$; $d_b = .079$ in

∴ bolt safety factor = 4.7

$R_S = 98.3$

Strap max. load = 260

∴ strap safety factor = 2.6

2. 26" round duct, 24 ga., $l = 6$ ft

$W = 8.5$ lb/ft run

$R_V = \frac{Wl}{2} = \frac{(8.5)(6)}{2} = 25.5$ lb.

$R_S = (25.5)(2.1)(1.5) = 80.3$ lb

$A_b = \frac{80.3}{20,000} = .0040\ in^2$, $d = .071$ in

∴ bolt safety factor = 5.3

Prepared By: /s/ [signature] 9/16/82
Date

SAFETY RELATED DESIGN ANALYSIS
Sheet 31 of 51

allowable strap load = 260 lb.

∴ strap safety factor = 3.2

All horizontal duct run hangers are sufficient to sustain vertical seismic loading. It is assumed that all vertical duct runs will remain within the penetration boundaries after hanger failure, and will not cause a problem as far as damage to safety related equipment is concerned. All vertical and horizontal duct hangers as called out in spec. 75-J-02 are designed to SMACNA Standards, 1976 Edition, with extra safety factors included. It is assumed that any failure of a vertical duct hanger will not cause a problem with safety related equipment due to the fact that duct will be contained within the duct floor penetration boundaries.

XI Fire Protection System

The fire protection system for the BRCR will be designed and installed as called out in spec. 75-J-02 per NFPA Standard 12A and UL requirements. The Contractor was supplied with room volumes and required Halon concentration (5% within 10 sec. of detection for 20 min soaking time at not less than 5% concentration with a full reserve charge) for all areas to be protected. The Contractor (or Subcontractor) will then design and install a Halon system to meet the criteria of spec. 75-J-02. The concentration and soaking time specified should be more than sufficient to put out the average deep seated fire and/or provide enough response time to get a

Prepared By: /s/ [signature] 9/8/82
Date

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

CN 1461D
BY M. Combard
PAGE B-32.1D

Form 344-22-4062

- [ ] ELECTRICAL
- [x] MECHANICAL
- [ ] STRUCTURAL
- [x] SAFETY RELATED
- [ ] NON-SAFETY RELATED

The use of beam clamps for attachment of the 3/8" rod for HVAC horizontal duct runs hangers to the building is allowed per this CN reissue. This low loading attached directly to the beams will cause no structural problems. Reviewing hanger design on pages B-28 thru B-32 of the initial issue of CN-1461, it is seen that the maximum seismic load resisted by the 3/8" rod is 98.3 lb. Using beam clamps rated at 300 pound minimum load, this yields a minimum safety factor of 3.1, and is considered acceptable for this application. The 300 pound minimum rating for the beam clamps will be added to spec. 75-J-02 by this reissue, along with the allowance to use the beam clamps themselves.

PREPARED BY [signature] 7/31/85
SIGNATURE DATE

(ENG-2)

CN 1461A
BY D. Lombard
PAGE B-33A
FORM NO. 372-30-2650

SAFETY RELATED DESIGN ANALYSIS
Sheet 32 of 51

fire fighting crew into the area. All design is subject to PSC approvals.

Fire dampers are to be installed everywhere that ductwork penetrates a wall or floor, and shall be of 3 hr. fire rated construction. Closure control shall be by a link that will close manually by a local push button, by a 165°F thermal fire link, or by an electrically actuated solenoid. This will enable the fire detection system to close all necessary dampers to seal against Halon leakage in a discharge area.

~~Electrical portion of the fire detection and Halon discharge control system will be done per CN-1462 and section 16000 of spec. 75-J-02.~~

Proto-Power Management Corp. has performed a fire hazards analysis for Building 10 and found the fire protection to be in compliance with Branch Technical Position 9.5-1, and is included as pages B-55A thru B-69A. Also see p. B-70A.

Added by CN-1461A

XII Plumbing Work

All plumbing work for this CN is for the computer room HVAC units and will be done per the 75-J-02 specification guidelines.

verification of Seismic hangers for copper pipe:

2" line, $W = 2$ lb/ft, $R_v = 20$ lb (10 ft. spacing)

$R_s = 20(1.5)(2.1) = 63$ lb.

$A_b = \frac{63}{20{,}000} = .00315 \text{ in}^2$

$d_b = \sqrt{\frac{4(.00315)}{\pi}} = .063 \text{ in}$ will use $d = .25$ in

∴ Safety Factor 3.97, piping hangers are O.K.

Prepared By: /s/ [signature] 9/15/82
Date

CN 1461
BY M. Lombard
PAGE B-33

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

SAFETY RELATED DESIGN ANALYSIS
Sheet 32 of 51

Electrical ☐
Mechanical ☒
Structural ☐

I. **Seismic Analysis:**

All hangers for horizontal duct runs were checked to verify that they could sustain a vertical seismic load. See p. B-28 thru B-32.

II. **Stress Analysis:**

This was done by Stone & Webster. See CN-1460.

III. **Piping/Hanger Analysis:**

See p. B-28 through B-32 for hanger analysis.

IV. **Hydraulic/Pneumatic Analysis:**

For duct system design, see p. B-24 thru B-26 and p. B-34 thru B-52.

CN 1461A
BY D. Lombard
PAGE B-33.2A
FORM NO. 372-30-2650

SAFETY RELATED DESIGN ANALYSIS (continued)

Sheet 33.2 of 51

V. **Thermal Analysis:**

N/A

VI. **Nuclear Analysis:**

N/A

VII. **Fire Protection Analysis:**

See p. B-33, B-35 and spec. 75-5-22.

A fire hazards analysis was performed by Proto-Power Corp. to review the fire protection for Building 10 per Branch Technical Position 9.5-1 and found the proposed system to be in compliance. See pages B-55A thru B-69A.
Also see p. B-70A for a discussion of the analysis.
Added by CN-1461A

VIII. **Environmental Analysis:**

N/A

IX. **Compatibility of Materials, Equipment and Processes:**

N/A

CN 1461A
BY [illegible]
PAGE 33.3A

SAFETY RELATED

DESIGN ANALYSIS

Sheet 23 of 51

Added by CN 1461 A

This analysis will calculate the airflow requirements for Room 103 of the walkway structure. Only conduction will be considered due to the configuration of this room and the fact that the sun will never be able to shine directly onto the walls of the room. The HVAC for this room will be supplied by the main Building 10 Rooftop unit.

HVAC Loads:

1. Heating

A. Walls $A = 2(10 \times 16.5) + 2(14 \times 16.5) = 800 ft^2$

$\Delta T = 70 - (-5) = 75$ $U = .105$ (3" insulation only)

$q = UA\Delta T = .105(800)(75)$

$q = 6300$ Btuh

B. Floor $U = .44$ (6" concrete) $\Delta T = 75$ (worst case) $A = 10(14) = 140 ft^2$

$q = .44(140)(75)$

$q = 4620$ Btuh

C. Ceiling $U = .31$ (12" concrete - conservative)

$q = .31(140)(75)$

$q = 3260$ Btuh

$q_{Total} = 14,180$ Btuh for heating

Revised by CN-1461A

$q = 14,180 \text{ Btuh} \left(\frac{1 W}{3.4121 Btuh}\right) = \underline{4160 W}$ or $\underline{4.2 kW}$ to be supplied by duct heater.

2. Cooling

A. Walls $\Delta T = 95 - 78 = 17°F$

$q = .105(800)(17)$

$q = 1430$ Btuh

B. Floor

$q = .44(140)(17)$

$q = 1050$ Btuh

C. Ceiling

$q = .31(140)(17)$ 740 Btuh

D. People, 8 max.

$q_s = 8(240) = 1920$

$q_L = 8(510) = \underline{4080}$

6000 Btuh

$q_{Total} = 9,220$ Btuh for cooling

$Q = \frac{q}{1.08\Delta T} = \frac{9220}{1.08(20)} = 427$ cfm

use 450 cfm

Prepared By: /s/ [signature] 10/20/82

Date

CN 1461
BY R. Lambert
PAGE B-34
FORM NO. 272-30-2680

```
VARITRANE AIR DISTRIBUTION SYSTEM
                                         PAGE    1
    06/23/82
                                         V  2000

THERE ARE NO ABORT LOGIC ERROR MESSAGES.
REMOVE TEST COMMENT AND SUBMIT FINAL RUN.

READY
logoff

TSDVR LOGGED OFF TSO AT 13:44:36 ON JUNE 23, 1982
LAST STEP COMPLETION CODE WAS USER   000

DFS2002 13:45:28 TERMINAL CONNECTED

/rcl

DFS058 13:55:06 RCLSDST COMMAND COMPLETED

tso tsdvr/1710

TSDVR LOGON IN PROGRESS AT 13:56:51 ON JUNE 23, 1982

*                                                      *
*          W E L C O M E   T O   L A C R O S S E   T S O   *
*                                                      *
*    USE OF THESE FACILITIES IS LIMITED TO TRANE APPROVED ACTIVITY   *
*                                                      *

   VARITRANE/TRANET OPERATORS NOTE:
   YOU MUST UNDERSTAND THE "TEST" PROCEDURE PAGE 4 POINT 6 AND PAGE
```

CN 1461
BY [signature]
PAGE 8-35
FORM NO. 372-30-2650

```
UNDERSTAND THESE POINTS, CALL JOHN WALTON.  YOU ARE BILLED $25 FOR
NON-TEST RUNS.  NO CREDITS WILL BE GIVEN FROM LA CROSSE FOR YOUR
ERRORS IN MAKING PRODUCTION RUNS WHEN YOU REALLY WANTED TO MAKE A
TEST RUN.

IMPORTANT:
IF THE SALES ENGINEER DESIRES HELP IN OPTIMIZING THE DUCT SYSTEM
AFTER THE INITIAL RUN IS MADE, CALL JOHN WALTON AT 787-3729.
RELAY INFORMATION CONCERNING OVERSIZING VAV BOXES, RELAXING SPACE
LIMITATIONS, LOWERING STATIC PRESSURES, ETC..  THIS CAN BE A GREAT
SELLING OPPORTUNITY BUT IT DOES MEAN AN ADDITIONAL $25.00 RUN.

JOB TSDVR(TSU04197) EXECUTING
JOB TSDVRV(JOB05217) ON OUTPUT QUEUE
JOB TSDVRT(JOB05240) ON OUTPUT QUEUE
JOB TSDVRY(JOB05405) ON OUTPUT QUEUE
JOB TSDVRT(JOB06741) ON OUTPUT QUEUE
JOB TSDVRT(JOB06772) ON OUTPUT.QUEUE
JOB TSDVRT(JOB08435) ON OUTPUT QUEUE
READY
varitrre public.data


JOB TSDVRG SUBMITTED
READY
14.09.29 JOB 7014 $HASP165 TSDVRG   ENDED AT LACROSSE CN(00)
%outproc tsdvrg
          (job07014) keep hold
```

CN 1461
BY [illegible]
PAGE B-36
FORM NO. 372-30-2680

```
//TSDVEG   JOB (1486,VAV),'PUBLIC EVD, 3 RM CON',CLASS=V,          JOB 9014
//  MSGCLASS=T,MSGLEVEL=(0,0),NOTIFY=TSDVR

IEF142I TSDVEG STEP1 VARIONE - STEP WAS EXECUTED - COND CODE 0000
IEF373I STEP /STEP1   / START 82174.1400
IEF374I STEP /STEP1   / STOP  82174.1400 CPU    0MIN 02.27SEC SRB    0MIN 00.10SEC VIRT   272K SYS   400K
IEF142I TSDVEG PRINT VARIONE - STEP WAS EXECUTED - COND CODE 0000
IEF373I STEP /PRINT   / START 82174.1400
IEF374I STEP /PRINT   / STOP  82174.1400 CPU    0MIN 00.40SEC SRB    0MIN 00.03SEC VIRT    80K SYS   180K
IEF375I  JOB /TSDVEG  / START 82174.1400
IEF376I  JOB /TSDVEG  / STOP  82174.1400 CPU    0MIN 02.67SEC SRB    0MIN 00.13SEC
```

CN 1441
BY [illegible]
PAGE B-37
FORM NO. 272-30-2650

CN 1461
BY D. Lanind
PAGE B-38
FORM NO. 872-30-2650

PUBLIC SVC. 3-RM COMPLEX ABDN.

PUBLIC SERVICE

FT. FT. VOAIN

MARK LUMBARD

JOB#

CN 1461
BY M. Lambert
PAGE B-39
FORM NO. 372-30-2650

THE SOLE LIABILITY OF THE TRANE COMPANY IN FURNISHING THE VARITRANE DUCT PROGRAM SHALL BE LIMITED TO REFUND OF THE PURCHASE PRICE OF THE PROGRAM SHOULD THERE BE ANY ERRORS IN PROGRAM LOGIC.

THE WARRANTY AND LIABILITY SET FORTH IN THE PRIOR PARAGRAPH IS IN LIEU OF ALL OTHER WARRANTIES AND LIABILITIES, WHETHER IN CONTRACT OR IN NEGLIGENCE; EXPRESS OR IMPLIED; IN LAW OR IN FACT; INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL THE TRANE COMPANY BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

VARITRANE AIR DISTRIBUTION SYSTEM

02/23/82

CN 1461
BY M. Lambert
PAGE B-40
FORM NO. 372-30-2650

PROGRAM INPUT

GENERAL SPECIFICATIONS OF THE SYSTEM

AIR DENSITY	TOTAL CFM	APPROX DESIGN	EST SP LOSS	MAX FAN SP	DISCHARGE FAN VEL	FAN TYPE	DESIGN METHOD	MAX NC LEVEL	CEILING EFFECT(DB)
0.062	22355.	3.30	2.00	3.50	1200.	DRAW-THRU	FIXED S.P.	35	10.

CALCULATE DUCT HEAT PICK UP	INSULATE ALL DUCTS	MAX % SUP AIR INCREASE	PRESS DROP DOWNSTREAM CONTROL UNIT	ORIFICE DIAMETER INTERVAL	SP BALANCE TOLERANCE	FAN EFF (%)	Y-FIT OPTION	MIN TRUNK DIA
NO	YES	10.	0.50	0.50	0.75	80.	NO	8.

CN 1461
BY M. Copland
PAGE B-41
FORM NO. 372-30-2650

VARITRANE AIR DISTRIBUTION SYSTEM PAG

06/21/83 V 3809

TRUNK DUCT DATA

TRUNK NO.	UP STREAM TRUNK	LENGTH	NO. ELBOWS 45	90	TAKEOFF ANGLE	DIVERSITY	MAX SPACE AVAIL	NO. CONSTRICTION	FIRE DAMP	OTHER SP LOSS	VEL AIR OUTSIDE DUCT	ACTUAL DESIGN	INSULATION	Y-OPT
1	1	4.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
2	1	44.	0	2	0	YES	0.	0	F	0.0	50.	1.10	1	0
12	1	3.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
13	3	3.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
3	2	7.	1	0	90	YES	0.	0		0.0	50.	1.10	1	0
4	3	27.	0	1	0	YES	0.	0		0.0	50.	1.10	1	0
5	2	24.	0	0	0	YES	0.	0	F	0.10	50.	1.10	1	0
6	5	27.	0	1	90	YES	0.	0		0.0	50.	1.10	1	0
7	6	10.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
8	7	10.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
9	8	10.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0
10	9	34.	0	1	90	YES	0.	0	F	0.0	50.	1.10	1	0
11	10	7.	0	0	0	YES	0.	0		0.0	50.	1.10	1	0

13 TRUNKS SPECIFIED FOR THIS SYSTEM

CN 1461
BY D. Lombard
PAGE B-42
FORM NO. 572-30-2650

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 3

03/23/82 V 2003

PROGRAM INPUT

RUN-OUT DATA

DUCT CONN NUMBER	UNIT CFM	UNIT TYPE	RUN-OUT LENGTH	FITTING TYPE	UNIT (SIZE)	DESIRED ROOM NC	ROOM NC CORRECTION	ADDITIONAL SP LOSS
1	2000.	VCCCE	2.	1	2000	35	0	0.0
12	2000.	VCCCE	2.	1	2000	35	0	0.0
13	2000.	VCCCC	2.	1	2000	35	0	0.0
3	2050.	VCCCE	2.	90	2000	35	0	0.0
4	1250.	VCCCP	3.	45	1200	35	0	0.0
4	1200.	VCCCE	3.	45	1200	35	0	0.0
6	2330.	VCCCE	2.	90	2000	35	0	0.0
7	2330.	VCCCE	2.	90	2000	35	0	0.0
5	2330.	VCCCE	2.	90	2000	35	0	0.0
9	1155.	VCCCP	3.	1	1200	35	0	0.0
10	1900.	VCCCE	3.	90	2000	35	0	0.0
14	1900.	VCCCP	3.	1	2000	35	0	0.0

12 RUN-OUTS SPECIFIED FOR THIS SYSTEM

CN 1461
BY M. Lombard
PAGE B-43
FORM NO. 372-30-2650

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 4

[illegible] U 2080

ERROR AND DIAGNOSTIC MESSAGES

* UNIT CHARACTERISTICS BASED ON JUNE 1977 CATALOG.

* FOR THE SOUND DATA TO BE ACCURATE, THE PROGRAM ASSUMES A 90 DEGREE
ATTENUATED ELBOW EXISTS BETWEEN THE FAN AND THE FIRST RUNOUT.

* CALCULATIONS BASED ON NO DUCT HEAT PICKUP.

CN 1481
BY B Lanlord
PAGE B-44
FORM NO. 372-30-2850

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 3

06/23/81 JJ 2020

OPTIMIZED AIR DISTRIBUTION SYSTEM

```
SCFM DELIVERED BY THE FAN (INCLUDING DUCT HEAT PICKUP)........................ 22855.
INCHES OF STATIC PRESSURE DEVELOPED BY FAN.................................... 4.12
INCHES OF STATIC PRESSURE LOSS THROUGH EQUIPMENT AND RETURN AIR SYSTEM........ 3.02
THIRD OCTAVE BAND ATTENUATION REQUIRED IN FAN SOUND ABSORBER.................. 4 DB
BASED ON ASSUMED FAN THIRD OCTAVE BAND SOUND POWER LEVEL OF.................... 92 DB
TOTAL PEAK CFM AS INPUT............. 22856 AFTER DUCT HEAT PICKUP............. 22855.
DIVERSITY OF THE SYSTEM............. 100%
```

TRUNK DUCT DATA

TRUNK NO.	UP STREAM	CFM	DUCT DIAMETER	DUCT LENGTH	NO. CONSTR	NO. ELBOWS	FITTING	FIRE DAMP	STATIC PRESS	INSUL ATION	DIVERSITY
TRUNK							ICTION 45 70				
1	1	2000.	12.	4.	0	0	0 REDUCER		2.40	1	YES

2	[illegible]	18550.	52.	447.	0	5	2	REDUCER		[illegible]		[illegible]
2	3	4460.	16.	8.	0	4	0	45 90 1		1.50	1	YES
4	3	2400.	14.	27.	0	0	1	REDUCER		1.61	1	YES
5	2	11955.	28.	21.	0	5	0	REDUCER	F	1.74	1	YES
6	5	8155.	26.	27.	0	4	1	Y-FIG-1		1.74	1	YES
7	6	5025.	25.	10.	0	0	0	REDUCER		1.72	1	YES
8	7	3405.	18.	10.	0	0	0	REDUCER		1.74	1	YES
9	2	4165.	10.	10.	0	0	0	REDUCER		1.64	1	YES
10	3	2850.	16.	34.	0	1	1	Y-FTG-2	F	1.45	1	YES
11	10	1950.	12.	7.	0	0	0	REDUCER		1.48	1	YES
12	4	2000.	42.	3.	0	0	3	REDUCER		2.18	1	YES
12	3	2000.	42.	3.	0	0	0	REDUCER		2.18	1	YES

CN 1461
BY R. Lombard
PAGE B-45
FORM NO. 372-30-2850

CN 1461
BY D. Cowhard
PAGE B-42
FORM NO. 372-30-2650

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 6

06/23/82 V 3232

RUN-OUT DATA

DUCT CONN NUMBER	UNIT CFM	UNIT SPECIFICATION		ELEC COIL KW	STGS	NC DESIRED	NC ACTUAL	DIAMETER	LENGTH	FITTING	ORIFICE DIAMETER	STATIC PRESSURE
1	2000,	VEEEE	2000	11.00	3	35	39*	12,	2,	REDUCER	9.80	+.42
3	2000,	VEEEE	2000	15.00	3	35	39*	12,	2,	90 T	9.0	+.06
4	1200,	VEEEE	1200	15.00	3	35	34	10,	3,	45 T	8.9	+.51
4	1200,	VEEEE	1200	15.00	3	35	34	10,	3,	45 T	8.6	+.51
6	2330,	VEEEE	2000			35	40*	12,	2,	90 T	8.8	+.12
7	2330,	VEEEE	2000			35	40*	12,	2,	90 T	8.9	+.07
8	2330,	VEEEE	2000			35	40*	12,	2,	90 T	8.3	+.41
9	1165,	VEEEE	1200			35	34	10,	3,	REDUCER	7.50	+.14
10	1700,	VEEEE	2000			35	37	12,	3,	90 T	8.8	+.34
11	1700,	VEEEE	2000			35	37	12,	3,	REDUCER	8.8	+.45
12	2000,	VEEEE	2000	11.00	3	35	39*	12,	2,	REDUCER	7.30	+.09
13	2000,	VEEEE	2000	11.00	3	35	39*	12,	2,	REDUCER	9.80	+.49

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 7

08/23/80 V 2000

TRUNK DUCT MATERIAL SUMMARY

ROUND DUCT DIAMETER INCHES	LENGTH FEET	SURFACE AREA SQ FEET	THICKNESS GAUGE	GALVANIZED STEEL LBS	STD GAUGE DUCT LBS/LINEAR FT	DUCT WEIGHT LBS PREFAB DUCT
10	10.0	26.2	26	23.7	2.55	25.50
12	17.0	53.4	26	48.4	3.04	51.68
14	27.0	99.0	26	89.7	3.50	94.50
16	43.0	180.4	24	200.2	5.40	242.30
18	10.0	47.1	24	54.5	5.73	57.30
22	10.0	57.6	24	66.6	7.00	70.00
26	27.0	183.8	24	212.5	8.42	227.34
28	34.2	475.9	22	247.[illegible]	11.37	385.60
2[illegible]	44.0	368.6	22	518.3	12.65	556.60
TOTALS	222.0	1491.7		1469.4		1567.90

CN 1461
BY B Lambert
PAGE B-48
FORM NO. 372-30-2650

NOTE THE DUCT WEIGHT IN LBS DOES NOT INCLUDE A WASTE FACTOR.

GAUGE THICKNESS BASED ON SMACNA RECOMMENDATIONS

CHECK PROGRAM PREFAB DUCT LBS/LINEAR FT AGAINST ACTUAL PREFAB DUCT WEIGHT.

FEET OF INSULATED TRUNK DUCTS 312.0

QUANTITY OF INSULATION ON TRUNK DUCTS 1247.2 SQ FEET

TRUNK CONNECTION MATERIAL SUMMARY

UPSTREAM TRUNK DIAMETER	NUMBER 90 DEGREE ELBOWS	NUMBER 45 DEGREE ELBOWS	NUMBER FIRE DAMPERS	NUMBER COUPLERS
14	1	0	0	0
16	1	2	1	0
26	1	1	0	0
23	0	0	1	0
32	2	0	1	0
TOTALS	5	3	3	0

CN 1461
BY [illegible]
PAGE 8-49
FORM NO. 372-30-2650

VARITRANE AIR DISTRIBUTION SYSTEM PAGE 8

06/23/88 -1- V 2000

TRUNK TRANSITION MATERIAL SUMMARY

....REDUCER....			...45 DEGREE....		...45 90 DEGREE...		.........Y FITTING.........		
UPSTREAM DIAMETER	NUMBER	DOWNSTREAM DIAMETER	NUMBER	DOWNSTREAM DIAMETER	NUMBER	DOWNSTREAM DIAMETER	NUMBER	DOWNSTREAM DIAMETER 1	DOWNSTREAM DIAMETER 2
FAN	1	42							
FAN	1	31							
FAN	1	12							
FAN	1	12							

22	4	20	0	0	1	15	0	0	0
25	0	0	0	0	0	0		25	15
25	1	22	0	0	0	0	0	0	0
23	4	18	0	0	0	0	0	0	0
18	1	16	0	0	0	0	0	0	0
16	1	14	0	0	0	0	0	0	0
16	1	12	0	0	0	0	0	0	0

TOTALS 6 REDUCERS 0 45 DEGREE 1 45-90 T 1 Y FITTINGS

CN 1461
BY M Lambert
PAGE 13-50
FORM NO. 372-20-2650

CN 1461
BY [illegible]
PAGE B-61
FORM NO. 372-30-2650

RUNOUT MATERIAL SUMMARY

RUNOUT DIAMETER	FLEX DUCT FEET	90 DEGREE TAKEOFFS	C-90 DEGREE TAKEOFFS	45 DEGREE TAKEOFFS	STRAIGHT OR REDUCER
10	9	0	0	2	1
12	20	5	0	0	4
TOTAL	29	5	0	2	5

CN 1461
BY M. Lambert
PAGE A-53
FORM NO. 372-…-2650

RATED CFM	200	400	800	1200	2000	3000	4000	5000	TOTAL
UNIT TYPE									
[illegible]	0	0	0	1	5	0	0	0	5
[illegible]	0	0	0	2	4	0	3	0	3

ELECTRIC COIL MATERIAL SUMMARY

RATED CFM		200	400	800	1200	2000	3000	4000	5000
KW & STAGE									
~~[illegible]~~	3	0	0	0	1	0	0	0	0
11.00	3	0	0	0	0	3	0	0	0
15.00	24	0	0	0	21	1	0	3	0

CHECK VAV PRODUCT CATALOG FOR AVAILABILITY OF DESIRED ELECTRIC COILS PER SPECIFIC BOX SIZES.

CN 1461A
BY M. Lehr
PAGE B-53A

CHECK LIST OF DESIGN VERIFICATION QUESTIONS

FOR DESIGN REVIEW METHOD

YES	NO	N/A		
(✓)	( )	( )	1.	Were the inputs correctly selected and incorporated into design?
(✓)	( )	( )	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
(✓)	( )	( )	3.	Are the appropriate quality and quality assurance requirements specified?
(✓)	( )	( )	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
(✓)	( )	( )	5.	Have applicable construction and operating experience been considered?
(✓)	( )	( )	6.	Have the design interface requirements been satisfied?
(✓)	( )	( )	7.	Was an appropriate design method used?
(✓)	( )	( )	8.	Is the output reasonable compared to inputs?
(✓)	( )	( )	9.	Are the specified parts, equipment, and processes suitable for the required application?
(✓)	( )	( )	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
(✓)	( )	( )	11.	Have adequate maintenance features and requirements been specified?
(✓)	( )	( )	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
(✓)	( )	( )	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
( )	( )	(✓)	14.	Has the design properly considered radiation exposure to the public and plant personnel?
(✓)	( )	( )	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

CN 14610
BY M. Lombard
PAGE B-540
FORM NO. 372-30-2650

CHECK LIST OF DESIGN VERIFICATION QUESTIONS - Cont'd.

YES NO N/A

( ) ( ) (✓) 16. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?

(✓) ( ) ( ) 17. Are adequate handling, storage, cleaning and shipping requirements specified?

( ) ( ) (✓) 18. Are adequate identification requirements specified?

( ) ( ) (✓) 19. Are requirements for record preparation review, approval, retention, etc., adequately specified?

Note: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES

UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

There are no problems with the design method used in this CN.

Mike [signature] 9/20/82

Mike [signature] 12/14/82

Mike [signature] 4/20/83 (Reissue C)

Mike [signature] 8/29/83 (Reissue D)

Mike [signature] (reviewed changes to reissue D 9/6/83)

Mike [signature] (reviewed copper ~~tubing~~ support spacing calcs. reissue D 9/13/83)

Note: This analysis was performed before the Three Room Complex Addition was changed to Building 10.

CN 1461A
BY M. Lombard
PAGE B-55A
FORM NO. 372-30-2650

PROTO-POWER MANAGEMENT CORPORATION

591 POQUONNOCK ROAD
GROTON, CONNECTICUT 06340
(203) 446-9725

File: 7511434

November 19, 1982

Mr. J.R. Reesy
Nuclear Design Department Manager
Public Service Company of Colorado
5909 East 38th Avenue
Denver, Colorado 80207

Dear Jack:

This letter contains the results of Proto-Power Corporation's fire protection review of the Fort St. Vrain Three Room Complex Addition. This review was requested by telecon with PSC on November 3, 1982. The review was performed in accordance with Branch Technical Position 9.5-1, Appendix A and 10CFR50, Appendix R as it applies to Fort St. Vrain. The Fire Hazards Analysis performed to evaluate compliance with regulatory requirements is included as Attachment A. The Three Room Complex Addition meets the requirements of these documents except for two points: 1) separation of redundant cables; and 2) lack of emergency lighting.

1. Cables designated B1L1 and B2L2 serving inverter 1A and 1B respectively are located in both the south end ground floor room and the ground floor walkover room 101. This cable routing violates Section G of Appendix R to 10CFR50 which states "one train of systems necessary to achieve and maintain hot shutdown conditions from either the Control Room or the emergency control station(s) is free of fire damage". Furthermore, BTP 9.5-1, Appendix A (Paragraph 3.4.1.a in PSC's response to BTP 9.5-1) requires that redundant safety related systems be separated from each other so that both are not subject to damage from a single fire hazard. Based on the understanding that, as a minimum, inverter 1A or 1B is needed for plant shutdown, Proto-Power finds the presence of both B1L1 and B2L2 cables serving inverter 1A and 1B respectively in the same fire area to be in conflict with regulatory requirements. Appendix R to 10CFR50 requires that redundant cables be protected by a combination of one hour rated fire retardant (or barriers), and fire detection and suppression system. To meet these requirements, Proto-Power

suggests wrapping one of the cable systems with a 1 hr. fire rated B&W Kaowool® blanket wrap currently being used by other utilities to meet this requirement. To meet the suppression system requirement, it could be demonstrated analytically that the in situ and transient combustibles in the two fire areas are too small (approximately 4 minutes) to be a fire hazard and therefore, don't warrant a fixed fire suppression system.

2. Fixed emergency lighting is not currently provided in the Three Room Complex Addition. BTP 9.5-1, Appendix A (Paragraph 3.4.5 in PSC's response to BTP 9.5-1) and Appendix R to 10CFR50 states that fixed emergency lighting is vital to safe shutdown and emergency response in the event of a fire. The absence of fixed emergency lighting violates regulatory requirements. Proto-Power suggests that fixed (battery pack) emergency lighting be provided for access and egress routes to and from the rooms within the Three Room Complex Addition.

Three additional points relating to fire protection are being suggested for your consideration, but are not required by either BTP 9.5-1 or Appendix R to 10CFR50.

- The 1C battery room exhaust fan should be provided with loss-of-flow indication in the Control Room. The fire hazards analysis assumes the fan is operating to ensure that H_2 concentrations are maintained below 2% (by volume).

- Pressure relief venting should be considered in the design of the Halon 1301 fire suppression systems to prevent overpressurizing the room during system discharge and, possibly destroying fire stops and door frames.

- If redundant sets of safety related equipment are planned for the south end ground floor room and mezzanine, consideration should be given at this time for their separation which may include fire barriers (walls) and the location of detectors, fire suppression (Halon 1301) system, and ventilation ducts.

In addition, there is one item concerning channel independence that is an apparent conflict with your present FSAR commitments. Attachment B outlines our concern on this item. While this item

CN 1461A
BY M. Lombard
PAGE B-57A
FORM NO. 372-30-2650

appears to be a departure from your FSAR commitments, it is independent from BTP 9.5-1, Appendix A or Appendix R to 10CFR50. If you agree with our conclusion on this matter we can recommend to you alternative ways of correcting this concern.

The above information contains the results of our review of the Three Room Complex Addition to the requirements of BTP 9.5-1, Appendix A and 10CFR50, Appendix R. If you have any questions, please call me at (203) 446-9725.

Sincerely,

R.A. Schaufler

R.A. Schaufler
Vice President

PDM:jmn
Attachment

ATTACHMENT A

The Three Room Complex Addition (3RCA) has 4 floors of rooms and a mezzanine over the northern portion of the ground floor. In descending order, the floors contain a training room, equipment and office rooms, a computer room, and a ground level battery room and two converter rooms at Elev. 4791'0". The ground level rooms including the mezzanine contain safety related equipment. The equipment room (El. 4824'0") was analyzed as a safety related room because it is anticipated that safety related equipment may be installed in the future, but none has been designated at this time. All other rooms are considered non-safety related equipment areas. A two level walkover structure abuts the 3 RCA from the west wall. The walkover floors access the ground level and computer rooms. The two walkover floors designated R101 and R102 contain safety related cables and cable trays, however, no equipment is to be installed in the walkover structure. The rooms designated as safety related fire areas therefore are the three rooms on the ground level, the two walkover rooms and the equipment room at El. 4824'0". Each of these fire areas is enclosed by three hour fire rated walls.

Access doors and emergency exits separating the building's outer wall and internal fire walls are U.L. Class A fire rated steel doors. Electrical cable in trays, risers, and conduit, and ventilation ducts that penetrate the floors and walls of fire areas are equipped with fire stops and ventilation fire dampers respectively.

When evaluating the effects of the design basis fire, consideration has been given to safety related equipment which, on the basis of vertical, as well as horizontal proximity, could be involved in the fire. Similarly, any combustibles above or below the design basis fire area, and the effects of using hose water on safety related equipment in and below the design basis fire area, have also been considered.

Communication during a fire situation is maintained primarily by the station's public address (GAI-Tronic) system. The 3 RCA ventilation system provides for the removal of smoke and corrosive gasses during and following a fire situation.

Emergency lighting, as required by 10CFR50, Appendix R, and BTP 9.5-1, is not incorporated in the design of the Three Room Complex Addition, or the attached walkover structure. Appropriate action as outlined in the attached letter should be taken to ensure compliance with this guideline.

Ground Floor South, Including Mezzanine - El. 4791'0" and El. 4800'0"

Area Description

Located on the ground level are safety related instrumentation inverter 1B, one 120 volt distribution panel, one 25 KVA backup power transformer and associated cable and cable trays. Safety related cable trays, designated for bus two, loop two (B2L2) routing, are installed above the ground level section of this fire area. The mezzanine contains no safety related equipment at this time. Safety related cable trays, designated for bus one, loop one (B1L1) routing, are installed above the mezzanine. As presently designed, the location of unprotected raceways, B1L1 and B2L2 in the same fire area, is a violation of 10CFR50, Appendix R and BTP 9.5-1. Appropriate corrective action, as outlined in the attached letter, should be taken to ensure compliance with these guidelines.

Fire Area Boundary

The south end ground floor is open to the mezzanine which is over the north end ground floor and battery rooms. This area is bounded by three hour fire rated walls, that separate it from the north ground floor room which contains the other raceways necessary for safe shutdown and the 1C battery room.

Fire Load

The fire load in this area is very small consisting of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 4320 Btu/ft^2 ($\approx$ 3-1/4 min.). These combustibles are not of sufficient quantity to be considered a hazard to both of the safety related raceways that exist within this fire area.

Fire Protection Systems

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire assumes the complete combustion of paper waste in two fifty-five gallon drums and all the electrical cable insulation. Ignition is dependent on a transient source. As a result of the low fire load (4320 Btu/ft^2), the separation of buses and the ability to achieve safe shutdown with equipment located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

Ground Level North - Elev. 4791'0"

Area Description

Located in the north ground level room are safety related instrument inverters 1A and 1C, their associated distribution panels, backup power transformers, cable and cable trays. While this safety related equipment is redundant (for 2 out of 3 P.P.S. inputs), only inverter 1A or 1B, which is in the south ground floor room, is needed to obtain safe shutdown. The cable trays installed in this fire area are designated for B2L2 routing. Cabling for inverter 1C is run in conduit.

Fire Area Boundary

The fire area consists of concrete walls and ceiling that have three hour fire ratings.

Fire Load

The fire load in this area is 5360 Btu/ft^2 ($\approx$ 4 min.). It is attributable to the small quantity of electrical cable insulation and waste consisting of paper in trash containers.

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire assumes the complete combustion of the paper waste that could exist in two fifty-five gallon drums, and all the electrical cable insulation within this fire area. Ignition is dependent on a transient source. As a result of the low fire load (5360 Btu/ft^2) and the ability to achieve safe shutdown with equipment located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

Battery Room - Ele. 4791'0"

Area Description

The battery room contains safety related bettery 1C.

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors. There is an exhaust fan which vents the room atmosphere directly to the outdoors. The exhaust fan duct is equipped with a three-hour fire rated damper.

Fire Load

The fire load in this area consists of electrical cable insulation, battery casing material, and loose paper in trash containers. The calculated fire load is 184,000 But/ft^2 (2.3 hrs.).

Fire Protection Systems

Fire detection is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes the complete combustion of the electrical cable insulation, battery casing material and paper waste in two fifty gallon drums. Ignition is dependent on a transient source. Since the battery is the only redundant safety related piece of equipment in this fire area and redundant safety related batteries are located in another separated fire area, the design basis fire will have no effect on the ability of the plant to achieve safe shutdown.

Equipment Room - Elev. 4824'0"

Area Description

The equipment room is capable of containing safety related equipment but none has been designated as yet. Safety related cable trays are designated for B2L2 service. The ceilings have noncombustible one hour rated acoustical paneling suspended from them. The concrete walls have one hour fire rated non-combustible drywall coverings.

Fire Area Boundary

The fire area is enclosed in three hour rated fire walls and ceiling and Class A fire rated doors.

Fire Load

The fire load in this area is 5280 Btu/ft^2 ($\approx$ 4 min.). It is based on electrical cable insulation and paper waste in trash containers.

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire for this area assumes the total combustion of the paper waste that could exist in two fifty-five gallon drums, and all electrical cable insulation in the fire area. Ignition is dependent on a transient source. As a result of the low fire load (5280 Btu/ft^2), and the absence of any safety related equipment, the design basis fire will have no affect on the ability of the plant to achieve safe shutdown.

Walkover Room 101 - Elev. 4791'0"

Area Description

Room 101 contains safety related cable routing B1L1 as well as cable routed as B2L2 service. As presently designed, the location of unprotected raceways B1L1 and B2L2 in the same fire area is a violation of 10CFR50, Appendix R and BTP 9.5-1. Appropriate corrective action as outlined in the attached letter should be taken to ensure compliance with these guidelines.

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors.

Fire Load

The fire load in this area is very small consisting of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 10,400 Btu/ft^2 (8 min.). These combustibles are not of sufficient quantity to be a hazard to both of the safety related raceways that exist within this fire area.

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable, dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes the complete combustion of paper waste contained in two fifty-five gallon drums, and all the electrical cable insulation within this fire area. Ignition is dependent on a transient source. As a result of the low fire load (10,400 Btu/ft^2), the design basis fire will not affect the ability of the plant to achieve safe shutdown.

Walkover Room 102 - Elev. 4811'0"

Area Description

Room 102 contains safety related cable and cable trays routed as B1L1.

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors.

Fire Load

The fire load is very small in this area and consists of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 9,600 Btu/ft^2 (7 min.).

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable, dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes complete combusiton of the paper waste contained in two fifty-five gallon drums, and all the electrical cable insulation contained in the fire area. Ignition is dependent on a transient source. As a result of the low fire load (9,600 Btu/ft^2) and the ability to achieve safe shutdown with system cables located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

THREE ROOM COMPLEX ADDITION
FORT ST. VRAIN

ATTACHMENT A TABLE 1

FIRE HAZARDS ANALYSIS SUMMARY

ITEM NO.	FIRE AREA LOCATION MAJOR EQUIPMENT	SAFETY RELATED	COMBUSTIBLE MATERIAL	QUANTITY	HEAT CONTENT (BTU/LB)	FIRE LOAD (BTU/FT²)	FIRE DETECTION	FIRE SUPPRESSION AVAILABLE	SEPARATION OF REDUNDANT S.R. EQUIPMENT
1	South Inverter Room Including Mezzanine	Yes	Cable Insulation	3 ft^3	12,000	4,320	Ionization Type	Dry Chemical	Separate Concrete Rooms & Cable Separation
2	North Inverter Room	Yes	Cable Insulation	.93 ft^3	12,000	5,360			Separate Concrete Rooms & Cable Separation
3	Battery Room	Yes	Cable Insulation Battery Cell Cases	.15 ft^3 12 ft^3	12,000 18,000	184,000			Separate Concrete Rooms
4	South Computer Room	No	Cable Insulation	.88 ft^3	12,000	8,400			
5	North Computer Room	No	Cable Insulation	.375 ft^3	12,000	7,520			
6	Equipment Room	Yes	Cable Insulation	.3 ft^3	12,000	5,280			No S.R. Equipment at present.
7	Office Room	No	Cable Insulation	.3 ft^3	12,000	5,280			
8	Walkover Room 101	Yes	Cable Insulation	.3 ft^3	12,000	10,400			Separate Concrete Room & Cable Separation
9	Walkover Room 102	Yes	Cable Insulation	.6 ft^3	12,000	9,600			" " "

CN 14610
BY M. Lombard
PAGE B-64A
FORM NO. 372-30-2650

ATTACHMENT B

The current design of the Three Room Complex Addition (3RCA) appears to conflict with current FSAR commitments in the specific area of the design for independence of the three logic channels. The conflict centers on the ability of a single event (i.e., a fire) to defeat the independence between the logic channels associated with Instrument Buses 1A and 1C. Specifically, the problem is the location of Inverter 1C and routing of cables associated with Inverter 1C in the same fire area as Inverter 1A and cables associated with Inverter 1A.

The bases for our convern are the FSAR commitments outlined below and as highlighted on the attached pages.

a. Compliance with Design Criteria 20 (See Attachment B-1).

b. Compliance with Design Criteria 21 (See Attachment B-2).

c. Compliance with the Principles of Design outlined in Section 7.1.1.2 (See Attachments B-3 and B-4).

This apparent conflict is not an area of non-compliance with BTP 9.5-1, Appendix A or Appendix R to 10CFR50 since the remaining channel 1B can be utilized to achieve safe shutdown.

CRITERION 20: PROTECTION SYSTEMS REDUNDANCY AND INDEPENDENCE (Category B)

"Redundancy and independence designed into protection systems shall be sufficient to assure that no single failure or removal from service of any component or channel of a system will result in loss of the protection function. The redundancy provided shall include, as a minimum, two channels of protection for each protection function to be served. Different principles shall be used where necessary to achieve true independence of redundant instrumentation components."

DISCUSSION:

On the basis of the following information, it is concluded that Criterion 20 is satisfied.

In general, three independent sensing circuits are provided for each plant protective system input parameter. Exceptions for Loop Shutdown and Circulator trip exist as shown in Figures 7.1-1, 7.1-2, 7.1-3; however these do have two sensing circuits.

The basic logic system is two-out-of-three for the scram and steam/water dump circuitry. Independence between the three logic channels is maintained up to the final output stage where the two-out-of-three combination is made. This includes supply of power from three independent instrument power sources. The loop shutdown and circulator trip circuitry utilizes dual output stages arranged in a one-out-of-two configuration to ensure system reliability. Either output is energized to actuate the final control element(s). (The output logic should not be confused with the input sensing channels which are generally two-out-of-three as previously stated.) (Section 7.1.2.1).

Since the basic logic is two-out-of-three, or one-out-of-two for loop shutdown and circulator trip, it follows that the unsafe failure of either an input sensing channel or an entire logic channel will not result in loss of the protective function.

Features included in the design for independence are outlined in Section 7.1.1.2.

ATTACHMENT B.2

CN 1461A
BY M. Lombard
PAGE B-67A
FORM NO. 372-30-2650

CRITERION 21: SINGLE FAILURE DEFINITION (Category B)

"Multiple failures resulting from a single event shall be treated as a single failure."

DISCUSSION:

On the basis of the following information, it is concluded that Criterion 21 is satisfied.

Multiple failures resulting from a single event are treated as a single failure. Single events considered in the design for independence are outlined in Section 7.1.1.1. The environmental conditions for areas in the Fort St. Vrain plant are given in Section 7.1.1.4. 7.1.1.2

In addition the Proposed IEEE Guide to the Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems, Fifth Draft, dated 9/30/68, has been used in the design of the Plant Protective System.

modules in the conducting or nonconducting mode, failure of power supplies, blockage or severance of process connections, and failures of transducers. The short circuits considered include those credible faults which affect multiple components, as may be illustrated by single interconnecting lines on a schematic, and which may prevent system action. The basic logic system employs 2 of 3 redundancy for the sensing channels. The scram control is designed using hindrance logic, i.e., loss of power produces a scram. The accidental shutdown of both coolant loops must be avoided to provide the necessary core cooling. The associated circuitry is therefore deenergized during plant operation. Steam/water dump, loop isolation, and circulator trip circuitry are therefore designed using transmission logic, i.e., circuits are energized to produce protective action. Redundant output circuitry and final control elements are provided.

Quality of Components and Modules. The bulk of the electronics and circuitry (excluding preamplifiers when required) is located in the reactor plant protective system controlboard. A high degree of quality is maintained by rigid specifications and quality control. Components employed are of a high quality level and generally derated by at least 50%. Failure mode analysis has been made on critical circuitry. Wherever possible previously used circuitry, components, and modules have been employed minimizing the design of new circuitry. Solid-state circuitry is employed in conjunction with relays, utilizing the advantages of solid-state devices in low-level signal amplification and the advantages of relays for circuit isolation and for handling power. The procurement of all major plant systems is from reliable suppliers having previous experience in the design and construction of similar systems.

Channel Independence. In designing for channel independence, single events which are considered plausible include:

1. Shearing or blocking of process connections.

2. Rise in temperature, pressure, or humidity in the sensor, signal transmission, or readout area.

3. Vibration of process connections.

4. Severance, crushing, or shorting of wiring paths.

5. Fires in control areas.

6. Missiles.

7. Module removal.

ATTACHMENT B.4

In the design of the instrument system, the following means are employed to achieve channel independence:

1. The combining of redundant channels is made as close to the output portion of the systems as is practical. Hence, the use of the general logic scheme.

2. Channels are connected to the process system by physically separated instrument connections.

3. Redundant sensors are physically separated. For example, the neutron detectors and reactor pressure sensors are mounted in separate wells and PCRV penetrations spaced about the PCRV.

4. Wiring or cabling between redundant sensor locations and control room or control panel and on the controlboard are physically separated and mechanically protected where required.

5. Redundant power supplies are used to supply the various channels so that loss of a given power supply will not prevent system action or cause an unnecessary protective action.

6. Circuits are suitably fused and protected so that in the event of single grounds or shorts, the fault will be isolated and will not feed back into the system.

7. Circuits and components are used that, insofar as is practical, fail in a safe direction.

8. Sensor, protective apparatus, and readout components are physically located and protected to minimize possibility of accidental contact or damage. For example, the location of instruments within penetrations in the PCRV provides a considerable degree of protection from physical damage. The scram and other redundant plant protective system circuitry is located in separate vertical sections of controlboard separated by physical and thermal barriers.

Equipment Qualification. Various functional and calibration tests have been performed to ensure that the equipment is in conformance with the specification. This testing included:

1. Testing of components (such as plug-in assemblies).

2. Testing of assemblies (such as drawers or transmitters).

3. Point-to-point continuity and insulation resistance of wiring.

Accuracy drift tests on assemblies have been made.

Discussion of Fire Hazards Analysis

As per the preceding fire hazards analysis by Proto-Power Management Corp., the fire protection supplied by the planned detection and annunciation system and the installation of handheld dry chemical fire extinguishers meets the intent of Branch Technical Position 9.5-1. Therefore, per Branch Technical Position (BTP) 9.5-1, the procurement and installation of these items shall be covered by a QA program, which will bring the fire protection system into compliance with BTP 9.5-1.

In addition to the installation of the equipment discussed above, a Halon suppression system will also be installed in Building 10 in all areas except for the Training Room and the Office Area. This system is being installed for insurance purposes to provide extra protection in equipment areas of the building, and by no means is it being installed to meet BTP 9.5-1. Therefore, installation of this system will not be covered by a QA program, even though the Contractor will insure that all equipment is designed, purchased and installed per NFPA 12A and UL guidelines.

CN 1461D
BY M. Lombard
PAGE B-71D
FORM NO. 372-30-2650

Unistrut Engineering Evaluation

The following pages contain an engineering evaluation on the use of P3300 Unistrut cast into concrete and used as a support for duct hangers and piping runs. Pages B-72D and B-73D contain the evaluation done by our Structural Dept. verifying the loading that the Unistrut would be rated for in the Building 10 situation, and also some recommended installation instructions. Pages B-74D thru B-77D contain the calculations verifying vertical duct run loads and the minimum safety factor involved when using Unistrut to support these duct runs.

The only type of loading not evaluated on p. B-72D and B-73D is when the Unistrut is loaded within two inches of the end of the insert. According to Unistrut engineering data, this loading would decrease the rating by a factor of two. This fact is addressed on page B-77D and this type of loading will be allowed only as absolutely necessary and as approved by the Engineer for the particular locations. The safety factors as given on p. B-76D do not take additional credit for the 3 to 1 safety factor included in the loading data given by Unistrut and used in the evaluation on p. B-72D.

CALCULATIONS FOR			CN 1461D
EQUIP. NO.	PROJ. NO.	CALC. NO.	BY M. Lambard
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B-72D
REVIEWED BY	DATE	Engineering Evaluat	FORM NO. 372-30-2650
APPROVED BY	DATE		

UNISTRUT CONCRETE INSERTS

THE PURPOSE OF THIS MEMO IS TO OUTLINE THE STRUCTURAL DEPARTMENT'S VIEWS AND RECOMMENDATIONS ON USE OF GTE UNISTRUT P3300 SERIES CONTINUOUS CONCRETE INSERTS TO SUPPORT CLASS I/[redacted] ATTACHMENTS
NON-CLASS I
TO BUILDING 10.

TEST DATA (REF: DETROIT TESTING LABORATORY, INC. REPORT NO. 312178-D DATED 9/24/74) DOCUMENT THE INITIAL YIELD AND ULTIMATE CAPACITY OF SUBJECT CONCRETE INSERTS. DESIGNS LOADS LISTED IN THE REPORT WERE EXCEEDED BY TEST RESULTS BY A MINIMUM FACTOR OF SAFETY OF 3. FOUR PULLOUT AND TWO SHEAR TESTS WERE CONDUCTED FOR VARIOUS LENGTHS OF UNISTRUT WITH THE CENTER OF GRAVITY OF LOAD AT THE MIDPOINT ALONG THE UNISTRUT LENGTH.

RECOMMENDED LOAD FOR THE INSERTS SHOWN IN THE UNISTRUT CATALOG NO. 9 IS 1500 LBS PER FOOT OF UNISTRUT LENGTH FOR PULLOUT TYPE LOADING; THIS VALUE IS BASED ON CONCRETE COMPRESSIVE STRENGTH OF 5000 PSI. FOR BUILDING 10 APPLICATIONS THE ALLOWABLE LOAD SHOULD BE REDUCED TO

$$1500\ \text{LBS/FT} \times \frac{3500\ \text{PSI}}{5000\ \text{PSI}} = 1050\ \text{LBS/FT (PULLOUT)}$$

ALLOWABLE LOAD FOR DIRECTION TRANSVERSE TO THE LONGITUDINAL AXIS (OTHER THAN PULLOUT) BASED ON UNISTRUT DESIGN LOAD DATA SHOULD BE

$$1260\ \text{LBS/FT} \times \frac{3500\ \text{PSI}}{5000\ \text{PSI}} = 880\ \text{LBS/FT (SHEAR)}$$

IN CONCLUSION, IT IS FELT THAT USE OF THE P3300 SERIES UNISTRUT CONCRETE INSERTS ARE ACCEPTABLE AS DESCRIBED HEREIN WITH THE FOLLOWING STIPULATIONS:

CALCULATIONS FOR			CN 1461D
EQUIP. NO.	PROJ. NO.	CALC. NO.	BY M. Lombard
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B-73D
REVIEWED BY	DATE		FORM NO. 372-30-2650
APPROVED BY	DATE		

Recommended Installation Instructions

1) UNISTRUT L-SHAPED ANCHORS MUST NOT BE BENT IN ANY WAY FROM THEIR INTENDED ORIENTATION (AS DEPICTED IN UNISTRUT CATALOG) TO AVOID OBSTRUCTIONS SUCH AS REBAR. ENTIRE UNISTRUT SHALL BE RELOCATED AS NECESSARY TO CIRCUMVENT OBSTRUCTIONS. Unistrut should not interfere with rebar at any point.

2) UNISTRUT SHALL BE SURROUNDED BY CONCRETE TO WITHIN 1/16" OF THE UNISTRUT'S EXPOSED SURFACE, and be installed per Unistrut recommended instructions. MLT 9/1/83

3) RESULTANT OF APPLIED LOADS FROM ATTACHMENTS SHALL ACT AS CLOSE TO THE CENTER OF THE UNISTRUT LENGTH AS POSSIBLE. DETAILS SUCH AS UNISTRUT LENGTH, AND DIRECTION, LOCATION AND MAGNITUDE OF LOADS APPLIED TO BE REVIEWED AND APPROVED BY STRUCTURAL ENGINEERING, or by Mechanical Engineering. MLT 9/1/83

4) A CLEAR DISTANCE OF 6 INCHES MINIMUM SHALL EXIST BETWEEN THE UNISTRUT AND:
   - A) EDGE OR DISCONTINUITY OF CONCRETE FOR LOADING TOWARD EDGE
   - B) ANY ANCHORING DEVICE (I.E., DRILLED IN PLACE CONCRETE ANCHOR BOLTS) RELYING ON MECHANICAL TRANSFER OF LOAD TO CONCRETE FOR RESISTANCE.

BY: John O. Tee
6/15/83

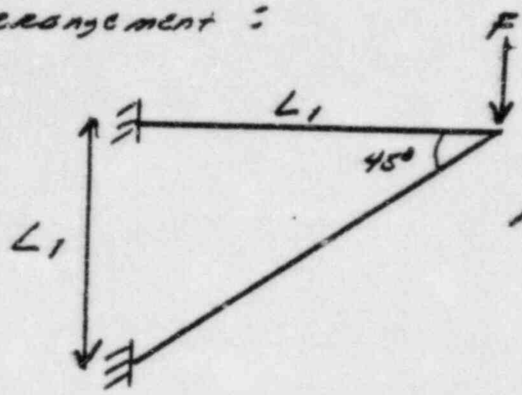
5. Unistrut should not be attached to within 2 inches of end of insert, unless absolutely necessary and approved by the Engineer. MLT 9/1/83

[signature] 9/1/83

CN 1461D
BY M. Combest
PAGE B-74 D
FORM NO. 372-30-2650

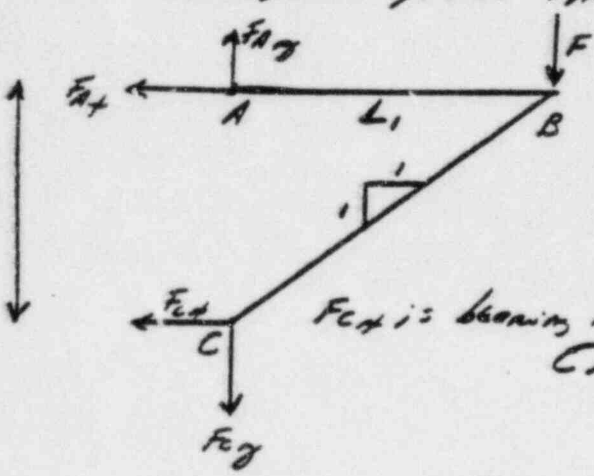
Unistrut Verification for Duct Hanger Attachment

Assume that all duct hangers are of the following arrangement:



F = total weight of duct ÷ 2, due to symmetry of duct hanger (see spec. 75-J-02, sec. 15000 for details) to be conservative, this total force will be assumed to act as shown.

This arrangement yields the following free body diagram:



$\Sigma M_A = 0$, ↻+ $\quad F L_1 + F_{Cx} L_1 = 0$

$F_{Cx} = -F\left(\frac{L_1}{L_1}\right) = -F$

and $F_{Cy} = F_{Cx}$, due to 45° angle

F_{Cx} is bearing load transmitted into wall, and can be ignored for this analysis

$\Sigma M_C = 0$, ↻+ $\quad F_{Ax} L_1 - F L_1 = 0$

$F_{Ax} = F\left(\frac{L_1}{L_1}\right) = F$

$\Sigma F_y = 0 \longrightarrow F_{Ay} = 0$ since $F_{Cy} = -F$

These equations will be used to check the loading put on the Unistrut inserts.

F_{Cy} = shear load to be resisted by Unistrut, F_{Ax} = pullout load to be resisted by Unistrut

Rectangular Duct, 8 ft. hanger spacing, vertical run

1. 24" x 24" duct.

from SMACNA Guidelines
- $8\,ft^2$ duct/lineal ft. $(8\,ft) = 64\,ft^2$ duct/8 ft. run
- 26 ga. metal, $.906\,\#/ft^2$; $(64\,ft^2)(.906\,\#/ft^2) = \underline{58.0\,\#/8\,ft\ run}$

Therefore, to be very conservative, assume $F = \frac{58.0}{2}$ lb. = 29.0 lb.

$F_{Cx} = -F = -29.0\#$, bearing load transferred into wall, insignificant
$F_{Cy} = -F = -29.0\#$, shear loading for Unistrut to resist
$F_{Ax} = F = 29.0\#$, pullout " " " " "

[signature] 8/26/83

2. 32" × 32" duct

10.7 ft² duct/lineal ft (8 ft) = 85.6 ft² duct/8 ft. run
24 ga. metal, 1.156 #/ft², (85.6 ft²)(1.156 #/ft²) = 99.0 #/8 ft. run

$F = 99.0^{\#} \div 2 = 49.5^{\#}$
$F_{Cx} = F = -49.5^{\#}$, bearing load transferred into wall, insignificant
$F_{Cy} = -F = -49.5^{\#}$, shear loading for Unistrut to resist
$F_{Ax} = F = 49.5^{\#}$, pullout " " " " "

3. 36" × 36" duct

12 ft²/lineal ft (8 ft) = 96 ft² duct/8 ft. run
24 ga. metal, 1.156 #/ft² (96 ft²)(1.156 #/ft²) = 110.0 #/8 ft. run
insulation 96 ft² (1.5 inch thick) $\left(\frac{1 ft.}{12 in}\right)$ = 12 ft³ $\left(\frac{.75 lb}{ft^3}\right)$ = 9 lb.

total weight of duct and insulation = 110.0 + 9.0 = 119.0 #/8 ft. run

$F = 119.0^{\#} \div 2 = 59.5^{\#}$
$F_{Cy} = -F = -59.5^{\#}$, shear loading
$F_{Ax} = F = 59.5^{\#}$, pullout loading

4. 42" × 42" duct

14 ft² duct/lineal ft (8 ft) = 112 ft² duct/8 ft. run
24 ga. metal, 1.156 #/ft², (112 ft²)(1.156) = 129.5 # duct/8 ft. run
insulation, 112 ft² (1.5 in) $\left(\frac{1}{12}\right)$ = 14 ft³ (.75) = 10.5 #/8 ft. run

total weight of duct and insulation = 129.5 + 10.5 = 140.0 #

$F = 140.0^{\#} \div 2 = 70.0^{\#}$
$F_{Cy} = -F = -70.0^{\#}$, shear loading
$F_{Ax} = F = 70.0^{\#}$, pullout loading

[signature] 8/20/83

Round Duct, 8 ft. hanger spacing, vertical run

1. 32" Round

22 ga., 12.6 #/lineal ft (8 ft) = 100.8 #/8 ft. run

insulation; surface area = $2\pi R$ (8 ft) = 2π (16 in)($\frac{1 ft}{12 in}$)(8 ft)

= 67.0 ft^2

volume = 67.0 ft^2 (1.5 in)($\frac{1}{12}$) = 8.4 ft^3

insulation weight = 8.4 ft^3 (.75 #/ft^3) = 6.3 #/8 ft run

total weight of duct and insulation = 100.8 + 6.3 = 107.1 #/8 ft run

F = 107.1 #/2 = 53.6 #

F_{cy} = −F = −53.6 #, shear loading

F_{At} = F = 53.6 #, pullout loading

2. 28" Round

22 ga, 11.0 #/lineal foot (8 ft) = 88 #/8 ft. run

insulation, surface area, = $2\pi R h$ = 2π (14)($\frac{1}{12}$)(8 ft) = 58.6 ft^2

volume = 58.6 ft^2 (1.5 in)($\frac{1}{12}$) = 7.3 ft^3

weight = 7.3 ft^3 (.75 #/ft^3) = 5.5 #/8 ft. run

total weight of duct and insulation = 88 + 5.5 = 93.5 #/8 ft. run

F = 93.5 # ÷ 2 = 46.8 #

F_{cy} = −F = −46.8 #, shear loading

F_{At} = F = 46.8 #, pullout loading

3. 16" round

24 ga, 5.1 #/lineal ft. (8 ft) = 40.8 #/8 ft. run

insulation, surface area = $2\pi R h$ = 2π(8)($\frac{1}{12}$)(8) = 33.5 ft^2

volume = 33.5 (1.5)($\frac{1}{12}$) = 4.2 ft^3

weight = 4.2 (.75) = 3.2 #/8 ft. run

total weight of duct and insulation = 40.8 + 3.2 = 44.0 #/8 ft run

F = 44.0 # ÷ 2 = 22.0 #

F_{cy} = −F = −22.0 #, shear loading

F_{At} = F = 22.0 #, pullout loading

[signature] 7/20/83

CN 1461D
BY M. Lombard
PAGE B-77D
FORM NO. 372-30-2650

Tabulation of hanger forces:

Duct Size and Type	Shear Loading	Pullout Loading
24" x 24" Rectangular	29.0#	29.0#
32" x 32" "	49.5#	49.5#
36" x 36" "	59.5#	59.5#
42" x 42" "	70.0#	70.0#
32" Round	53.6#	53.6#
28" "	46.8#	46.8#
16" "	22.0#	22.0#

Per the attached Unistrut calculations on p. B-72D and B-73D, the Unistrut is rated for 1050#/ft. pullout load and 880#/ft shear load. Using the maximum loading from the table above, this would give a 12.6 to 1 safety factor in shear and a 15.0 to 1 safety factor for pullout loading, assuming that a one foot minimum piece of insert is used for each attachment point. If the insert is loaded within two inches of the end, the safety factor minimums drop to 6.3 to 1 in shear and 7.5 to 1 in pullout. These safety factors do not include the additional 3 to 1 safety factor put into the loading data by Unistrut, and are considered adequate for this application.

Due to the very low loading involved, Unistrut inserts can also be used to anchor refrigeration piping runs at 8 ft. spacings, and also drain and vent lines and water supply piping anchors at 10 ft. spacing or less per spec. 75-J-02:

1. Refrigeration piping, worst case, 4½" line full of refrigerant, 8 ft. spacing, pipe - .5#/ft, refrigerant - .41#/ft, approximately 30#/hanger, safety factor = 29.3 to 1 (shear loading)
2. Drain and vent line, 2" copper, 2#/ft, 20#/hanger, safety factor = 44 to 1
3. Water supply line, pipe - .14#/ft, water - .29#/ft, 3.44#/8 ft. safety factor = 256 to 1 (shear loading)

[signature] 8/20/83

CN 1461 D
BY M. Lombard
PAGE B-78 D
FORM NO. 372-[illegible]-2650

Additional Hanger Information

Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) guidelines were used to size angle iron and duct fasteners for vertical duct runs. SMACNA recommends using 1"x1"x1/8" or 1¼"x1¼"x1/8" angle at 12 foot spacings for similar vertical duct hangers, therefore the use of 1"x1"x1/4" angle at 8 ft. spacings is considered very acceptable. The attachment of the vertical duct to the angle iron hanger was also designed using SMACNA guidelines per the following table:

Duct size and type	Weight per 8 ft. section (insulation included if app.)	number of fasteners	safety factor
42"x42" Rectangular	140.0#	14	3.5
36"x36" "	119.0#	10	2.9
32"x32" "	99.0#	10	3.5
24"x24"	58.0#	8	4.8
32" Round	107.1#	8	2.6
28" "	93.5#	6	2.2
16" "	44.0	4	3.2

[signature] 7/26/83

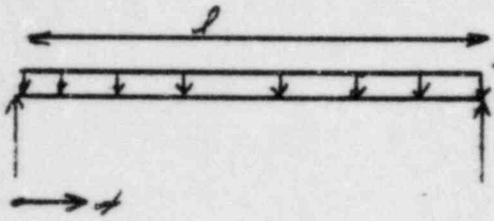
CN 1461 D
BY Mark Crandall
PAGE B-79 D
FORM NO. 372-30-2650

Additional Fire Protection Information

It is our intent that fire hydrant #9 and the hose reels contained in the building that envelops the hydrant will provide back up fire protection for Building 10. The hose reels are long enough to reach the equipment areas inside the building through the east access doors, and the recent relocation of fire hydrant #9 and its building make it more accessible for the fire fighting crews.

[signature] 8/21/83

1/4" tube, $d_o = .375"$, $d_i = .311"$, $w = .134$ #/ft, 4' hanger spacing, copper



Uniform load (from Mechanical Engineering Design, by Shigley)

$$M = \frac{wx}{2}(l - x) \quad M_{max} \text{ at } x = l/2$$

$$M = \frac{w(l/2)}{2}(l - l/2) = \frac{wl}{4}\left(\frac{l}{2}\right)$$

$$M_{max} = \frac{wl^2}{8}$$

Z = section modulus

$$Z = \frac{\pi}{32 d_o}(d_o^4 - d_i^4)$$

I = moment of inertia

$$I = \frac{\pi}{64}(d_o^4 - d_i^4)$$

weight of water in tube,

$$\text{volume} = \pi R_i^2 L = \pi\left(\frac{.311}{2}\right)^2(48)$$

$$= 3.65\ in^3\left(\frac{1 ft^3}{1728 in^3}\right) = .0021\ ft^3$$

$$\text{weight} = (.0021)(62.4\ \#/ft^3) = .132\ \#$$

$$w_{water} = \frac{.132\#}{4'} = .033\ \#/ft$$

$$w_{total} = .033 + .134 = .167\ \#/ft$$

$$M_{max} = \frac{wl^2}{8} = \frac{(.167\ \#/ft)(4 ft)^2}{8} = .334\ ft{\cdot}lb\left(\frac{12 in}{1 ft}\right) = 4.01\ in{\cdot}lb$$

$$Z = \frac{\pi}{32 d_o}(d_o^4 - d_i^4) = \frac{\pi}{32(.375)}(.375^4 - .311^4)$$

$$Z = .00273\ in^3$$

$$\sigma = \frac{M}{Z} = \frac{4.01\ in{\cdot}lb}{.00273\ in^3} = 1468.9\ psi$$

$$I = \frac{\pi}{64}(d_o^4 - d_i^4) = \frac{\pi}{64}(.375^4 - .311^4)$$

$$I = .000512\ in^4 \qquad E = 15.6 \times 10^6\ psi$$

δ = deflection

$$\delta_{max} = \frac{5wl^4}{384EI} = \frac{5(.167\ \#/ft)\left(\frac{1 ft}{12 in}\right)(48 in)^4}{384(15.6\times10^6 psi)(.000512\ in^4)}$$

$$\delta_{max} = .12\ in$$

1/2" tube, $d_o = .625"$, $d_i = .527"$, $w = .344$ #/ft, 4 ft. hanger spacing, copper

weight of water in tube,

$$vol = \pi R_i^2 h = \pi \left(\frac{.527}{2}\right)^2 (48) = 10.5\ in^3 \left(\frac{1\ ft^3}{1728\ in^3}\right)$$

$$vol. = .0061\ ft^3$$

$$weight = (.0061)(62.4) = .381\ \#$$

$$w = \frac{.381\#}{4\ ft} = .095\ \#/ft$$

$$w_{tot} = .095 + .344 = .439\ \#/ft$$

$$M_{max} = \frac{w l^2}{8} = \frac{(.439\ \#/ft)(4\ ft)^2}{8} = .88\ ft\text{-}lb \left(\frac{12\ in}{1\ ft}\right) = 10.54\ in\text{-}lb$$

$$Z = \frac{\pi (.625^4 - .527^4)}{32(.625)} = .012\ in^3$$

$$I = \frac{\pi (.625^4 - .527^4)}{64} = .0037\ in^4$$

$$\sigma_{max} = \frac{M_{max}}{Z} = \frac{10.54\ in\text{-}lb}{.012\ in^3} = 878.3\ psi$$

$$\delta_{max} = \frac{5 w l^4}{384 E I} = \frac{5(.439\ \#/ft)\left(\frac{1\ ft}{12\ in}\right)(48\ in)^4}{384(15.6 \times 10^6\ psi)(.0037\ in^4)} = .047\ in$$

5/8" tube, $d_o = .750"$; $d_i = .652"$; $w = .418$ #/ft, 4' hanger spacing, copper

weight of water in tube

$$vol. = \pi R_i^2 h = \pi \left(\frac{.652\ in}{2}\right)^2 (48\ in) = 16.03\ in^3 \left(\frac{1\ ft^3}{1728\ in^3}\right)$$

$$vol. = .0093\ ft^3$$

$$weight = (.0093\ ft^3)(62.4\ lb/ft^3) = .58\ \#$$

$$w = \frac{.58\#}{4\ ft} = .15\ \#/ft$$

$$w_{tot} = .418 + .15 = .57\ \frac{\#}{ft}\left(\frac{1\ ft}{12\ in}\right) = .047\ \#/in$$

$$M_{max} = \frac{w l^2}{8} = \frac{(.047\ \#/in)(48\ in)^2}{8} = 13.5\ in\text{-}lb$$

$$Z = \frac{\pi (.750^4 - .652^4)}{32(.750\ in)} = .018\ in^3 \qquad \sigma = \frac{M}{Z} = \frac{13.5\ in\text{-}lb}{.018\ in^3} = 750\ psi$$

$$I = \frac{\pi}{64}(.750^4 - .652^4) = .0067\ in^4$$

$$\delta_{max} = \frac{5 w l^4}{384 E I} = \frac{5(.047\ \#/in)(48\ in)^4}{384(15.6 \times 10^6\ psi)(.0067)\ in^4}\ in = .032\ in$$

CN 14810
BY M. Lombard
PAGE R-820
FORM NO. 372-30-2650

3/4" tube, $d_o = .875"$; $d_i = .745"$; w = .641 #/ft, 7 ft. hanger spacing (84"), copper

weight of water in tube

$$vol = \pi R_i^2 L = \pi\left(\frac{.745}{2}\right)^2(84) = 36.6\ in^3\left(\frac{1\ ft^3}{1728\ in^3}\right)$$

$$vol = .021\ ft^3$$

$$weight = .021\ ft^3(62.4\ \#/ft^3) = 1.31\ \#$$

$$w = \frac{1.31\ \#}{7\ ft} = .19\ \#/ft$$

$$w_{total} = .19 + .641 = .83\ \frac{\#}{ft}\left(\frac{1\ ft}{12\ in}\right) = .069\ \#/in$$

$$M_{max} = \frac{wl^2}{8} = \frac{(.069\ \#/in)(84\ in)^2}{8} = 60.86\ in\text{-}lb$$

$$Z = \frac{\pi(.875^4 - .745^4)}{32(.875)} = .031\ in^3$$

$$I = \frac{\pi}{64}(.875^4 - .745^4) = .014\ in^4$$

$$\sigma = \frac{M}{Z} = \frac{60.86\ in\text{-}lb}{.031\ in^3} = 1963\ psi$$

$$\delta = \frac{5wl^4}{384EI} = \frac{5(.069\ \#/in)(84\ in)^4}{384(15.6\times10^6\ psi)(.014\ in^4)} = .20\ in$$

The above analysis shows the maximum stress for 1/4", 1/2", 5/8", and 3/4" tubing with hanger spacing for horizontal runs as specified in work specification 75-J-02 will not exceed the 6000 psi max. stress as given in ANSI B31.1-1980. Also by inspection the max. deflections are acceptable. All copper tube sizes in between these sizes above shall be acceptable for horizontal hanger spacing as shown in 75-J-02 (for under 1") per this analysis and engineering judgement, and guidelines given in ANSI B31.1-1980 (for 1" and over). Hanger failure will not affect safety related equipment since it will not be routed above such equipment.

[signature] 9/13/83

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) TCR / SCR / PC / TR
NO. 14628
PAGE 2

CATEGORY

TYPE:

☒ CN OVERALL ☐ CN SUBMITTAL ☐ SETPOINT CHANGE REPORT ☐ TEST REQUEST
☐ TEMPORARY CONFIGURATION REPORT ☐ PROCEDURE CHANGE (FSAR) ☐ OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

CLASS I	☒ YES	☐ NO	ENGINEERED SAFEGUARD	☐ YES	☒ NO
SAFE SHUTDOWN	☐ YES	☒ NO	PLANT PROTECTIVE SYSTEM	☐ YES	☒ NO
SAFETY RELATED	☒ YES	☐ NO	SECURITY SYSTEM	☐ YES	☒ NO

REMARKS This CN is Safety Related due to cable routing in the Safety Related Cable Tray System. Fire Protection for Building 10 must also be treated as Safety Related!

EVALUATION USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE F S A R OR TECH SPEC? ☐ YES ☒ NO
LIST THE APPLICABLE SECTIONS REVIEWED. FSAR sections 1.2, 1.4, 1.6, 7.1.1.4, 7.4.1, 8.2.4, 8.2.6, 9.12 Tech Specs sections LCO 4.10.1, 4.10.2, 4.10.3, 4.10.4

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE F S A R OR TECH SPEC? ☒ YES ☐ NO
LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE. At the completion of the Building 10 addition, FSAR section 1.6 should be revised to reflect the new addition. Other items more specific will require FSAR update within Building 10 however they will be accomplished by other CNs.

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE F S A R BEEN INCREASED?
☐ YES ☒ NO STATE BASIS: This CN only affects the Class I Safety Related Cable Tray system and Bldg 10 fire protection (treated as safety related) system which could have an effect on plant safety. Both are being constructed in accordance with current regulatory requirements, therefore, the probability of occurrence or the consequences of an accident evaluated in the FSAR have not been increased.

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE F S A R BEEN CREATED? ☐ YES ☒ NO STATE BASIS: This CN has no effect on reactor plant functional operations. The items within the CN that are important to safety are ~~is~~ ^not^ being constructed in accordance with current requirements and therefore do not create the possibility of a new accident.

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE F S A R BEEN REDUCED? ☐ YES ☒ NO STATE BASIS: No margin of safety ~~exist~~ is defined in the FSAR or Tech Specs concerning construction of Building 10 and therefore cannot be reduced. The margin of safety defined for tech specs associated with the three room control complex fire protection has not been reduced as it's operation remains unchanged.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION ☐ YES ☒ NO
BE SAFETY SIGNIFICANT ☐ YES ☒ NO

BY Mike Claver (SIGNATURE) 9/12/83 (DATE) *APPROVED J R Johns (SIGNATURE) 9-13-83 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372-02-3382

CN 1462
BY K. Bush
PAGE B1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS
Sheet 1 of 1

1. Install Electrical portion of the Three Room Complex Addition And Walkover Structure.

2. Work to be completed in compliance with Specification 75-J-02 and 45-S-14.

3. Work to be completed in accordance with drawings;

E-1945
E-1946
E-1947
E-1948
E-1949
E-1950
E-1951
E-1952
E-1953
E-1954

Fire Protection System shall be installed per manufacturer's supplied drawings.

All other drawings shall be included in the Change Notice as sketches.

4. Relocate conduits, cables, grounding, etc., which will inhibit the construction of the Three Room Complex Addition.

5. Justify cable tray and hanger details for safety related equipment.

Prepared By: /s/ Keith B. Bush 9/27/82 Date
Approved By: /s/ [signature] 9/28/82 Date

REPLACE ENTIRE PAGE PER CN-1962

CN 1962 B
BY K. Bush
PAGE B2 B
FORM NO. 372-30-2650

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

SAFETY RELATED DESIGN ANALYSIS

Electrical ☒
Mechanical ☐
Structural ☐

I. **Seismic Analysis:**

For detailed analysis of the Seismic Response Spectra generated for this building, see Seismic Book S2, Tab 2. All Safety Related, Class I Equipment shall be designed in accordance with the Response Spectra.

II. **Stress Analysis:**

For details of stress analysis, see seismic Book S2, tab 9.

For Unistrut Inserts, see page B6. Add Per CN-1962 B

III. **Piping/Hanger Analysis:**

Cable Tray Hanger Analysis is shown on sheets B5 thru B13 and B18 thru B21. All supports are designed in accordance with Seismic Book S2, Tab 9.
Cable Grip calculations on pages B18A thru B21A.

IV. **Hydraulic/Pneumatic Analysis:**

N/A

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
SAFETY RELATED DESIGN ANALYSIS SHEET 2

CN 1462A
BY K. Buil
PAGE B3A

REPLACE ENTIRE PAGE PER CN-1462A

Form 344-22-4068

V. THERMAL ANALYSIS

All heat generated by Electrical Equipment (now or in the future) have been accounted for or estimated for in calculations in Cooling Load. See mechanical CN-1961 for HVAC calculations.

VI. NUCLEAR ANALYSIS

N/A

VII. FIRE PROTECTION ANALYSIS

A complete Fire Protection Review on Building 10, is attached on pages B3.1 thru B3.15. Emergency Lighting provides lighting for access to essential plant equipment required to shut down the plant, and for escape routes from the building. The System consists of fixed incandescent type fixtures powered by the station batteries. This Lighting conforms to PSC response to BTP-9.5-1.
Cable trays will be wrapped with a 1 hour fire rated blanket to meet BTP-9.5-1 requirements.

VIII. ENVIRONMENTAL ANALYSIS

All equipment installed is designed for the type of environment it is placed in.

IX. COMPATIBILITY OF MATERIALS, EQUIPMENT, AND PROCESSES

Fire Detection system is not tied into the Existing System. The New System is Compatible for use in Building 10. All gaitronics, load centers, etc. will be compatible with plant operations.

(ENG-2)

CN 1462A
BY K. Bush
PAGE B3.1A
FORM NO. 372-30-2650

PROTO-POWER MANAGEMENT CORPORATION

391 POQUONNOCK ROAD
GROTON, CONNECTICUT 06340
(203) 446-9725

File: 7511434

November 19, 1982

Mr. J.R. Reesy
Nuclear Design Department Manager
Public Service Company of Colorado
5909 East 38th Avenue
Denver, Colorado 80207

Dear Jack:

This letter contains the results of Proto-Power Corporation's fire protection review of the Fort St. Vrain Three Room Complex Addition. This review was requested by telecon with PSC on November 3, 1982. The review was performed in accordance with Branch Technical Position 9.5-1, Appendix A and 10CFR50, Appendix R as it applies to Fort St. Vrain. The Fire Hazards Analysis performed to evaluate compliance with regulatory requirements is included as Attachment A. The Three Room Complex Addition meets the requirements of these documents except for two points: 1) separation of redundant cables; and 2) lack of emergency lighting.

1. Cables designated B1L1 and B2L2 serving inverter 1A and 1B respectively are located in both the south end ground floor room and the ground floor walkover room 101. This cable routing violates Section G of Appendix R to 10CFR50 which states "one train of systems necessary to achieve and maintain hot shutdown conditions from either the Control Room or the emergency control station(s) is free of fire damage". Furthermore, BTP 9.5-1, Appendix A (Paragraph 3.4.1.a in PSC's response to BTP 9.5-1) requires that redundant safety related systems be separated from each other so that both are not subject to damage from a single fire hazard. Based on the understanding that, as a minimum, inverter 1A or 1B is needed for plant shutdown, Proto-Power finds the presence of both B1L1 and B2L2 cables serving inverter 1A and 1B respectively in the same fire area to be in conflict with regulatory requirements. Appendix R to 10CFR50 requires that redundant cables be protected by a combination of one hour rated fire retardant (or barriers), and fire detection and suppression system. To meet these requirements, Proto-Power

suggests wrapping one of the cable systems with a 1 hr. fire rated B&W Kaowool® blanket wrap currently being used by other utilities to meet this requirement. To meet the suppression system requirement, it could be demonstrated analytically that the in situ and transient combustibles in the two fire areas are too small (approximately 4 minutes) to be a fire hazard and therefore, don't warrant a fixed fire suppression system.

2. Fixed emergency lighting is not currently provided in the Three Room Complex Addition. BTP 9.5-1, Appendix A (Paragraph 3.4.5 in PSC's response to BTP 9.5-1) and Appendix R to 10CFR50 states that fixed emergency lighting is vital to safe shutdown and emergency response in the event of a fire. The absence of fixed emergency lighting violates regulatory requirements. Proto-Power suggests that fixed (battery pack) emergency lighting be provided for access and egress routes to and from the rooms within the Three Room Complex Addition.

Three additional points relating to fire protection are being suggested for your consideration, but are not required by either BTP 9.5-1 or Appendix R to 10CFR50.

- The 1C battery room exhaust fan should be provided with loss-of-flow indication in the Control Room. The fire hazards analysis assumes the fan is operating to ensure that H_2 concentrations are maintained below 2% (by volume).

- Pressure relief venting should be considered in the design of the Halon 1301 fire suppression systems to prevent overpressurizing the room during system discharge and, possibly destroying fire stops and door frames.

- If redundant sets of safety related equipment are planned for the south end ground floor room and mezzanine, consideration should be given at this time for their separation which may include fire barriers (walls) and the location of detectors, fire suppression (Halon 1301) system, and ventilation ducts.

In addition, there is one item concerning channel independence that is an apparent conflict with your present FSAR commitments. Attachment B outlines our concern on this item. While this item

CN 1962
BY K. Bush
PAGE B3.3A
FORM NO. 372-30-2650

appears to be a departure from your FSAR commitments, it is independent from BTP 9.5-1, Appendix A or Appendix R to 10CFR50. If you agree with our conclusion on this matter we can recommend to you alternative ways of correcting this concern.

The above information contains the results of our review of the Three Room Complex Addition to the requirements of BTP 9.5-1, Appendix A and 10CFR50, Appendix R. If you have any questions, please call me at (203) 446-9725.

Sincerely,

R.A. Schaufler

R.A. Schaufler
Vice President

PDM:jmn
Attachment

CN 1962A
BY K. Bush
PAGE B3.4A
FORM NO. 572-30-2630

ATTACHMENT A

The Three Room Complex Addition (3RCA) has 4 floors of rooms and a mezzanine over the northern portion of the ground floor. In descending order, the floors contain a training room, equipment and office rooms, a computer room, and a ground level battery room and two converter rooms at Elev. 4791'0". The ground level rooms including the mezzanine contain safety related equipment. The equipment room (El. 4824'0") was analyzed as a safety related room because it is anticipated that safety related equipment may be installed in the future, but none has been designated at this time. All other rooms are considered non-safety related equipment areas. A two level walkover structure abuts the 3 RCA from the west wall. The walkover floors access the ground level and computer rooms. The two walkover floors designated R101 and R102 contain safety related cables and cable trays, however, no equipment is to be installed in the walkover structure. The rooms designated as safety related fire areas therefore are the three rooms on the ground level, the two walkover rooms and the equipment room at El. 4824'0". Each of these fire areas is enclosed by three hour fire rated walls.

Access doors and emergency exits separating the building's outer wall and internal fire walls are U.L. Class A fire rated steel doors. Electrical cable in trays, risers, and conduit, and ventilation ducts that penetrate the floors and walls of fire areas are equipped with fire stops and ventilation fire dampers respectively.

When evaluating the effects of the design basis fire, consideration has been given to safety related equipment which, on the basis of vertical, as well as horizontal proximity, could be involved in the fire. Similarly, any combustibles above or below the design basis fire area, and the effects of using hose water on safety related equipment in and below the design basis fire area, have also been considered.

Communication during a fire situation is maintained primarily by the station's public address (GAI-Tronic) system. The 3 RCA ventilation system provides for the removal of smoke and corrosive gasses during and following a fire situation.

Emergency lighting, as required by 10CFR50, Appendix R, and BTP 9.5-1, is not incorporated in the design of the Three Room Complex Addition, or the attached walkover structure. Appropriate action as outlined in the attached letter should be taken to ensure compliance with this guideline.

CN 1462A
BY K. Bush
PAGE B3.5A
FORM NO. 372-30-2650

Ground Floor South, Including Mezzanine - El. 4791'0" and El. 4800'0"

Area Description

Located on the ground level are safety related instrumentation inverter 1B, one 120 volt distribution panel, one 25 KVA backup power transformer and associated cable and cable trays. Safety related cable trays, designated for bus two, loop two (B2L2) routing, are installed above the ground level section of this fire area. The mezzanine contains no safety related equipment at this time. Safety related cable trays, designated for bus one, loop one (B1L1) routing, are installed above the mezzanine. As presently designed, the location of unprotected raceways, B1L1 and B2L2 in the same fire area, is a violation of 10CFR50, Appendix R and BTP 9.5-1. Appropriate corrective action, as outlined in the attached letter, should be taken to ensure compliance with these guidelines.

Fire Area Boundary

The south end ground floor is open to the mezzanine which is over the north end ground floor and battery rooms. This area is bounded by three hour fire rated walls, that separate it from the north ground floor room which contains the other raceways necessary for safe shutdown and the 1C battery room.

Fire Load

The fire load in this area is very small consisting of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 4320 Btu/ft^2 ($\approx$ 3-1/4 min.). These combustibles are not of sufficient quantity to be considered a hazard to both of the safety related raceways that exist within this fire area.

Fire Protection Systems

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire assumes the complete combustion of paper waste in two fifty-five gallon drums and all the electrical cable insulation. Ignition is dependent on a transient source. As a result of the low fire load (4320 Btu/ft^2), the separation of buses and the ability to achieve safe shutdown with equipment located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

CN 1462A
BY K. Bush
PAGE B3.6A
FORM NO. 372-30-2650

Ground Level North - Elev. 4791'0"

Area Description

Located in the north ground level room are safety related instrument inverters 1A and 1C, their associated distribution panels, backup power transformers, cable and cable trays. While this safety related equipment is redundant (for 2 out of 3 P.P.S. inputs), only inverter 1A or 1B, which is in the south ground floor room, is needed to obtain safe shutdown. The cable trays installed in this fire area are designated for B2L2 routing. Cabling for inverter 1C is run in conduit.

Fire Area Boundary

The fire area consists of concrete walls and ceiling that have three hour fire ratings.

Fire Load

The fire load in this area is 5360 Btu/ft^2 ($\approx$ 4 min.). It is attributable to the small quantity of electrical cable insulation and waste consisting of paper in trash containers.

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire assumes the complete combustion of the paper waste that could exist in two fifty-five gallon drums, and all the electrical cable insulation within this fire area. Ignition is dependent on a transient source. As a result of the low fire load (5360 Btu/ft^2) and the ability to achieve safe shutdown with equipment located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

Battery Room - Ele. 4791'0"

Area Description

The battery room contains safety related bettery 1C.

CN 1962A
BY K. Bush
PAGE B3.7A
FORM NO. 372-30-2650

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors. There is an exhaust fan which vents the room atmosphere directly to the outdoors. The exhaust fan duct is equipped with a three-hour fire rated damper.

Fire Load

The fire load in this area consists of electrical cable insulation, battery casing material, and loose paper in trash containers. The calculated fire load is 184,000 But/ft^2 (2.3 hrs.).

Fire Protection Systems

Fire detection is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes the complete combustion of the electrical cable insulation, battery casing material and paper waste in two fifty gallon drums. Ignition is dependent on a transient source. Since the battery is the only redundant safety related piece of equipment in this fire area and redundant safety related batteries are located in another separated fire area, the design basis fire will have no effect on the ability of the plant to achieve safe shutdown.

Equipment Room - Elev. 4824'0"

Area Description

The equipment room is capable of containing safety related equipment but none has been designated as yet. Safety related cable trays are designated for B2L2 service. The ceilings have non-combustible one hour rated acoustical paneling suspended from them. The concrete walls have one hour fire rated non-combustible drywall coverings.

Fire Area Boundary

The fire area is enclosed in three hour rated fire walls and ceiling and Class A fire rated doors.

Fire Load

The fire load in this area is 5280 Btu/ft^2 ($\approx$ 4 min.). It is based on electrical cable insulation and paper waste in trash containers.

CN 1962A
BY K. Bush
PAGE B3.8A
FORM NO. 372-30-2650

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable dry chemical extinguishers. Floor drains are not required as the floor mounted equipment is elevated by three inch channel, which elevates the equipment above the potential water level.

Design Basis Fire

The design basis fire for this area assumes the total combustion of the paper waste that could exist in two fifty-five gallon drums, and all electrical cable insulation in the fire area. Ignition is dependent on a transient source. As a result of the low fire load (5280 Btu/ft^2), and the absence of any safety related equipment, the design basis fire will have no affect on the ability of the plant to achieve safe shutdown.

Walkover Room 101 - Elev. 4791'0"

Area Description

Room 101 contains safety related cable routing B1L1 as well as cable routed as B2L2 service. As presently designed, the location of unprotected raceways B1L1 and B2L2 in the same fire area is a violation of 10CFR50, Appendix R and BTP 9.5-1. Appropriate corrective action as outlined in the attached letter should be taken to ensure compliance with these guidelines.

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors.

Fire Load

The fire load in this area is very small consisting of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 10,400 Btu/ft^2 (8 min.). These combustibles are not of sufficient quantity to be a hazard to both of the safety related raceways that exist within this fire area.

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable, dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes the complete combustion of paper waste contained in two fifty-five gallon drums, and all the electrical cable insulation within this fire area. Ignition is dependent on a transient source. As a result of the low fire load (10,400 Btu/ft^2), the design basis fire will not affect the ability of the plant to achieve safe shutdown.

Walkover Room 102 - Elev. 4811'0"

Area Description

Room 102 contains safety related cable and cable trays routed as B1L1.

Fire Area

The fire area is enclosed in three hour rated fire walls and ceiling and utilizes Class A fire rated doors.

Fire Load

The fire load is very small in this area and consists of small quantities of electrical cable insulation and paper waste in trash containers. The calculated fire load for this area is 9,600 Btu/ft^2 (7 min.).

Fire Protection System

Fire detection for this area is provided by an ionization type detector which alarms and annunciates in the Control Room. Primary fire suppression is provided by portable, dry chemical extinguishers.

Design Basis Fire

The design basis fire assumes complete combusiton of the paper waste contained in two fifty-five gallon drums, and all the electrical cable insulation contained in the fire area. Ignition is dependent on a transient source. As a result of the low fire load (9,600 Btu/ft^2) and the ability to achieve safe shutdown with system cables located in another separated fire area, the design basis fire will not affect the ability of the plant to achieve safe shutdown.

THREE ROOM COMPLEX ADDITION
FORT ST. VRAIN

ATTACHMENT A TABLE 1

FIRE HAZARDS ANALYSIS SUMMARY

ITEM NO.	FIRE AREA LOCATION MAJOR EQUIPMENT	SAFETY RELATED	COMBUSTIBLE MATERIAL	QUANTITY	HEAT CONTENT (BTU/LB)	FIRE LOAD (BTU/FT^2)	FIRE DETECTION	FIRE SUPPRESSION AVAILABLE	SEPARATION OF REDUNDANT S.R. EQUIPMENT
1	South Inverter Room Including Mezzanine	Yes	Cable Insulation	3 ft^3	12,000	4,320	Ionization Type	Dry Chemical	Separate Concrete Rooms & Cable Separation
2	North Inverter Room	Yes	Cable Insulation	.93 ft^3	12,000	5,360			Separate Concrete Rooms & Cable Separation
3	Battery Room	Yes	Cable Insulation Battery Cell Cases	.15 ft^3 12 ft^3	12,000 18,000	184,000			Separate Concrete Rooms
4	South Computer Room	No	Cable Insulation	.08 ft^3	12,000	8,400			
5	North Computer Room	No	Cable Insulation	.375 ft^3	12,000	7,520			
6	Equipment Room	Yes	Cable Insulation	.3 ft^3	12,000	[illegible]			No S.R. Equipment at present.
7	Office Room	No	Cable Insulation	.3 ft^3	12,000	5,200			
8	Walkover Room 101	Yes	Cable Insulation	.3 ft^3	12,000	10,400			Separate Concrete Room & Cable Separation
9	Walkover Room 102	Yes	Cable Insulation	.6 ft^3	12,000	9,600			" " "

CN 1462A
BY K. Bush
PAGE B3.10A
FORM NO. 372-30-2650

CN 1962A
BY K. Bush
PAGE B3.11A
FORM NO. 372-30-2630

ATTACHMENT B

The current design of the Three Room Complex Addition (3RCA) appears to conflict with current FSAR commitments in the specific area of the design for independence of the three logic channels. The conflict centers on the ability of a single event (i.e., a fire) to defeat the independence between the logic channels associated with Instrument Buses 1A and 1C. Specifically, the problem is the location of Inverter 1C and routing of cables associated with Inverter 1C in the same fire area as Inverter 1A and cables associated with Inverter 1A.

The bases for our convern are the FSAR commitments outlined below and as highlighted on the attached pages.

a. Compliance with Design Criteria 20 (See Attachment B-1).

b. Compliance with Design Criteria 21 (See Attachment B-2).

c. Compliance with the Principles of Design outlined in Section 7.1.1.2 (See Attachments B-3 and B-4).

This apparent conflict is not an area of non-compliance with BTP 9.5-1, Appendix A or Appendix R to 10CFR50 since the remaining channel 1B can be utilized to achieve safe shutdown.

CN 1962A
BY K. Bush
PAGE B3.12A
FORM NO. 372-30-2650

FSAR UPDATE
C.20-1

ATTACHMENT B.1

CRITERION 20: PROTECTION SYSTEMS REDUNDANCY AND INDEPENDENCE (Category B)

> "Redundancy and independence designed into protection systems shall be sufficient to assure that no single failure or removal from service of any component or channel of a system will result in loss of the protection function. The redundancy provided shall include, as a minimum, two channels of protection for each protection function to be served. Different principles shall be used where necessary to achieve true independence of redundant instrumentation components."

DISCUSSION:

On the basis of the following information, it is concluded that Criterion 20 is satisfied.

In general, three independent sensing circuits are provided for each plant protective system input parameter. Exceptions for Loop Shutdown and Circulator trip exist as shown in Figures 7.1-1, 7.1-2, 7.1-3; however these do have two sensing circuits.

The basic logic system is two-out-of-three for the scram and steam/water dump circuitry. Independence between the three logic channels is maintained up to the final output stage where the two-out-of-three combination is made. This includes supply of power from three independent instrument power sources. The loop shutdown and circulator trip circuitry utilizes dual output stages arranged in a one-out-of-two configuration to ensure system reliability. Either output is energized to actuate the final control element(s). (The output logic should not be confused with the input sensing channels which are generally two-out-of-three as previously stated.) (Section 7.1.2.1).

Since the basic logic is two-out-of-three, or one-out-of-two for loop shutdown and circulator trip, it follows that the unsafe failure of either an input sensing channel or an entire logic channel will not result in loss of the protective function.

Features included in the design for independence are outlined in Section 7.1.1.2.

CN 1962A
BY K. Bush
PAGE B3.13A
FORM NO. 372-30-2650

FSAR UPDATE
C.21-1

ATTACHMENT B.2

CRITERION 21: SINGLE FAILURE DEFINITION (Category B)

"Multiple failures resulting from a single event shall be treated as a single failure."

DISCUSSION:

On the basis of the following information, it is concluded that Criterion 21 is satisfied.

Multiple failures resulting from a single event are treated as a single failure. Single events considered in the design for independence are outlined in Section 7.1.1.1. 7.1.1.2 The environmental conditions for areas in the Fort St. Vrain plant are given in Section 7.1.1.4.

In addition the Proposed IEEE Guide to the Application of the Single Failure Criterion to Nuclear Power Plant Protection Systems, Fifth Draft, dated 9/30/68, has been used in the design of the Plant Protective System.

modules in the conducting or nonconducting mode, failure of power supplies, blockage or severance of process connections, and failures of transducers. The short circuits considered include those credible faults which affect multiple components, as may be illustrated by single interconnecting lines on a schematic, and which may prevent system action. The basic logic system employs 2 of 3 redundancy for the sensing channels. The scram control is designed using hindrance logic, i.e., loss of power produces a scram. The accidental shutdown of both coolant loops must be avoided to provide the necessary core cooling. The associated circuitry is therefore deenergized during plant operation. Steam/water dump, loop isolation, and circulator trip circuitry are therefore designed using transmission logic, i.e., circuits are energized to produce protective action. Redundant output circuitry and final control elements are provided.

Quality of Components and Modules. The bulk of the electronics and circuitry (excluding preamplifiers when required) is located in the reactor plant protective system controlboard. A high degree of quality is maintained by rigid specifications and quality control. Components employed are of a high quality level and generally derated by at least 50%. Failure mode analysis has been made on critical circuitry. Wherever possible previously used circuitry, components, and modules have been employed minimizing the design of new circuitry. Solid-state circuitry is employed in conjunction with relays, utilizing the advantages of solid-state devices in low-level signal amplification and the advantages of relays for circuit isolation and for handling power. The procurement of all major plant systems is from reliable suppliers having previous experience in the design and construction of similar systems.

Channel Independence. In designing for channel independence, single events which are considered plausible include:

1. Shearing or blocking of process connections.
2. Rise in temperature, pressure, or humidity in the sensor, signal transmission, or readout area.
3. Vibration of process connections.
4. Severance, crushing, or shorting of wiring paths.
5. Fires in control areas.
6. Missiles.
7. Module removal.

ATTACHMENT B.4

CN 1462A
BY K. Bush
PAGE B3.15A
FORM NO. 372-30-2650

FSAR UPDATE
7.1-6

In the design of the instrument system, the following means are employed to achieve channel independence:

1. The combining of redundant channels is made as close to the output portion of the systems as is practical. Hence, the use of the general logic scheme.

2. Channels are connected to the process system by physically separated instrument connections.

3. Redundant sensors are physically separated. For example, the neutron detectors and reactor pressure sensors are mounted in separate wells and PCRV penetrations spaced about the PCRV.

4. Wiring or cabling between redundant sensor locations and control room or control panel and on the controlboard are physically separated and mechanically protected where required.

5. Redundant power supplies are used to supply the various channels so that loss of a given power supply will not prevent system action or cause an unnecessary protective action.

6. Circuits are suitably fused and protected so that in the event of single grounds or shorts, the fault will be isolated and will not feed back into the system.

7. Circuits and components are used that, insofar as is practical, fail in a safe direction.

8. Sensor, protective apparatus, and readout components are physically located and protected to minimize possibility of accidental contact or damage. For example, the location of instruments within penetrations in the PCRV provides a considerable degree of protection from physical damage. The scram and other redundant plant protective system circuitry is located in separate vertical sections of controlboard separated by physical and thermal barriers.

Equipment Qualification. Various functional and calibration tests have been performed to ensure that the equipment is in conformance with the specification. This testing included:

1. Testing of components (such as plug-in assemblies).

2. Testing of assemblies (such as drawers or transmitters).

3. Point-to-point continuity and insulation resistance of wiring.

Accuracy drift tests on assemblies have been made.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY ~~RELATED DESIGN ANALYSIS~~ - SHEET 3

REPLACE ENTIRE PAGE PER CN-1462A

CN 1462A

BY K. Bush

PAGE B4A

Form 344-22-4069

X. ACCESSIBILITY FOR IN-SERVICE INSPECTION, MAINTENANCE, AND REPAIR

All equipment is accessible for inservice inspection or maintenance from one or more sides at all times.

XI. SEPARATION AND SEGREGATION ANALYSIS

All cables trays are designated by bus, loop and service. Tray spacing for redundant cables of 1 ft horizontally and 3 ft. vertically as stated by Reg Guide 1.75 and IEEE 384 are being met by the installation. These design criteria are being met due to only failure or faults internal to electrical equipment. Power cables under the computer room raised floor shall be in flexible conduit.

XII. ELECTRICAL ANALYSIS

Electrical Equipment will be powered by the Distribution System, secondary power shall be via the ACM. Computer Room HVAC South will feed from HVAC MCC (N-9262) with secondary of ACM and Distribution. All electrical equipment is non-safety related and does not require a reliable power source.

XIII. ACCIDENT ANALYSIS

No new accident or hazzard shall be created by this CN. All equipment will meet the spectra responce for its application.

PREPARED BY Keith B. Bush 3/3/83

DATE

(ENG-2)

GTICES STRUDL

CN 1462
BY N. KNOX
PAGE B4.1
FORM NO. 372-30-2650

INFORMATION ONLY

"This was the perfect program for static analysis and design of dam spillway tainter gates. We made rapid and accurate analyses that led to weight-savings of several hundred pounds per gate, and that resulted in a real increase in the service life of the operating equipment for the gates."

What GTICES STRUDL* is

GTICES STRUDL, (Georgia Institute of Technology Integrated Civil Engineering System STRUctural Design Language), is an advanced system for analysis and design of simple, complex, and one-of-a-kind structures. It allows the engineer to specify a structural problem, perform a variety of analyses, reduce and combine results, and output printed or graphic information.

GTICES STRUDL provides a highly cost effective means for analyzing and designing framed structures and performing finite element analysis of plates, shells, and other continuous structures. The system also provides automatic structural topology generation and the processing of joint releases and eccentricities, elastic supports, and a variety of loading types.

GTICES STRUDL also offers a finite element dictionary, a library of high quality proprietary elements which represent a major improvement over competitive versions of STRUDL.

STRUDL is one of the most widely used and applied engineering software packages in the field, and GTICES STRUDL, as offered by BCS, is the most efficient and cost-effective version available.

What GTICES STRUDL does

- Provides a highly user oriented, comprehensive, state-of-the-art, and integrated general purpose structural analysis and design information processing system for practical engineering use
- Provides more cost effective utilization of structural engineering computer time and engineering personnel, while generating less costly, more reliable design results

GTICES STRUDL Capabilities

- Structural analysis, (2D, 3D, finite element)
- Steel member selection, (AISC specifications)
- Dynamic analysis, (natural frequency, response spectrum, time history)
- Buckling analysis
- Geometric non-linear analysis for frames
- Problem size independent

GTICES STRUDL is easy to use

- Command structured input
- Batch or Interactive processing
- User-defined output
- Automatic computation of structural weight
- Automatic generation of structural topology
- Nondestructive SAVE/RESTORE capabilities
- Data base management features that work
- Extensive error checking capabilities

GTICES STRUDL is used by

- Architectural/engineering firms
- Structural engineering consultants
- Manufacturing companies
- Construction and fabrication industries
- Research and development facilities
- Universities and educational centers
- Power and public utilities
- Military and government agencies

CN 1462
BY N. KNOX
PAGE B4.2
FORM NO. 372-30-2650

GTICES STRUDL aids analysis and design

INFORMATION ONLY

LOADING - 7   DL + .75(LL) + .75(WL2)

RESULTANT JOINT DISPLACEMENTS FREE JOINTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	-.0115	-.0025	.0003	.0006	.0088	-.1481
3	GLOBAL	-.0172	-.0027	-.0001	.0004	-.0022	-.1513
5	GLOBAL	-.0172	-.0027	.0001	-.0004	.0022	-.1513
6	GLOBAL	-.0115	-.0025	-.0003	-.0006	-.0088	-.1481
8	GLOBAL	.0896	-.0019	-.0003	.0011	-.0252	-.1313
9	GLOBAL	.1293	-.0023	-.0002	.0007	-.0130	-.1361
10	GLOBAL	.1294	-.0024	.0009	.0007	.0114	-.1399
11	GLOBAL	.0976	-.0019	.0000	.0000	-.0000	-.1421
12	GLOBAL	.1294	-.0024	-.0009	-.0007	-.0134	-.1399

GTICES STRUDL is a practical, totally user oriented system for the analysis and design of simple, complex, and one-of-a-kind structures. Output for the stiffness analysis consists, in part, of a tabulation of displacement values at each joint for each applied loading condition. STRUDL then selects members in compliance with AISC steel design codes. (1969 code shown, 1978 code available)

JOBID - NAVFAC   TITLE - X 12

STANDARD UNITS - INCH POUND RADIAN DEGREE F SECOND

Code criteria
Axial tension & bending members

*** NOTE: 1) PROVISION VALUES ARE GIVEN IN CODE UNITS SHOWN BELOW, WHEN APPLICABLE
2) PARAMETER VALUES ARE GIVEN IN STANDARD UNITS, WHEN APPLICABLE
3) WHEN CRITICAL IS SPECIFIED ONLY ACTUAL/ALLOWABLE RATIOS ARE GIVEN FOR PROVISIONS
4) MEMBERS WHICH DO NOT SATISFY ALL RELEVANT CODE PROVISIONS ARE MARKED BY TWO ASTERISKS (**)
5) WHEN CRITICAL IS SPECIFIED PARAMETERS GIVEN ARE FOR MOST CRITICAL LOCATION

MEMBER CODE	PROFILE TABLE	RATIO LOCATION SECTION	LOADING	CRITICAL PROVISION NAME	RATIO	PARAMETER NAME	VALUE	PARAMETER NAME	VALUE
1	W18X40	0.00	7	E01.6-1A	.9256	FYLD	3.600E+04	KZ	1.150E+00
69AISC	STEELW	0.00	6	E01.6-2	.8613	KY	1.000E+00	CODETOL	1.000E+00
2	W10X25	60.00	5	E01.6-1B	1.0021	FYLD	3.600E+04	KZ	1.150E+00
69AISC	STEELW	60.00	6	E01.6-2	.9278	KY	1.000E+00	CODETOL	1.000E+00

GTICES STRUDL summary of selected steel sections.

JOB ID - NAVFAC   JOB TITLE - X 12

ACTIVE UNITS - LENGTH INCH   WEIGHT KIP   ANGLE DEG   TEMPERATURE DEGF   TIME SEC

From AISC tables for wide flange sections

MEMBER PROPERTIES

MEMBER/SEG	TYPE			AX/YD	AY/ZD	AZ/YC	IX/ZC	IY/EY	IZ/EZ	SY	SZ
1	TABLE	STEELW	W18X40	11.800	5.656	4.289	.808	19.100	612.000	6.340	68.400
				17.900	6.018	1.453	3.009	0.000	0.000		
2	TABLE	STEELW	W10X25	7.360	2.540	3.334	.373	13.700	133.000	4.760	26.500
				10.080	5.762	3.040	2.881	0.000	0.000		

*GTICES STRUDL is a proprietary product of Georgia Institute of Technology, Atlanta, GA.

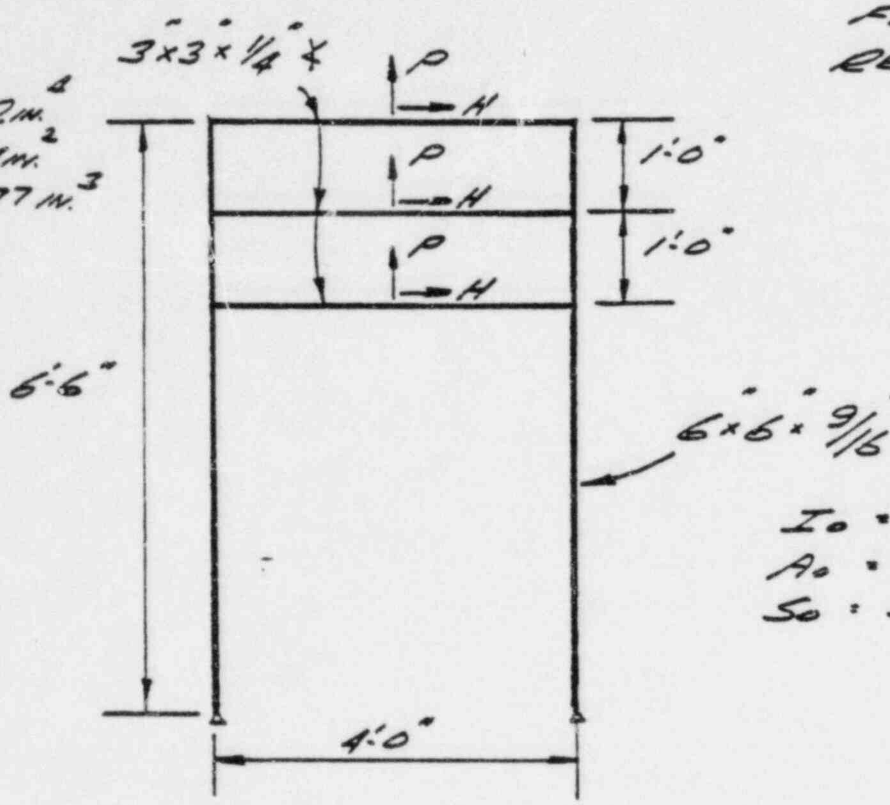
CN 1462
BY K. Bush
PAGE B5
FORM NO. 372-30-2650

FT. ST. VRAIN 3RCA CABLE TRAY SEISMIC SUPPO[RT] CALCULATIONS.

SUPPORT SPACING = 6'-0" c.c.
CABLE TRAY WIDTH = 1.5'
CABLE TRAY WEIGHT = 55 psf
DESIGN LOAD = 6 × 1.5 × 55 = 495 #

MAX HORZ "G" = 3.4
MAX VERT "G" = 1.1
ELEV. 4835'-6"
w/ 2% DAMPING
FSV 3RCA
RESPONSE SPECTRA

$I_o = 1.22\ in.^4$
$A_o = 1.44\ in.^2$
$S_o = 0.577\ in.^3$



$I_o = 22.1\ in.^4$
$A_o = 6.43\ in.^2$
$S_o = 5.14\ in.^3$

CABLE TRAY HANGER

LOADS: P & H = MAX. "G" FORCE × DESIGN LOAD
P = (1.1 + 1) 495 = 1039.5 # USE 1040 #
H = (3.4) 495 = 1683 #

ANALYSIS BY ED HICKS 9/28/82

Ed Hicks by Bob Glenn

CN 1462 B
BY K. Bush
PAGE 35.1 B
FORM NO. 372-30-2649

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CN 1462 B
BY K. Bush
PAGE B5.2 B
FORM NO. 372-30-2549

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CN 1462B
BY K. Bush
PAGE 35.3B
FORM NO. 372-30-2649

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CN 1962 B
BY J. TESNER
PAGE B6 B
FORM NO. 372-30-2650

CULATIONS FOR
EQUIP. NO. PROJ. NO. CALC. NO.
PREPARED BY DATE
REVIEWED BY Mark Muller DATE 8/16/83
APPROVED BY DATE

REPLACE ENTIRE PAGE PER CN-1962B

UNISTRUT CONCRETE INSERTS

THE PURPOSE OF THIS MEMO IS TO OUTLINE THE STRUCTURAL DEPARTMENT'S VIEWS AND RECOMMENDATIONS ON USE OF GTE UNISTRUT P3300 SERIES CONTINUOUS CONCRETE INSERTS TO SUPPORT CLASS I / NON CLASS I ATTACHMENTS TO BUILDING 10.

TEST DATA (REF: DETROIT TESTING LABORATORY, INC. REPORT NO. 312178-D DATED 9/24/74) DOCUMENT THE INITIAL YIELD AND ULTIMATE CAPACITY OF SUBJECT CONCRETE INSERTS. DESIGNS LOADS LISTED IN THE REPORT WERE EXCEEDED BY TEST RESULTS BY A MINIMUM FACTOR OF SAFETY OF 3. FOUR PULLOUT AND TWO SHEAR TESTS WERE CONDUCTED FOR VARIOUS LENGTHS OF UNISTRUT WITH THE CENTER OF GRAVITY OF LOAD AT THE MIDPOINT ALONG THE UNISTRUT LENGTH.

RECOMMENDED LOAD FOR THE INSERTS SHOWN IN THE UNISTRUT CATALOG NO. 9 IS 1500 LBS PER FOOT OF UNISTRUT LENGTH FOR PULLOUT TYPE LOADING; THIS VALUE IS BASED ON CONCRETE COMPRESSIVE STRENGTH OF 5000 PSI. FOR BUILDING 10 APPLICATIONS THE ALLOWABLE LOAD SHOULD BE REDUCED TO

$$1500 \text{ LBS/FT} \times \frac{3500 \text{ PSI}}{5000 \text{ PSI}} = 1050 \text{ LBS/FT (PULLOUT)}$$

ALLOWABLE LOAD FOR DIRECTION TRANSVERSE TO THE LONGITUDINAL AXIS (OTHER THAN PULLOUT) BASED ON UNISTRUT DESIGN LOAD DATA SHOULD BE

$$1260 \text{ LBS/FT} \times \frac{3500 \text{ PSI}}{5000 \text{ PSI}} = 880 \text{ LBS/FT (SHEAR)}$$

IN CONCLUSION, IT IS FELT THAT USE OF THE P3300 SERIES UNISTRUT CONCRETE INSERTS ARE ACCEPTABLE AS DESCRIBED HEREIN WITH THE FOLLOWING STIPULATIONS: (SEE PAGE 69.4 B)

CN 1462B
BY K. Bush
PAGE B7 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE 88 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE 39 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE B10 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE B11 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE B12 B
FORM NO. 372-30-2649

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CN-1462 B

CN 1462 B
BY K. Bush
PAGE B13 B
FORM NO. 372-30-2649

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CN-1462 B

CALCULATIONS FOR REPLACE ENTIRE PAGE PER CN-1962B	CALC. NO.	CN 14628
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY Mark Malka	DATE 8/16/83		PAGE B14 B
			FORM NO. 372-30-2650

CABLE TRAY SUPPORTS - GENERAL DESIGN NOTES

1) LOADS FROM TRAYS FOR SEISMIC AND DEAD WEIGHT CONDITIONS USED IN STRUCTURAL EVALUATION OF SUPPORTS (EXCEPT 10" x 14" BASE PLATE/ANCHOR BOLTS FOR L6x6 VERTICAL MEMBERS) WERE CALCULATED IN CN-1462 (PAGE B-5). THESE LOADS ARE BASED ON A SUPPORT SPACING OF 6 FT WITH TRAYS HOLDING THE MAXIMUM RECOMMENDED WEIGHT OF CABLES. A FACTOR OF 1.5 IS APPLIED TO THE PEAK HORIZONTAL AND VERTICAL SEISMIC DBE RESPONSE ACCELERATIONS (AND, CONSERVATIVELY, TO THE DEAD WEIGHT) TO ACCOUNT FOR CONTRIBUTION OF VARIOUS MODES OF VIBRATION.

2) SOME OVERALL DIMENSIONS FOR THE SUPPORTS WERE CHANGED FROM THOSE IN THE FOLLOWING ANALYSIS DUE TO CONSTRUCTION CONSIDERATIONS. FOR CHANGES IN HORIZONTAL CLEAR SPANS BETWEEN VERTICAL ANGLES THE FINAL DIMENSIONS SHOWN ON DRAWINGS REISSUED PER CN-14628 ARE LESS THAN OR EQUAL TO THOSE USED IN THE CALCULATIONS, THUS THE ANALYSIS PRODUCES CONSERVATIVE RESULTS. LENGTHS FOR VERTICAL MEMBERS, WHICH EXHIBIT A BENDING MODE UPON LATERAL LOAD APPLICATION, WERE SHORTENED WITH THE EXCEPTION BEING THE TYPE 1/TYPE 2 SUPPORTS. FOR THESE, THE DISTANCE FROM THE BOTTOM OF FLOOR SLAB DECKING TO THE UPPER TRAY WAS INCREASED 2 INCHES WHILE THE POSITION OF THE LOWER TRAY REMAINED UNCHANGED. THIS SLIGHT INCREASE IS ACCEPTABLE BY ENGINEERING JUDGEMENT.

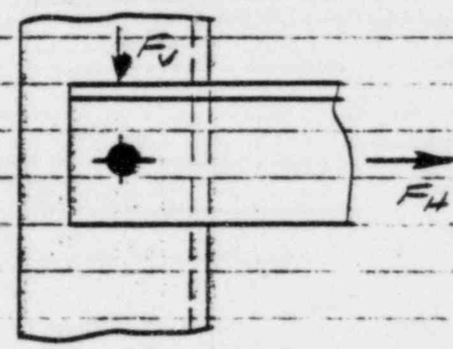
3) IN CHECKING OF ANGLE-TO-ANGLE CONNECTION BOLTS, THE FOLLOWING OBSERVATIONS AND ASSUMPTIONS ARE MADE:

A) ALL SUPPORTS CARRY ONE 18 INCH WIDE TRAY OR TWO 9 INCH WIDE TRAYS PER LEVEL. SUPPORT TYPE 6 WAS CHANGED FROM A THREE 18 INCH TRAY TO A TWO 9 INCH TRAY SUPPORT BY ELECTRICAL ENGINEERING

CALCULATIONS FOR Add ENTIRE PAGE	CALC. NO.	CN 1462B
PREPARED BY PER CN-1462B — DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY — DATE		PAGE 814.1
↳ Mark Mullen 8/16/83		FORM NO. 372-30-2650

B) ASSUME HORIZONTAL SEISMIC LOAD PER LEVEL IS ATTEMPTING TO SHEAR THE JOINT BOLTS AT EACH END OF THE HORIZONTAL ANGLE EQUALLY.

C) FOR VERTICAL LOAD, WORST CASE IS FOUND IN SUPPORT TYPE 4 SINCE TRAYS ARE STAGGERED AND ONE 18 INCH TRAY WILL BE MOUNTED CLOSE TO THE END OF THE HORIZONTAL ∠4×4×5/16 ON BOTH THE TOP AND BOTTOM LEVELS. ASSUME ENTIRE VERTICAL LOAD OF ONE 18 INCH TRAY IS SUPPORTED BY A SINGLE BOLT.



$F_V = 1040$ LBS

$F_H = \frac{1683}{2} = 842$ LBS

$F_R = \sqrt{F_V^2 + F_H^2}$

$= \sqrt{(1040)^2 + (842)^2}$

$= 1338$ LBS

SHEAR STRESS BASED ON NOMINAL BOLT AREA —

GROSS A_b FOR 1/2" ϕ BOLT = 0.196 SQ IN

$$f_v = \frac{F_R}{A_b} = \frac{1338 \text{ LBS}}{0.196 \text{ SQ IN}} = 6827 \text{ PSI} < 21 \text{ KSI}^{*} \text{ OK}$$

* ALLOWABLE FOR BEARING TYPE CONNECTION, THREADS IN SHEAR PLANE, ASTM A325 BOLTS

BEARING ON ANGLE HOLE AND END TEAR-OUT WILL NOT GOVERN BY INSPECTION OF MATERIAL THICKNESS & EDGE DISTANCE

4) CHECK ANGLE UNBRACED LENGTHS [REF SDCC-011 ISSUE 6, SECT. 4.6]

MAXIMUM UNBRACED LENGTH = $76 b_f / \sqrt{F_y}$

FOR ∠3×3, $l_B = 76(3)/\sqrt{36} = 38$ IN.; ACTUAL MAX. 38 IN (TYPE 2)

FOR ∠4×4, $l_B = 76(4)/\sqrt{36} = 51$ IN.; ACTUAL MAX. 66 IN (TYPE 4)

FOR ∠6×6, $l_B = 76(6)/\sqrt{36} = 76$ IN.; ACTUAL MAX. 76 IN (TYPE 3)

(CLEAR SPAN LENGTHS LISTED FOR ACTUAL SPANS)

CALCULATIONS FOR Add ENTIRE PAGE	CALC. NO.	CN 1462B
PREPARED BY PER CN-1462B DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY DATE		PAGE B14.2 B
↳ Mark Mullen 8/16/83		FORM NO. 372-30-2650

FOR ∠4x4, TYPE 4, MAXIMUM MOMENT OCCURS WITH SINGLE 18 INCH TRAY AT CENTER OF SPAN (SPAN DIM. USED IS ℄ TO ℄ BOLTS)

$$M = \frac{PL}{4} = \frac{(1040\ LBS)(73\ IN)}{4} = 18980\ IN\text{-}LBS$$

PROPERTIES OF ∠4x4x5/16 CALCULATED ELSEWHERE IN THIS CN:

$$S_W = 2.09\ IN^3 \quad \text{(STRONG PRINCIPAL AXIS)}$$

$$\left.\begin{array}{l} S_{Z_{MIN}} = 0.95\ IN^3 \\ S_{Z_{MAX}} = 1.20\ IN^3 \end{array}\right\} \text{WEAK PRINCIPAL AXIS}$$

STRESS AT ANGLE VERTEX -

$$\sigma_1 = \frac{0.707M}{S_{Z_{MIN}}} = \frac{(0.707)(18980\ IN\text{-}LBS)}{0.95\ IN^3} = 14,125\ PSI$$

STRESS AT ANGLE LEG TIP -

$$\sigma_2 = 0.707M\left(\frac{1}{S_W} + \frac{1}{S_{Z_{MAX}}}\right)$$

$$= (0.707)(18980\ IN\text{-}LBS)\left(\frac{1}{2.09\ IN^3} + \frac{1}{1.20\ IN^3}\right) = 17,603\ PSI$$

EACH OF THESE FIGURES LIES FAR BELOW $F_Y = 36\ KSI$, THE PERMISSIBLE BENDING STRESS FOR THE DW + OBE EARTHQUAKE LOAD COMBINATION PER THE FSAR. THEREFORE, LATERAL BUCKLING OF THE BEAM IS NOT A POSSIBLE FAILURE MODE.

FOR ALL OTHER SECTIONS, CALCULATED STRESSES ON FOLLOWING PAGES FOR ANGLES IN BENDING ARE LESS THAN 36 KSI, WHICH IS ACCEPTABLE.

CALCULATIONS FOR: Add ENTIRE PAGE PER CN-1462B

PREPARED BY | DATE

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Mark Muller 8/18/83

CALC. NO.

REF. DOCUMENTS:

CN 1462B

BY J. TESNER

PAGE B14.3 B

FORM NO. 372-30-2650

CABLE TRAY SUPPORTS   GENERIC CALCULATIONS

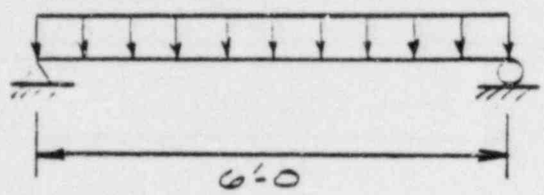
HORIZONTAL MEMBERS - MAX. SPAN, MAX. LOAD - TYPE 6

3 TRAYS 18" EACH

TOTAL VERT. LOAD = (3)(1040)
= 3120 LBS

EQUIVALENT DISTRIBUTED LOAD

w = 3120 LBS/6 FT
= 520 LBS/FT



$$M = \frac{wl^2}{8} = \frac{(520\,LBS/FT)(6\,FT)(72\,IN)}{8}$$
= 28080 IN-LBS

FROM PROPERTIES OF ∠4×4×5/16:

S_w = 2.09 IN^3

S_z = 0.95 IN^3

$$f_b = (0.707)(28080)\left(\frac{1}{2.09} + \frac{1}{0.95}\right) = 30{,}400\,PSI < 36\,KSI$$

(DBE LOAD CONDITION)

CHECK AXIAL COMPRESSION:

P = (3)(1683 LBS) = 5049 LBS

$f_a = P/A$ = 5049 LBS/2.4 SQ IN = 2104 PSI

$$\frac{Kl}{r} = \frac{(1)(72\,IN)}{0.791} = 91 \qquad F_a = 14.09\,KSI$$

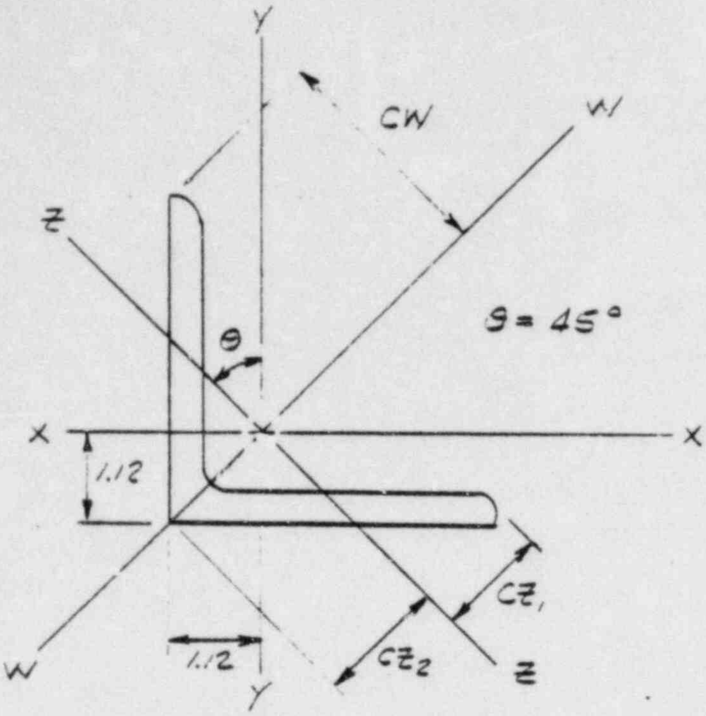
$$f_a/F_a = \frac{2104}{14{,}090} = 0.15$$ COMBINED STRESSES OK

SHEAR STRESS OK BY INSPECTION

→ USE ∠4×4×5/16 FOR HORIZ. MEMBER, 6 FT SPAN

(TYPES 4 & 6 TRAYS)

CALCULATIONS FOR Add PAGE PER	CALC. NO.	CN 1462 B
PREPARED BY CN-1462 B · DATE	REF. DOCUMENTS:	BY J. TESTER
REVIEWED BY · DATE		PAGE 814.4 B
Mark Muller 8/18/83		FORM NO. 372-30-2650



FOR ∠4x4x5/16:

$I_x = I_y = 3.71\ IN^4$

$r_z = 0.791\ IN$

$A = 2.4\ IN^2$

$r = \sqrt{I/A}$ $\quad I = Ar^2$

$I_z = (2.4)(0.791)^2 = 1.50\ IN^4$

$I_w = I_x + I_y - I_z$

$= (2)(3.71) - 1.50$

$= 5.92\ IN^4$

$CZ_2 = (1.414)(1.12\ IN)$

$= 1.58\ IN$

$CZ_1 = (4\ IN)(0.707) - 1.58\ IN.$

$= 1.25\ IN.$

$CW = (4\ IN)(0.707)$

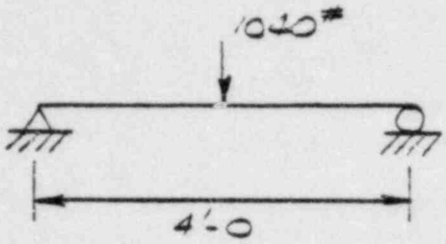
$= 2.83\ IN.$

$$S_W = \frac{I_W}{CW} = \frac{5.92}{2.83} = 2.09\ IN^3$$

$$S_{Z_{MIN}} = \frac{I_Z}{CZ_2} = \frac{1.50}{1.58} = 0.95\ IN^3$$

CALCULATIONS FOR Add PAGE PER CN-1462 B		CALC. NO.	CN 1462 B
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY	DATE		PAGE B14.5 B
Mark Mullen 8/18/83			FORM NO. 372-30-2650

HORIZONTAL MEMBERS CHECK 4'-0 SPAN, 1 18" TRAY



$M = \frac{PL}{4} = \frac{(1040^{\#})(48IN)}{4} = 12480$ IN-LBS

REF: SOCC-025 ISSUE 3 ATACH. A

TRY ∠ 3 x 3 x 1/4

$f_b = MB = (12480$ IN-LBS$)(2.155)$

$= 26,900$ PSI < 36 KSI

AXIAL, SHEAR STRESS ACCEPTABLE BY INSPECTION

→ USE ∠ 3 x 3 x 1/4 FOR HORIZ. MEMBER 4'-0 SPAN AND UNDER (TYPES 1, 2, 3, 5, 7 & 8)

VERTICAL MEMBERS

TYPE 1: $M = (1/2)(1683$ LBS$)(0.5)(24$ IN $+ 44$ IN$) = 28611$ IN-LBS
(9" TRAYS)

TYPE 2: SAME AS ABOVE
(9" TRAYS)

TYPE 3: $M = (1/2)(1683$ LBS$)(36$ IN $+ 54$ IN $+ 72$ IN$) = 136,323$ IN-LBS
(18" TRAYS)

TYPE 4: $M = (1/2)(1683$ LBS$)(36$ IN $+ 48$ IN $+ 66$ IN$) = 126,225$ IN-LBS
(18" TRAYS)

TYPE 5: $M = (1/2)(1683$ LBS$)(28$ IN$) = 23562$ IN-LBS
(18" TRAY)

TYPE 6: $M = (1/2)(1683$ LBS$)(3)(28$ IN$) = 70686$ IN-LBS
(18" TRAYS)

TYPE 7: $M = (1/2)(1683$ LBS$)(60$ IN $+ 78$ IN $+ 96$ IN$) = 196,911$ IN-LBS
(18" TRAYS)

TYPE 8: $M = (1/2)(1683$ LBS$)(24$ IN$) = 20,196$ IN-LBS

GROUP A: TYPES 1, 2, 5, 8

GROUP B: TYPES 3, 4, 7

GROUP C: TYPE 6

CALCULATIONS FOR Add PAGE PER CN-1462B		CALC. NO.	CN 1462 B
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY, Mark Mullen 8/18/83	DATE		PAGE B14.6 8
			FORM NO. 372-30-2650

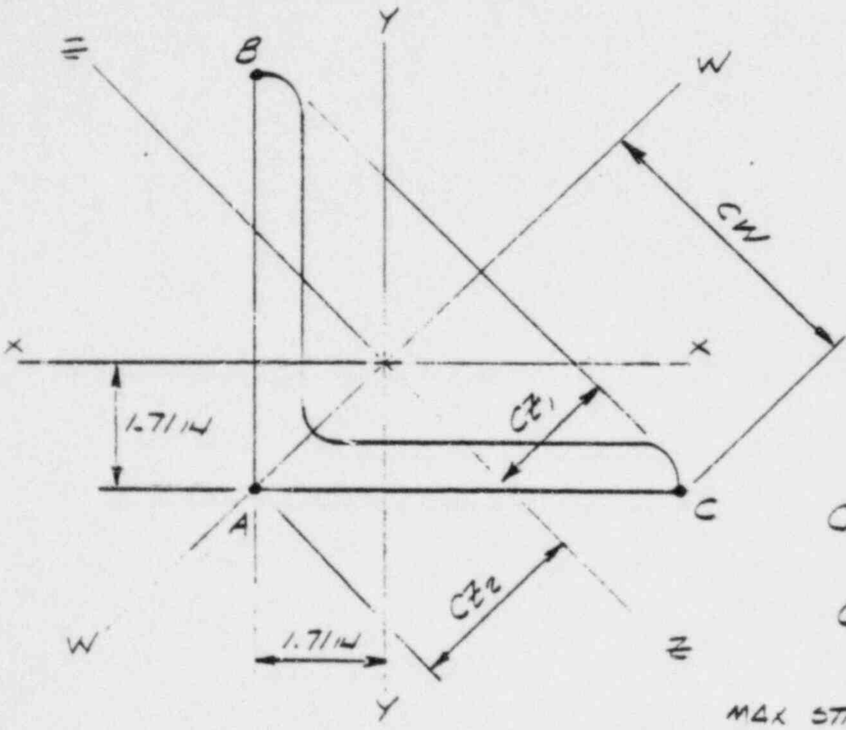
FOR GROUP A USE ∠4 x 4 x 5/16 (PREVIOUS HORIZ. MEMBER CALCS SHOW ∠4x4 CAN HANDLE M = 28,080 IN-LBS)

FOR GROUP C TRY ∠6 x 6 x 3/16 -

$S_Z = 3.71\ IN^3$ } FROM STAAD RUN
$S_W = 8.29\ IN^3$

$f_b = (0.707)(70686\ IN\text{-}LBS)\left(\frac{1}{3.71 IN^3} + \frac{1}{8.29 IN^3}\right) = 19,500\ PSI < 36\ KSI$ (CONSERVATIVE) OK

FOR GROUP B TRY ∠6 x 6 x 3/16 -



$A = 6.43\ SQ\ IN$
$r_Z = 1.18\ IN$
$I_X = I_Y = 22.1\ IN^4$

$I_Z = (6.43)(1.18)^2 = 8.95\ IN^4$
$I_W = I_X + I_Y - I_Z = (2)(22.1) - 8.95 = 35.25\ IN^4$

$CZ_2 = (1.414)(1.71\ IN) = 2.42\ IN$
$CZ_1 = (6\ IN)(0.707) - 2.42\ IN = 1.822\ IN$

MAX STRESS FOR M_Z OCCURS AT A
$CW = (6\ IN)(0.707) = 4.24\ IN$

$M_Y = 196,911\ IN\text{-}LBS$
$M_Z = M_W = (0.707)(196,911\ IN\text{-}LBS) = 139,216\ IN\text{-}LBS$

$S_{Z\,MIN} = \frac{I_Z}{CZ_2} = \frac{8.95 IN^4}{2.42 IN} = 3.70\ IN^3$

$S_{Z\,MAX} = \frac{I_Z}{CZ_1} = \frac{8.95 IN^4}{1.82 IN} = 4.92\ IN^3$

$S_W = \frac{I_W}{CW} = \frac{35.25 IN^4}{4.24 IN} = 8.31\ IN^3$

CALCULATIONS FOR	Add PAGE PER CN-1462 B	CALC. NO.	CN 1462 B
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY	DATE		PAGE B14.7 B
Mark Mullen 8/18/83			FORM NO. 372-30-2650

STRESS AT POINT A:

$$(f_b)_A = \frac{M_z}{S_{z\,MIN}} = \frac{139,216 \text{ IN-LBS}}{3.70 \text{ IN}^3} = 37,626 \text{ PSI N.G.}$$

STRESS AT POINTS B & C:

$$(f_b)_{B,C} = \frac{M_z}{S_{z\,MAX}} + \frac{M_W}{S_W} = \frac{139,216 \text{ IN-LBS}}{4.92 \text{ IN}^3} + \frac{139,216 \text{ IN-LBS}}{8.31 \text{ IN}^3}$$

$$= 28,296 \text{ PSI} + 16,753 \text{ PSI}$$

$$= 45,049 \text{ PSI N.G.}$$

TRY TYPES 3 & 4:

$$M_Y = 136,323 \text{ IN-LBS}$$

$$M_z = M_W = (0.707)(136,323 \text{ IN-LBS})$$

$$= 96,380 \text{ IN-LBS}$$

$$(f_b)_A = \frac{96380}{3.70} = 26,049 \text{ PSI} < 36 \text{ KSI OK}$$

$$(f_b)_{B,C} = \frac{96380}{4.92} + \frac{96380}{8.31} = 19,589 + 11,598 = 31,187 \text{ PSI} < 36 \text{ KSI OK}$$

AXIAL, SHEAR STRESS ACCEPTABLE BY INSPECTION

USE ∠6×6×9/16 FOR TYPE 3 & 4, ALSO FOR TYPE 7 BUT ADD DIAGONAL BRACES

SUPPORT TYPE	HORIZONTAL MEMBERS (QTY)	VERTICAL MEMBERS (QTY)	BRACING REQ'D
1	∠3×3×1/4 (2)	∠4×4×5/16 (2)	NO
2	∠3×3×1/4 (2)	∠4×4×5/16 (2)	NO
3	∠3×3×1/4 (3)	∠6×6×9/16 (2)	NO
4	∠4×4×5/16 (3)	∠6×6×9/16 (2)	NO
5	∠3×3×1/4 (1)	∠4×4×5/16 (2)	NO
6	∠4×4×5/16 (1)	∠6×6×9/16 (2)	NO
7	∠3×3×1/4 (3)	∠6×6×9/16 (2)	YES
8	∠3×3×1/4 (1)	∠4×4×5/16 (2)	NO

CALCULATIONS FOR: Add PER CN-1462B		CALC. NO.	CN 1462B
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY Mark Muller	DATE 8/18/83		PAGE 319.8 B

FORM NO. 372-30-2650

CABLE TRAY SUPPORTS - BASE PLATES

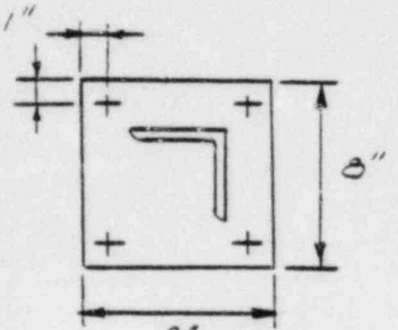
FOR ∠4x4x5/16, M = 28,611 IN-LBS

$P = \frac{1040}{2} = 520$ LBS

$V = \frac{1683}{2} = 842$ LBS

TRY PL 8x8x5/8

REF SDCC-025 ATTACH. A P. 2

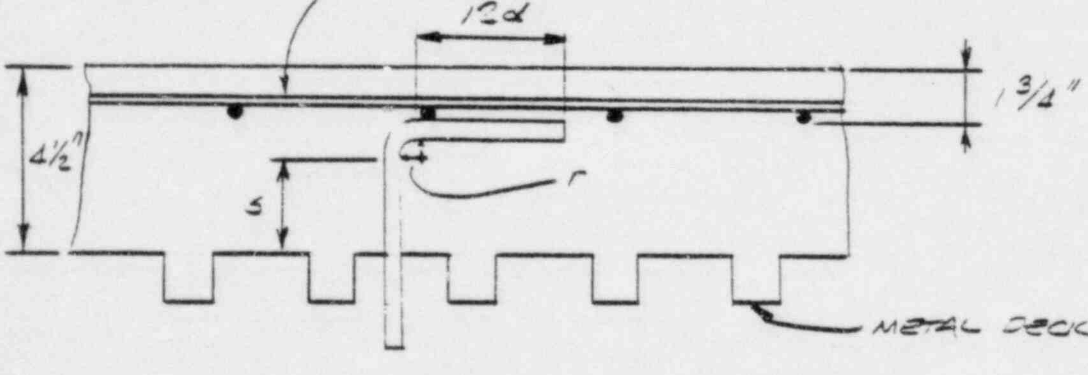


$T_m = \frac{28{,}611 \text{ IN-LBS}}{(2 \text{ BOLTS})(7/3)(0.75 \text{ IN})} = 3179$ LBS/BOLT

$T_P = \frac{520 \text{ LBS}}{4 \text{ BOLTS}} = 130$ LBS/BOLT

$T_{TOTAL} = T_M + T_P = 3179 + 130 = 3309$ LBS

TRY 3/4" BOLTS



r = BEND INSIDE RADIUS = 3d = (3)(0.75 IN) = 2.25 IN

s = STRAIGHT EMBEDMENT (MIN.) = 4.5 - 1.75 - 0.75 - 2.25 = -0.25 N.G.

SET TOP OF ANCHOR BOLTS IMMEDIATELY BELOW BOTTOM OF TOP SLAB BARS

s = 4.5 - 1.25 - 0.75 - 2.25 = 0.25 IN

CALCULATIONS FOR		CALC. NO.	CN 1462 B
Add PAGE PER CN-1462 B			BY J. TESNER
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B14.9 B
REVIEWED BY	DATE		FORM NO. 372-30-2650
Mark Mullen 8/18/83			OF

CHECK EFFECTIVE ANCHORAGE OF STANDARD HOOK IN TENSION

FOR #6 BAR (NOM. DIA. 3/4") ASSUME TOP BAR $\xi = 450$ FOR $f_y = 60{,}000$ PSI

$$f_h = \xi\sqrt{f'_c} = 450\sqrt{3500} = 26{,}622 \text{ PSI}$$ (REF ACI 318-77 SECT. 12.5.1)

CORRECTING FOR SMOOTH BAR, $f_y = 36{,}000$ PSI –

$$f'_h = (1/2)\left(\frac{36}{60}\right)(26{,}622 \text{ PSI}) = 7987 \text{ PSI}$$

PER THE ACI 1963 CODE, BOND STRESS TO DETERMINE EFFECTIVE ANCHORAGE OF EMBEDMENT LENGTHS FOR SMOOTH BARS IS EQUAL TO 1/2 OF THAT FOR DEFORMED BARS

ACTUAL TENSILE STRESS BASED ON NOMINAL BOLT DIA.

$$\sigma = \frac{P}{A} = \frac{3309 \text{ LBS}}{\pi(0.75\text{IN})^2/4} = 7490 \text{ PSI} < 7987 \text{ PSI OK}$$

SHEAR STRESS ACCEPTABLE BY INSPECTION

CHECK BAR BEARING ON CONCRETE –

ALLOWABLE STRESS $= 0.375 f'_c = 1312.5$ PSI (AISC 1.5.5)

$$\text{ACTUAL STRESS} = \frac{P}{A} = \frac{3309 \text{ LBS}}{(9\text{IN})(0.75\text{IN})} = 490 \text{ PSI OK}$$

PROJECTED AREA OF STRAIGHT PORTION OF BAR ON CONCRETE

CONCRETE CONE PULLOUT IS NOT A GOVERNING CONSIDERATION SINCE CONCRETE IS CONFINED BY DECKING AND SLAB IS WELL REINFORCED.

CHECK ℄ BENDING –

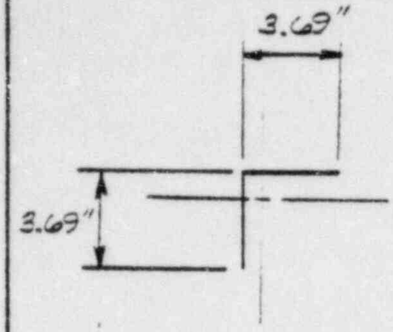
$$M = (2)(3309 \text{ LBS})(1\text{IN}) = 6618 \text{ IN-LBS}$$

$$S = bd^2/6 = (3\text{IN})(0.625\text{IN})^2/6 = 0.521 \text{ IN}^3$$

$$\sigma = \frac{M}{S} = \frac{6618 \text{ IN-LBS}}{0.521 \text{ IN}^3} = 12{,}707 \text{ PSI} < 36 \text{ KSI } (A\text{-}36\ f_y) \text{ OK}$$

CALCULATIONS FOR Add PAGE PER	CALC. NO.	CN 1462 B	OF
PREPARED BY CN-1462 B	DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY	DATE		PAGE B-14.10 B
↳ Mark Mueller	8/18/83		FORM NO. 372-30-2650

CHECK BASE WELD



$$S = \frac{(3.69)^2((4)(3.69)+3.69)}{(6)((2)(3.69)+3.69)}$$ [REF. BLODGETT, DESIGN OF WELDED STRUCTURES]

$$= 3.78\ IN^2$$

$$L_w = (2)(3.69) = 7.38\ IN$$

$$f_{WRES} \approx f_{WY} = \frac{28{,}611\ IN\cdot LBS}{3.78\ IN^2} + \frac{520\ LBS}{7.38\ IN}$$

$$= 7640\ LBS/IN$$

ALLOWABLE STRESS - ACTUAL STRESS BASED ON AREA THROUGH WELD THROAT

WELD GOVERNS: $(21\ KSI)(4/3) = 28\ KSI$ (INCREASED 1/3 FOR OBE)

BASE METAL GOVERNS: $[(0.4)(36\ KSI)/0.707](4/3) = 27.2\ KSI$

$$\tau_W = \frac{f_{WRES}}{(t)(0.707)} \qquad t = \frac{7640\ LBS/IN}{(27{,}200\ PSI)(0.707)} = 0.40\ IN$$

USE 1/4 IN. FILLET ALL AROUND - S WILL BE APPROX. DOUBLE SINCE C DISTANCE REMAINS ESSENTIALLY THE SAME AND I WILL MORE THAN DOUBLE.

CALCULATIONS FOR	Add PAGE PER	CALC. NO.	CN 1462 B
PREPARED BY	CN-1462 B DATE	REF. DOCUMENTS:	BY J. TESNER
REVIEWED BY	DATE		PAGE 814.11 B
			FORM NO. 372-30-2600

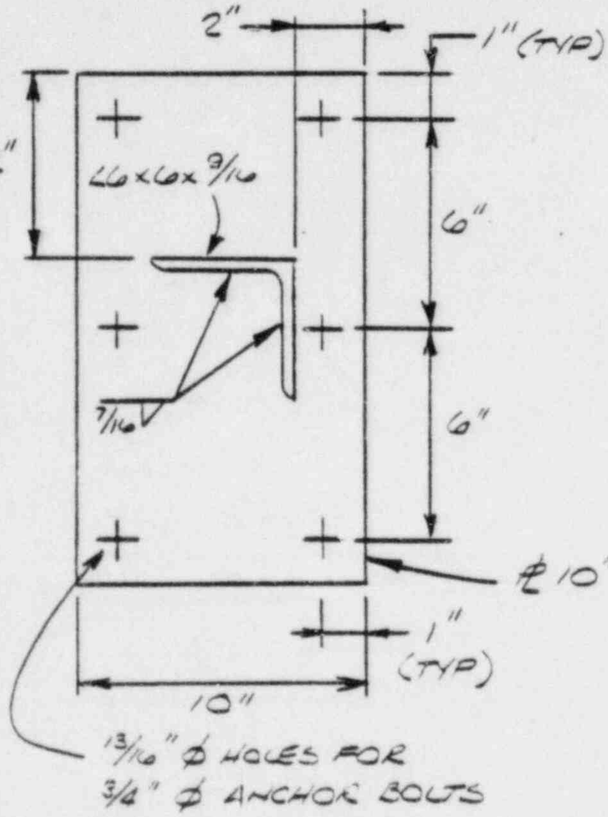
Mark Mullen 2/18/83

BASE PLATES

FOR SUPPORTS WITH VERTICAL L6x6, ELEV. T.O.C. SLAB TO WHICH THEY ARE ATTACHED IS 4811'-0. ORIGINAL ANALYSIS BASED ON ARS AT 4835'-6". REDUCTION IN HORIZONTAL SEISMIC LOAD IS AS FOLLOWS:

PEAK HORIZ. g AT 4835'-6" (2% DAMPING) = 3.4 (DBE)
PEAK HORIZ. g AT 4811'-0 (5%* DAMPING) = 1.4 (DBE)

$$M_{MAX} = (136{,}323 \text{ IN-LBS})\left(\frac{1.4}{3.4}\right) = 56{,}133 \text{ IN-LBS}$$



$$T_M = \frac{56{,}133 \text{ IN-LBS}}{(3 \text{ BOLTS})(2/3)(8.75 \text{ IN})}$$

= 3208 LBS/BOLT

T (DIRECT PULLOUT) = (3 TRAYS)(1040 LBS PER TRAY)/(2)(6 BOLTS)
= 260 LBS/BOLT

V = (3 TRAYS)(1683 LBS/TRAY)/(2)(6)
= 421 LBS/BOLT

TENSION LOAD OF 3208 + 260 = 3468 LBS ACCEPTABLE FOR 3/4" Ø L-BOLT PER CALCS FOR BASE PL ON L4x4x5/16

SHEAR ACCEPTABLE BY INSPECTION

* ACTUAL CABLE TRAY SUPPORTS ARE BOLTED STEEL STRUCTURES WITH RIGID BASE ATTACHMENTS. REG. GUIDE 1.61 ALLOWS USE OF 4% DAMPING FOR WELDED STEEL AND 7% FOR BOLTED STEEL STRUCTURES WHEN CONSIDERING DBE LOADS. USE OF 5% DAMPING IS REALISTIC.

CALCULATIONS FOR	Add Page Per CN-1462 B	CALC. NO.	CN 1462 B	OF
PREPARED BY	DATE	REF. DOCUMENTS:	BY J. TESNER	
REVIEWED BY	DATE		PAGE B14.12 B	
March Mueller	8/18/83		FORM NO 372-30-2650	

CHECK WELD AT BASE -

FOR 6x6x 9/16 ANGLE, WELD ON INSIDE LEGS:
(SEE BELOW FOR CALCULATION OF WELD PROPERTIES)

$S = 8.22 \text{ IN}^2 \qquad L_w = 10.88 \text{ IN}$

$$f_{wy} = \frac{1560 \text{ LBS}}{10.88 \text{ IN}} + \frac{56,133 \text{ IN-LBS}}{8.22 \text{ IN}^2} = 6972 \text{ LBS/IN}$$

SHEAR STRESS IS LOW, f_{wy} IS ESSENTIALLY RESULTANT

$$\sigma_w = \frac{6972 \text{ LBS/IN}}{(0.707)(0.375 \text{ IN})} = 26.3 \text{ KSI} < 27.2 \text{ KSI} \text{ OK FOR } 3/8'' \text{ FILLET}$$

SPECIFY 7/16" FILLET FOR SAFETY MARGIN

CHECK BASE PLATE -

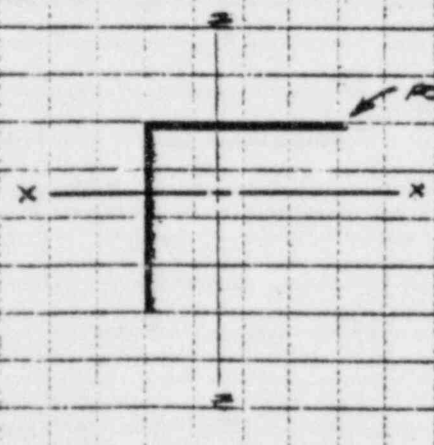
$M = (3 \text{ BOLTS})(3468 \text{ LBS/BOLT})(1 \text{ IN.})$
$= 10,404 \text{ IN-LBS}$

$S = (14 \text{ IN})(0.875 \text{ IN})^2/6 = 1.79 \text{ IN}^3$

$$\sigma = \frac{M}{S} = \frac{10,404 \text{ IN-LBS}}{1.79 \text{ IN}^3} = 5824 \text{ PSI} < 56 \text{ KSI OK}$$

USE 7/8" THICK PLATE FOR RIGIDITY

CHECK WELD BETWEEN L6x6 AND PLATE



$$S_z (\text{POINT A}) = \frac{d^2(4b+d)}{6(2b+d)}$$

$b = d = 5.44 \text{ IN}$ (WELD ON INSIDE LEGS)

$$S_z = \frac{(5.44)^2((4)(5.44)+5.44)}{(6)((2)(5.44)+5.44)}$$

$= 8.22 \text{ IN.}^2$

$L_w = (2)(5.44) = 10.88 \text{ IN.}$

REF. O. BLODGETT, DESIGN OF WELDED STRUCTURES

CN 1462A
BY K. Bush
PAGE B15A
FORM NO. 372-30-2850

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CN-1462A

CN 1962
BY G Bates
PAGE B16
FORM NO. 372-30-2550

CHECK LIST OF DESIGN VERIFICATION QUESTIONS

FOR DESIGN REVIEW METHOD

YES	NO	N/A		
(X)	( )	( )	1.	Were the inputs correctly selected and incorporated into design?
(X)	( )	( )	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
(X)	( )	( )	3.	Are the appropriate quality and quality assurance requirements specified?
(X)	( )	( )	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
(X)	( )	( )	5.	Have applicable construction and operating experience been considered?
(X)	( )	( )	6.	Have the design interface requirements been satisfied?
(X)	( )	( )	7.	Was an appropriate design method used?
(X)	( )	( )	8.	Is the output reasonable compared to inputs?
(X)	( )	( )	9.	Are the specified parts, equipment, and processes suitable for the required application?
(X)	( )	( )	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
( )	( )	(X)	11.	Have adequate maintenance features and requirements been specified?
(X)	( )	( )	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
(X)	( )	( )	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
( )	( )	(X)	14.	Has the design properly considered radiation exposure to the public and plant personnel?
(X)	( )	( )	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

CN 1462
BY G Bates
PAGE B17
FORM NO. 372-30-2650

CHECK LIST OF DESIGN VERIFICATION QUESTIONS - Cont'd.

YES NO N/A

( ) ( ) (X) 16. Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?

(X) ( ) ( ) 17. Are adequate handling, storage, cleaning and shipping requirements specified?

(X) ( ) ( ) 18. Are adequate identification requirements specified?

(X) ( ) ( ) 19. Are requirements for record preparation review, approval, retention, etc., adequately specified?

Note: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES

UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

No Deficiencies Found

Gregory S. Bates
10/1/82

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CN 14628

BY Larson / Mullen

PAGE B17.1

CHECK LIST OF DESIGN VERIFICATION QUESTIONS FOR DESIGN REVIEW METHOD

Form 344-22-4095

YES	NO	N/A		
☑	☐	☐	1.	Were the inputs correctly selected and incorporated into design?
☑	☐	☐	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
☑	☐	☐	3.	Are the appropriate quality and quality assurance requirements specified?
☑	☐	☐	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
☑	☐	☐	5.	Have applicable construction and operating experience been considered?
☑	☐	☐	6.	Have the design interface requirements been satisfied?
☑	☐	☐	7.	Was an appropriate design method used?
☑	☐	☐	8.	Is the output reasonable compared to inputs?
☑	☐	☐	9.	Are the specified parts, equipment, and processes suitable for the required application?
☑	☐	☐	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
☑	☐	☐	11.	Have adequate maintenance features and requirements been specified?
☑	☐	☐	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
☑	☐	☐	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
☐	☐	☑	14.	Has the design properly considered radiation exposure to the public and plant personnel?
☑	☐	☐	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
☐	☐	☑	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
☑	☐	☐	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
☑	☐	☐	18.	Are adequate identification requirements specified?
☑	☐	☐	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

NOTE: If the answer to any question is no, provide additional information and resolution below:

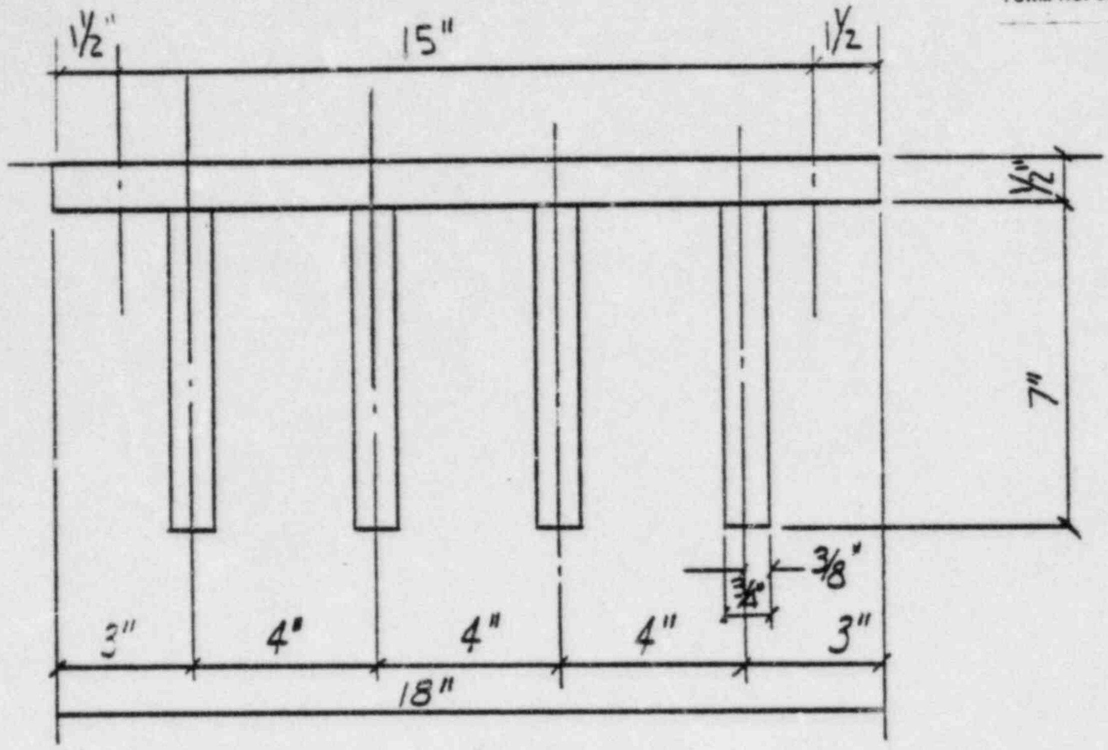
RESOLUTION OF DESIGN DEFICIENCIES UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

NO DEFICIENCIES WERE FOUND DURING THE ELECTRICAL REVIEW. Wayne Kendall 8/15/83 ~~[illegible]~~

No deficiencies were found in the structural review. Mark Mullen 8/18/83

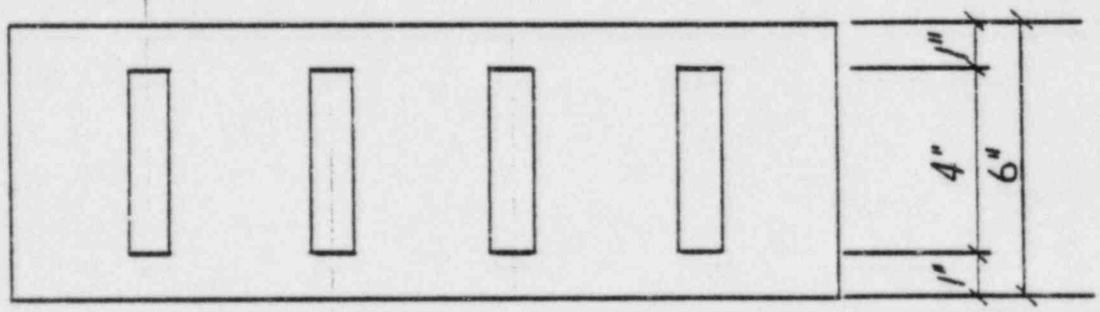
NO DEFICIENCIES FOUND DURING REVIEW OF MINOR ELECTRICAL CHANGES
Wayne Kendall
8-26-83

CN 1462A
BY Hicks
PAGE B18A
FORM NO. 372-30-2650



PLAN

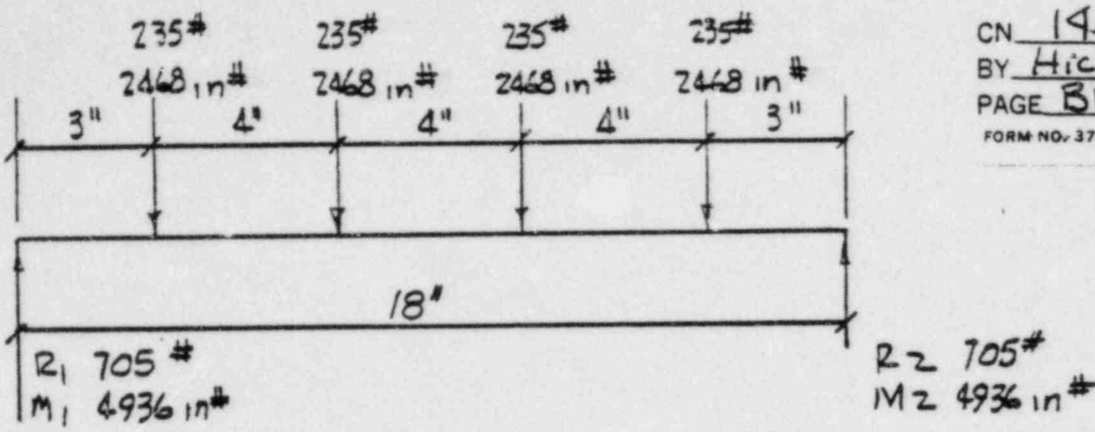
MILD STEEL PL



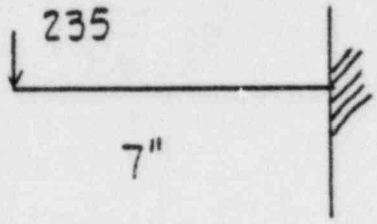
ELEVATION

CABLE SUPPORT FOR BUILDING 10
FOR CABLES FROM EL 4791 TO
4835 SUPPORT WILL BE
MOUNTED TO WALL

CN 1462A
BY Hicks
PAGE B19A
FORM NO. 372-30-2650



DESIGN FOR CONCENTRATED LOAD AT END OF 3/4" x 7" bar



M MAX = Pl = 235×7 = 1645 in#
M Seismic 1645 × 1.0 × 1.5 = 2467.5

$S_m = \frac{1645}{22K} = .074 \text{ in}^3$

RETANGLE AXIS OF MOMENT THROUGH CENTER

$S = \frac{bd^3}{6} = \frac{.75 \times 4^3}{6} = 8 \text{ in}^3$

18 R1 = 3×235 + 7×235 + 11×235 + 15×235
18 R1 = 705 + 1645 + 2585 + 3525 = 8460
R1 = 470#
R1 Seismic 470 × 1 × 1.5 = 705#
18 M1 = 3×2468 in# + 7×2468 in# + 11×2468 in# + 15×2468 in#
18 M1 7404 + 17276 + 27148 + 37020
18 M1 = 88848
M1 = 4936 in#

$M = 4936$

$S_{M} = \frac{4936}{22K} \quad .224 \text{ in}^3$

RETANGLE AXIS OF MOMENT THROUGH CENTER

$S = \frac{bd^3}{6} = \frac{.5 \times 6^3}{6} = 18 \text{ in}^3$

USE A RED HEAD CONC ANCHOR
MIN SIZE 1/2" Ø PULL OUT = 1700 > 705
SHEAR = 1344 > 705

CHECK NATURAL FREQUENCY OF SYSTEM

$$f = \frac{3.52}{2\pi}\sqrt{\frac{E I g}{W L^3}}$$ cps, FOR CANTILEVER

$$f = \frac{3.52}{2\pi}\sqrt{\frac{29\times10^6 \times 4 \times 386.4}{235 \times 7^3}}$$ cps

$f = 417$ cps THEREFORE SYSTEM IS RIGID AND WILL MOVE THE SAME AS THE BUILDING. NO SEISMIC PROBLEMS.

where: $I = \frac{1}{12} b h^3 = \frac{1}{12}(.75) 4^3 = 4 \text{ IN.}^4$

$L = 7$ IN.
$W = 235$ #
$g = 386.4$ IN/SEC.^{2}
$E = 29 \times 10^6$ PSI
f = NATURAL FREQ.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) / TCR / SCR / PC / TR
NO. 1255
PAGE 2

CATEGORY

TYPE:

☒ CN OVERALL ☐ CN SUBMITTAL ☐ SETPOINT CHANGE REPORT ☐ TEST REQUEST
☐ TEMPORARY CONFIGURATION REPORT ☐ PROCEDURE CHANGE (FSAR) ☐ OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

CLASS I	☒ YES	☐ NO	ENGINEERED SAFEGUARD	☒ YES	☐ NO
SAFE SHUTDOWN	☒ YES	☐ NO	PLANT PROTECTIVE SYSTEM	☐ YES	☒ NO
SAFETY RELATED	☒ YES	☐ NO	SECURITY SYSTEM	☐ YES	☒ NO

REMARKS ______

EVALUATION USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE FSAR OR TECH SPEC? ☒ YES ☐ NO

LIST THE APPLICABLE SECTIONS REVIEWED. FSAR sections 7.4.3, 8.2.2.3, 8.2.2.4, 8.2.3.4, 8.2.3.5, 8.2.5.2 Tech Specs LCO 4.6, SR 5.6.2

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE FSAR OR TECH SPEC? ☒ YES ☐ NO

LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE. Sections 7.4.3, 8.2.2.3 must be revised to indicate the new configuration. FSAR figure 8.2-13 must be revised; a possible but not mandatory example is shown on page 3 and 4 of this CN. Tech Spec LCO 4.6 must be revised; a possible but not mandatory revision is shown as page 5 of this CN

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE FSAR BEEN INCREASED?

☐ YES ☒ NO STATE BASIS: CN 1255 provides an independent instrument power transformer to provide back-up power for each inverter (1A and 1B) which provides power to the non-interruptible buses 1A and 1B. Power is transferred from the preferred source to the alternate source via static transfer switches replacing manual transfer switches in the present configuration. The electrical power source for the new Instrument Power Transformers 1A-1 and 1B-1 is Essential 480V Swgr (see attached)

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE FSAR BEEN CREATED? ☐ YES ☒ NO STATE BASIS: Because the system functions as before to provide power to vital equipment only with increased reliability as described in 3(A), the possibility of a new accident or malfunction has not been created.

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE FSAR BEEN REDUCED? ☐ YES ☒ NO STATE BASIS: Increasing the reliability and flexibility of the non-interruptible power supply system can only increase the system's margin of safety.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION ☐ YES ☒ NO
BE SAFETY SIGNIFICANT ☐ YES ☒ NO

BY Michael C. Eler [signature] (SIGNATURE) 6/10/83 (DATE) *APPROVED J R Johnson [signature] (SIGNATURE) 6-10-83 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372-02-3382

3 (A) (cont)

Bus 1 and Bus 3 respectively. The present electrical configuration allows backup power for Non-interruptible buses 1A and 1B to be provided from the same source. The inverters (1A and 1B) are also being upgraded from 14.5 KVA to 25 KVA which will prevent system overload and allow sufficient margin for future modifications. Interruptible Bus 3 will also be provided with a static transfer switch utilizing instrument power tranformers 1A and 1B for power sources. Each item changed within this CN adds to the reliability and flexibility of a vital electrical power system within FSU. Due to the increased reliability of this system, the probability of occurrence of the consequences of an accident or malfunction of equipment important to safety evaluated in the FSAR has not been increased.

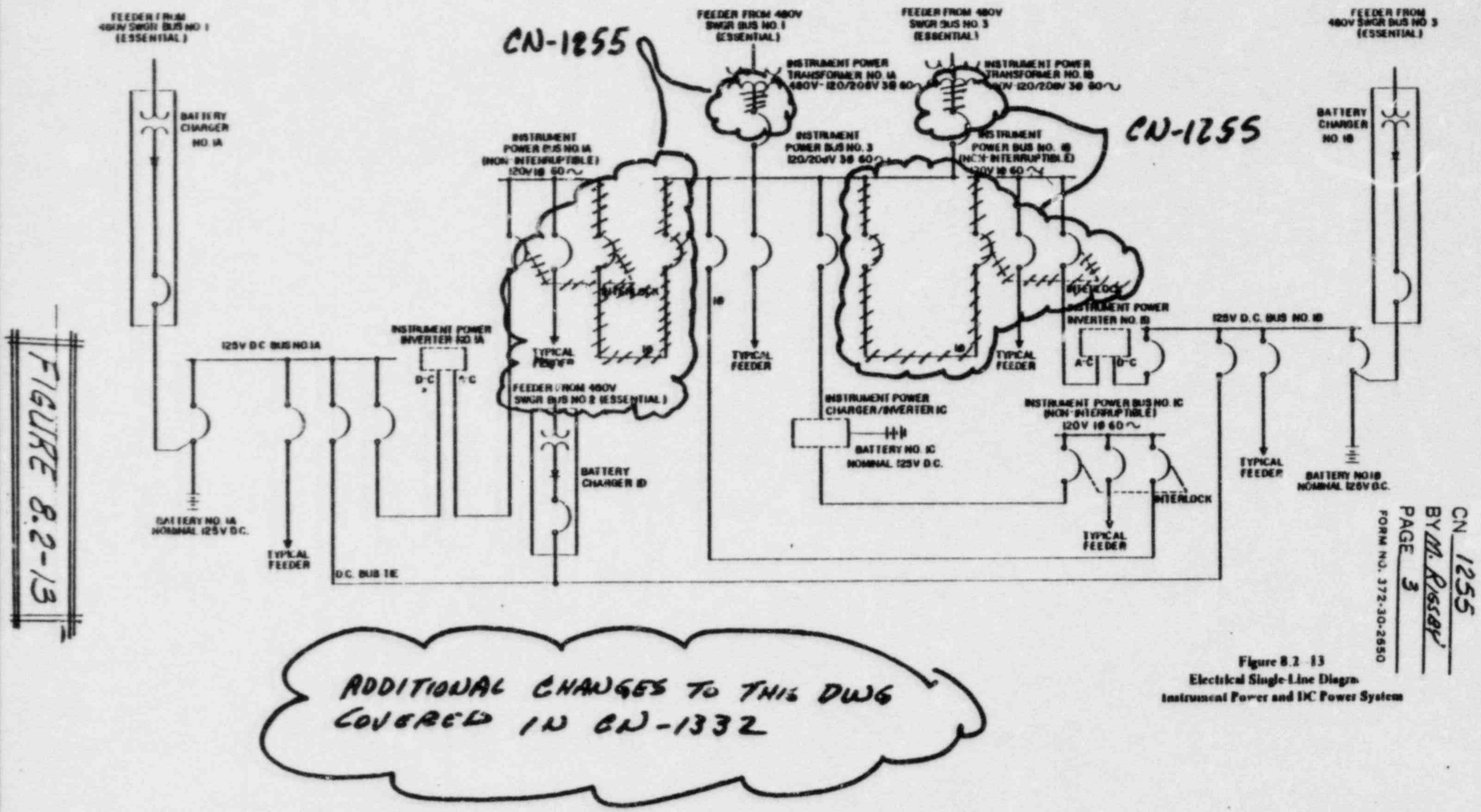
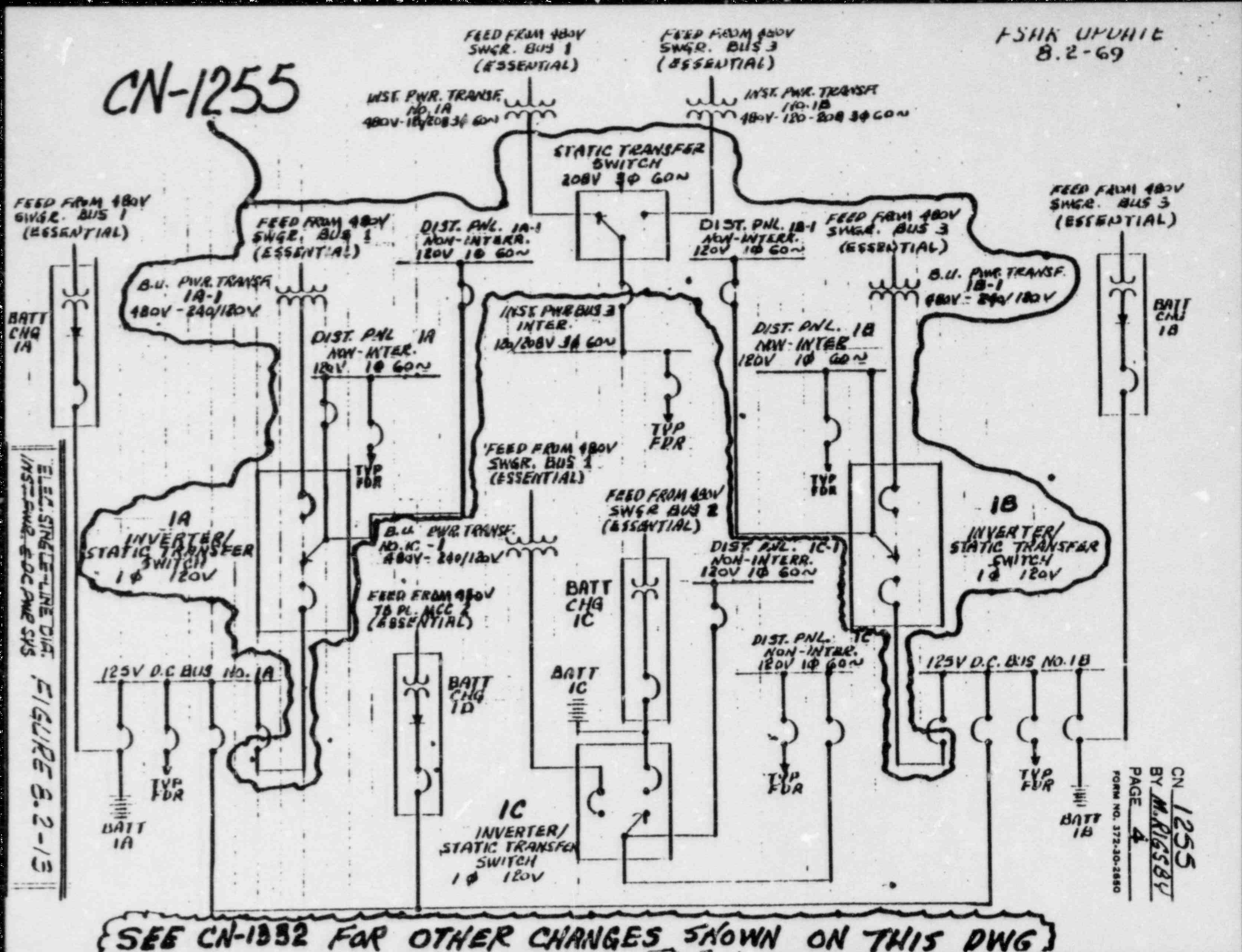


FIGURE 8.2-13

CN 1255
BY M. RIGSBY
PAGE 3
FORM NO. 372-30-2650

Figure 8.2-13
Electrical Single-Line Diagram
Instrument Power and DC Power System



CN-1255
FSAR UPDATE 8.2-69
FEED FROM 480V SWGR. BUS 1 (ESSENTIAL)
INST. PWR. TRANSF. NO. 1A 480V-120/208 3Φ 60~
FEED FROM 480V SWGR. BUS 3 (ESSENTIAL)
INST. PWR. TRANSF. NO. 1B 480V-120-208 3Φ 60~
STATIC TRANSFER SWITCH 208V 3Φ 60~
BATT CHG 1A
B.U. PWR. TRANSF. 1A-1 480V-240/120V
DIST. PNL. 1A-1 NON-INTERR. 120V 1Φ 60~
DIST. PNL. 1A NON-INTER. 120V 1Φ 60~
INST. PWR BUS 3 INTER. 120/208V 3Φ 60~
DIST. PNL. 1B-1 NON-INTERR. 120V 1Φ 60~
B.U. PWR. TRANSF. 1B-1 480V-240/120V
DIST. PNL. 1B NON-INTER 120V 1Φ 60~
BATT CHG 1B
TYP FDR
1A INVERTER/ STATIC TRANSFER SWITCH 1Φ 120V
B.U. PWR. TRANSF. NO. IC-1 480V-240/120V
FEED FROM 480V SWGR. BUS 2 (ESSENTIAL)
FEED FROM 480V SWGR BUS 2 (ESSENTIAL)
FEED FROM 480V TB PL. MCC 2 (ESSENTIAL)
DIST. PNL. IC-1 NON-INTERR. 120V 1Φ 60~
1B INVERTER/ STATIC TRANSFER SWITCH 1Φ 120V
BATT CHG IC
BATT IC
BATT CHG 1D
125V D.C BUS No. 1A
DIST. PNL. IC NON-INTER. 120V 1Φ 60~
125V D.C. BUS NO. 1B
BATT 1A
BATT 1B
IC INVERTER/ STATIC TRANSFER SWITCH 1Φ 120V
CN 1255
BY M. RIGSBY
PAGE 4
FORM NO. 372-30-2650
ELEC. SINGLE-LINE DIA. INST. PWR. & DC PWR SYS
FIGURE 8.2-13
SEE CN-1332 FOR OTHER CHANGES SHOWN ON THIS DWG

CN 1255
BY M. RIGSBY
PAGE 5
FORM NO. 372-30-2650

CN-1255

Backup electric power for the non-interruptible a-c instrument loads is provided by bus ties from Instrument Bus No. 3 to Instrument Buses 1 and 2 which are normally fed by the two Instrument Power Inverters. * SEE BELOW Bus No. 3 receives its power from redundant instrument transformers which are supplied from the essential 480 volt switchgear. (FSAR Section 8.2.2.3.)

A redundant source of electric power for the d-c instrument loads is available from a bus tie between the two d-c buses which allows one battery or a-c to d-c rectifier to supply both buses.

These backups and redundancies permit the temporary removal from service of an instrument power inverter, a battery, a d-c bus or an a-c to d-c rectifier.

A diesel fuel storage capacity of 50,000 gallons is provided. A supply of 20,000 gallons of diesel fuel is adequate to provide for operation of the standby generators for at least seven days under required loading conditions. This allows adequate time to obtain additional fuel and to make provisions to restore the standby source of power into the station.

* ON INSTRUMENT BUSES 1 AND 2 IS SUPPLIED BY INDIVIDUAL 480-120/240V BACK-UP POWER TRANSFORMERS. THE NORMAL FEED TO THESE BUSES IS INDIVIDUAL INSTRUMENT POWER INVERTERS. THE 480-120/240V BACK-UP POWER TRANSFORMERS WILL BE SUPPLIED FROM ESSENTIAL 480V SWITCHGEAR.

CN-1255

TECH. SPEC. LCO 4.6
Pg. 4.6-6

CN 1255
BY M RIGSBY
PAGE E-1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS
Sheet 1 of 2

THIS CN IS A PORTION OF THE WORK INVOLVED WITH UPGRADING THE INTERRUPTIBLE AND NON-INTERRUPTIBLE INSTRUMENT BUSES. THE REMAINDER OF THIS PROJECT IS COVERED BY CN-1332 (200A(DC) OUTPUT BATT. CHG AND 15KVA INVERTER) AND CN-1?9 (REPLACEMENT AND UPGRADE OF BATTERIES 1A, 1B AND 1C).

THE PRIMARY FEEDS TO NON-INTERRUPTIBLE BUSES 1 AND 2 ARE THE 125V DC BUSES 1A AND 1B THROUGH INVERTERS 1A AND 1B. BACK-UP POWER TO BUSES 1 AND 2 IS SUPPLIED FROM 1A AND 1B (480-120/208V) TRANSFORMERS. THESE TRANSFORMERS ARE RATED AT 45KVA EACH. IN EACH CASE A MANUAL THROW-OVER SCHEME IS USED. PAST OPERATION HAS PROVEN THAT INSTRUMENT TRANSFORMERS 1A AND 1B ARE NOT SIZED PROPERLY TO HANDLE THE CONNECTED LOADS DURING AN UPSET CONDITION. INVERTERS 1A AND 1B ARE RATED AT 14.5KVA AND ARE PRESENTLY LOADED TO CAPACITY.

THIS CN WILL REPLACE EXISTING INVERTERS 1A AND 1B (RATED AT 14.5KVA) WITH NEW INVERTERS RATED AT 25KVA TO PROVIDE FOR ADDITIONAL INSTRUMENT BUS LOADS AS NEEDED FOR PLANT MODIFICATIONS OR ADDITIONS. THE NEW INVERTERS WILL BE EQUIPPED WITH STATIC TRANSFER SWITCHES FOR AUTOMATIC THROW-OVER TO BACK-UP POWER SOURCES WHEN CONDITIONS DICTATE. THE BACK-UP POWER SOURCES TO NON-INTERRUPTIBLE INSTRUMENT BUSES 1 AND 2 WILL BE REMOVED FROM INSTRUMENT POWER TRANSFORMERS 1A AND 1B AND NEW 25KVA BACK-UP POWER TRANSFORMERS WILL BE INSTALLED FOR THIS PURPOSE. INTERRUPTIBLE BUS 3 WILL REMAIN TIED TO 1A AND 1B TRANSFORMERS.

Prepared By: /s/ M. RIGSBY 9/15/82 Date   Approved By: /s/ [signature] 11-9-82 Date

CN 1255
BY M RIGSBY
PAGE B1.1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS

Sheet 2 of 2

THIS WILL ALLEVIATE THE OVERLOAD CONDITIONS FOUND PREVIOUSLY ON THESE TRANSFORMERS. IN ADDITION TO RELEIVING THE OVERLOAD PROBLEMS ASSOCIATED WITH THESE TRANSFORMERS A THREE PHASE STATIC TRANSFER SWITCH WILL BE INSTALLED TO MONITOR AND THROW-OVER AUTOMATICALLY FROM PREFERRED TO SECONDARY TRANSFORMER FEED TO INTERRUPTIBLE BUS 3.

THE NEW 25KVA BACK-UP POWER TRANSFORMERS TO BE INSTALLED AS BACK-UP POWER SOURCES WILL BE FED FROM ESSENTIAL 480V SWITCHGEAR.

ALL ELECTRICAL WORK WILL BE PERFORMED IN ACCORDANCE WITH SPEC. 1-N-2 AND FSV STANDARDS.

A FLAMASTIC COATING WILL BE APPLIED TO ALL CABLES, WHERE APPLICABLE, PER SPEC 93-2-7.

THIS WORK HAS BEEN UNDERTAKEN BECAUSE OF COMMITMENTS MADE IN ANSWER TO IE BULLETIN 79-27.

Prepared By: /s/ M. RIGSBY 9/15/82 Date   Approved By: /s/ [signature] 11-9-82 Date

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY RELATED DESIGN ANALYSIS - SHEET 1

CN 1255

BY M. RIGSBY

PAGE B-2

Form 344-22-4063

- [x] ELECTRICAL
- [ ] MECHANICAL
- [ ] STRUCTURAL

I. SEISMIC ANALYSIS

THE 25KVA INVERTERS, 25KVA BACK-UP POWER TRANSFORMERS, 3 PHASE STATIC TRANSFER SWITCH AND 120V DISTRIBUTION PANELS WILL BE SEISMICALLY QUALIFIED TO FSV STANDARD CURVES FOR BUILDING 10 AND THE 480V SWITCHGEAR ROOM.

25KVA TRANSFORMER SEISMIC TEST REPORT # PEI-TR-81-7, TAB 87 IN SEISMIC QUALIFICATION BOOK (SR-EQ-QR).

25KVA INVERTER SEISMIC TEST REPORT # 10046, TAB 88 IN SEISMIC QUALIFICATION BOOK (SR-EQ-QR).

120V DIST. PNL. AND STATIC TRANSFER SWITCH TEST REPORTS WILL BE ENTERED INTO THE SYSTEM ON A RE-ISSUE OF THIS CN.

II. STRESS ANALYSIS

N/A

III. PIPING/HANGER ANALYSIS

N/A

IV. HYDRAULIC/PNEUMATIC ANALYSIS

N/A

SAFETY RELATED DESIGN ANALYSIS (continued)
Sheet 2 of 3

V. Thermal Analysis:

EQUIPMENT HAS BEEN DESIGNED TO OPERATE AT AN AMBIENT TEMPERATURE OF 120°F WHICH HAS BEEN CALCULATED AS "WORST CASE" WITH LOSS OF COOLING.

CABLE BEING INSTALLED IS CERTIFIED TO PASS THE IEEE 383 VERTICAL FLAME TEST.

VI. Nuclear Analysis:

N/A

VII. Fire Protection Analysis:

CABLE BEING INSTALLED IS CERTIFIED TO PASS THE IEEE 383 VERTICAL FLAME TEST AND WILL BE PROTECTED, WHERE REQUIRED, BY A FLAMASTIC COVERING PER FSV STANDARD PROCEDURES. A DRIP SHIELD WILL BE PROVIDED TO PROTECT INSTALLED EQUIPMENT FROM FIRE PROTECTION WATER SPRAY.

VIII. Environmental Analysis:

THE EQUIPMENT CABINETS AND THERMAL OPERATING CHARACTERISTICS MAKE THIS EQUIPMENT SUITABLE FOR INSTALLATION PER FSV STANDARDS.

TRANSFORMER QUALIFICATION - LETTER DTD 4/1/1983 - TAB AS, SR-AC-QR
INVERTER QUALIFICATION - LETTER DTD 4/11/1983 - TAB AT, SR-AC-QR
STATIC TRANSFER SWITCH - LETTER DTD 3/22/1983 - TAB AU, SR-AC-QR

120V DIST. PNL. QUALIFICATION WILL BE ENTERED INTO SYSTEM ON RE-ISSUE OF THIS CN.

IX. Compatibility of Materials, Equipment and Processes:

ALL MATERIAL SUPPLIED FOR THIS INSTALLATION WILL BE COMPATIBLE PER FSV STANDARDS.

SAFETY RELATED DESIGN ANALYSIS (continued)
Sheet 3 of 3

X. Accessibility for In-Service Inspection, Maintenance and Repair:

120V NON-INT DIST. PNL. 1A-1, 1B-1, INVERTER 1A, 25KVA B.U. POWER TRANSF 1A-1, INVERTER 1B, AND 25KVA B.U. PWR. TRANSF 1B-1 WILL BE INSTALLED ON THE GROUND FLOOR OF THE NEW 3 ROOM COMPLEX. THE 3 PHASE STATIC TRANSFER SWITCH WILL BE INSTALLED ON THE FLOOR OF THE EXISTING 480V SWGR ROOM. SUFFICIENT CLEARANCES WILL BE PROVIDED FOR INSPECTION, MTCE & REPAIR.

XI Separation and Segregation Analysis:

SEPARATION/SEGREGATION CRITERIA WILL BE MET.

XII. Electrical Analysis:

THE ADDITIONAL CAPACITIES BEING PROVIDED WITH THE 25KVA INVERTERS ALONG WITH THE BACK-UP POWER SOURCE AND [illegible] LOAD RE-ARRANGEMENT WILL ADD TO THE SYSTEM STABILITIES AND PROVIDE FOR FUTURE GROWTH.
ALL WORK WILL CONFORM TO SPEC. I-N-I

XIII. Accident Analysis:

NO NEW ACCIDENT MODES WILL BE CREATED BY IMPLEMENTATION OF THIS CN.

Prepared By: /s/ M. RIGSBY 9/16/82
Date

CN 1255
BY R Schenderlein
PAGE B-5
FORM NO. 372-30-2650

CHECK LIST OF DESIGN VERIFICATION QUESTIONS

FOR DESIGN REVIEW METHOD

YES	NO	N/A		
(✓)	( )	( )	1.	Were the inputs correctly selected and incorporated into design?
(✓)	( )	( )	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
(✓)	( )	( )	3.	Are the appropriate quality and quality assurance requirements specified?
(✓) 5/24/83	(~~✓~~) 6/23/83	( )	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
(✓)	( )	( )	5.	Have applicable construction and operating experience been considered?
(✓)	( )	( )	6.	Have the design interface requirements been satisfied?
(✓)	( )	( )	7.	Was an appropriate design method used?
(✓)	( )	( )	8.	Is the output reasonable compared to inputs?
(✓)	( )	( )	9.	Are the specified parts, equipment, and processes suitable for the required application?
(✓)	( )	( )	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
(✓)	( )	( )	11.	Have adequate maintenance features and requirements been specified?
(✓)	( )	( )	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
(✓)	( )	( )	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
( )	( )	(✓)	14.	Has the design properly considered radiation exposure to the public and plant personnel?
(✓)	( )	( )	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

CHECK LIST OF DESIGN VERIFICATION QUESTIONS - Cont'd.

YES	NO	N/A		
( )	( )	(✓)	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
(✓)	( )	( )	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
(✓)	( )	( )	18.	Are adequate identification requirements specified?
(✓)	( )	( )	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

Note: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES

UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

1.) Pgs. B1 thru B4; Additional design input information required to fully meet the intent of Eng. 2.

2.) Add Flamastic material to Bill of Materials.

3.) Pg. G40; Clarify cable change out with an additional dwg.

4.) Pg. G61; Clarify cable change out with an additional dwg.

5.) Pg G51; Clarify cable change out with an additional dwg.

6.) Pg. G70; Clarify Cable change out with an additional dwg.

7.) Add Spec. 92-N-88 to D.U.L.

R.A. Schwenderlein 5/18/83

All design deficiencies have been resolved satisfactorily.

R.A. Schwenderlein 5/23/83
RAS 9/23/83

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) TCR / SCR / PC / TR
NO. 1332B
PAGE 2

CATEGORY

TYPE:

[X] CN OVERALL [ ] CN SUBMITTAL [ ] SETPOINT CHANGE REPORT [ ] TEST REQUEST
[ ] TEMPORARY CONFIGURATION REPORT [ ] PROCEDURE CHANGE (FSAR) [ ] OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

CLASS I	[X] YES	[ ] NO	ENGINEERED SAFEGUARD	[ ] YES	[X] NO
SAFE SHUTDOWN	[X] YES	[ ] NO	PLANT PROTECTIVE SYSTEM	[ ] YES	[X] NO
SAFETY RELATED	[X] YES	[ ] NO	SECURITY SYSTEM	[ ] YES	[X] NO

REMARKS ________

EVALUATION USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE FSAR OR TECH SPEC? [X] YES [ ] NO
LIST THE APPLICABLE SECTIONS REVIEWED. FSAR section 7.4.3, 8.2.2.3, 8.2.2.4, 8.2.3, 8.2.3.3, 8.2.3.4, 8.2.3.5, 8.2.5.1, 8.2.5.2, Figures 8.2-13, 8.2-14, Reviewed tech specs section LCO 4.6

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE FSAR OR TECH SPEC? [X] YES [ ] NO
LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE. Figures 8.2-13 and 8.2-14 of the FSAR must be revised. A change of the tech specs is shown in CN-1255 and is related to this change. LCO 4.6 has several changes needed to: eliminate reference to PPS battery and battery charger/inverter; redescribe paragraph in basis for backup power to Bus 3; possibly describe additional flexibility with new system. FSAR Section 8.2.3.4 needs changed to eliminate reference to PPS battery.

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE FSAR BEEN INCREASED?
[ ] YES [X] NO STATE BASIS: This change increases the capacity and reliability of the non-interruptible bus 3 system. It also increases the capacity of the 125 V DC system by upgrading battery charger 1D. An additional DC source has been made available to the Battery/Charger/Inverter 1C configuration. By increasing the capacity and reliability and adding a dedicated backup supply from 480V Essential Bus #1 via Inst. Pwr Transformer 1C-1 and a static transfer switch, the overall integrity of the non-interruptible power supply system is improved. (see next page)

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE FSAR BEEN CREATED? [ ] YES [X] NO STATE BASIS: The discussion above in item 3(A) concerning increased reliability and capacity also applies here. Since the system reliability and capacity has been enhanced by this modification the possibility of a new accident or malfunction of equipment, as a result of a non-interruptible power supply failure has not been created.

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE FSAR BEEN REDUCED? [ ] YES [X] NO STATE BASIS: Increasing the reliability and capacity of the non-interruptible power supply system increases it's margin of safety as defined in the basis for LCO 4.6. A change to LCO 4.6 is required with this CN.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION [ ] YES [X] NO
BE SAFETY SIGNIFICANT [ ] YES [X] NO

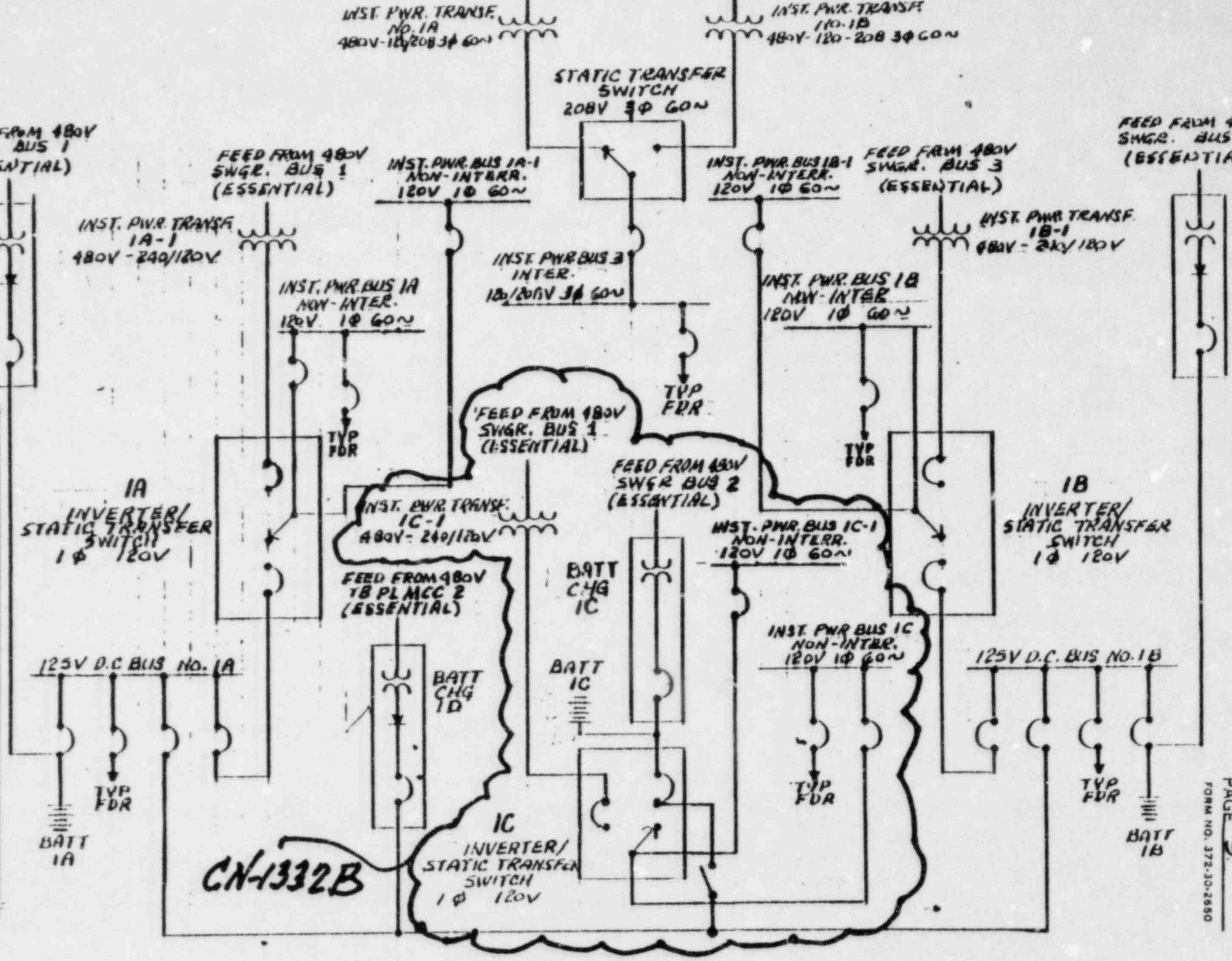
BY Michael G. Glenn (SIGNATURE) 9/28/83 (DATE) *APPROVED J. C. Johns (SIGNATURE) 9-30-83 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372-02-3382

3(A) (continued) The probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the FSAR as a result of a non-interruptible power supply failure has been definitely reduced by this modification.

FSAR UPDATE
8.2-69



ELEC. SINGLE-LINE DIA. INST. PWR. & DC PWR SYS

FIGURE 8.2-13

CN 1332 B
BY M. RIGSBY
PAGE 3
FORM NO. 372-30-2650

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

DESIGN INPUT REQUIREMENTS

CN 1332 B

BY M. RIGSBY

PAGE B-1B

Form 344-22-4060

- [x] ELECTRICAL
- [ ] MECHANICAL
- [ ] STRUCTURAL
- [x] SAFETY RELATED
- [ ] NON-SAFETY RELATED

SH. 1 OF 2

THIS CN IS A PORTION OF THE PROJECT TO UPGRADE THE INTERRUPTIBLE AND NON-INTERRUPTIBLE INSTRUMENT BUSES. THE REMAINDER OF THIS PROJECT IS COVERED BY CN-1255 (BACK-UP PWR TRANSF'S., 25KVA INVERTERS AND A 3 PHASE STATIC TRANSFER SW.) AND CN-1391 (REPLACEMENT AND UPGRADE OF BATTERIES 1A, 1B AND 1C).

THE EXISTING BATT. CHG 1D IS CONNECTED TO THE DC BUS TIE LINE AS A BACKUP SOURCE FOR 125V DC BUSES 1A AND 1B THROUGH BUS TIE AIR CIRCUIT BREAKERS. THE EXISTING 1D BATT. CHG. IS RATED AT 200A(DC) OUTPUT WHILE THE 1A AND 1B PRIMARY BATT. CHGS. ARE RATED AT 825A(DC) OUTPUT.

CN-1332B

THE EXISTING 200A(DC) OUTPUT BATT. CHG. IS TO BE REPLACED WITH A 400A(DC) OUTPUT BATT. CHG. THE NEW 400A(DC) OUTPUT BATT. CHG. WILL ALSO BE TIED INTO THE NEW CONFIGURATION FOR INVERTER 1C (NON-INT. BUS 3) BY MEANS OF A SAFETY SWITCH DISCONNECT, FOR A BACK-UP SOURCE OF 125V DC. THE REPLACEMENT OF THE EXIST. 200A(DC) OUTPUT BATT. CHG. WITH A 400A(DC) OUTPUT BATT. CHG. WILL ENHANCE THE STABILITY OF THE SYSTEM WHEN IT BECOMES NECESSARY TO UTILIZE THE 1D BATT. CHG. AS THE PRIMARY DC SOURCE FOR BUSES 1A AND/OR 1B AND/OR INVERTER 1C (NON-INT BUS 3).

THE EXISTING NON-INTERRUPTIBLE INSTRUMENT BUS 3 IS NOT SIZED TO ACCEPT ANY ADDITIONAL LOAD. WITH THE CONTINUING PLANT MODIFICATIONS AND SUBSEQUENT ADDITIONAL LOADS FOR THE INSTRUMENT BUS SYSTEM IT HAS BECOME NECESSARY TO UPGRADE NON-INTERRUPTIBLE BUS 3. THIS CN WILL UTILIZE THE EXISTING 200A(DC) OUTPUT BATT. CHG. (1D), THAT IS BEING REPLACED, IN CONJUNCTION WITH A NEW 15KVA INVERTER TO PROVIDE ADDITIONAL CAPACITY AND STABILITY FOR THE #3 NON-INTERRUPTIBLE INSTRUMENT BUS. THE BATT. CHG. & INVERTER WILL BE THE PRIMARY FEED TO NON-INT BUS 3 WITH BACK-UP POWER BEING SUPPLIED FROM A NEW 480V-120V INSTRUMENT POWER TRANSFORMER.

IEEE 383-74 "TYPE TEST OF CLASS 1E ELECTRIC CABLES, FIELD SPLICES, AND CONNECTIONS FOR NUCLEAR POWER GENERATING STATIONS."

PREPARED BY Murray Rigsby (SIGNATURE) 9/15/83 (DATE) APPROVED BY G. Bates (SIGNATURE) 9-12-83 (DATE)

(ENG-2)

CN 1332
BY M. RIGSBY
PAGE B-1.1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS
Sheet 2 of 2

ALL ELECTRICAL WORK WILL BE PERFORMED IN ACCORDANCE WITH SPEC. 1-N-2 AND FSV STANDARDS.

A FLAMASTIC COATING WILL BE APPLIED TO ALL CABLES, WHERE APPLICABLE, PER SPEC. 93-I-71.

INVERTER AND BATTERY CHARGER HAVE BEEN SEISMICALLY AND ENVIRONMENTALLY QUALIFIED TO FT. ST. VRAIN CLASS 1E REQUIREMENTS.

Prepared By: /s/ Murray Rigsby 9/10/82 Date Approved By: /s/ V E Nichols 11-2-82 Date

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY RELATED DESIGN ANALYSIS - SHEET 1

CN 1332B

BY M. RIGSBY

PAGE B-2B

Form 344-22-4063

- [x] ELECTRICAL
- [ ] MECHANICAL
- [ ] STRUCTURAL

I. SEISMIC ANALYSIS

BATTERY CHG. (400 A DC OUTPUT), 15 KVA INVERTER, 480/120V BACK-UP PWR. TRANSFORMER AND 120V DIST. PNL. ARE SEISMICALLY QUALIFIED.

THE ADDITION OF 5 AUX. RELAYS AND 5 INDICATING LIGHTS TO THE 400 A DC BATT. CHG. WILL HAVE NO EFFECT ON SEISMIC QUALIFICATION BECAUSE OF THE SMALL MASS INVOLVED.

FOR EVALUATION OF CONDUIT HANGERS, EQUIPMENT MOUNTING AND ANCHORING AND THE RELOCATION OF THE 200 A DC BATT. CHG FROM THE 480V [illegible] TO BUILDING 10 SEE PG'S. B-8B THRU B-13B.

II. STRESS ANALYSIS

N/A

III. PIPING/HANGER ANALYSIS

N/A

IV. HYDRAULIC/PNEUMATIC ANALYSIS

N/A

SAFETY RELATED DESIGN ANALYSIS (continued)
Sheet 2 of 3

V. Thermal Analysis:

EQUIPMENT HAS BEEN DESIGNED TO OPERATE AT AN AMBIENT TEMPERATURE OF 120° F WHICH HAS BEEN CALCULATED AS "WORST CASE" WITH LOSS OF COOLING.
CABLE BEING INSTALLED IS CERTIFIED TO PASS THE IEEE 383 VERTICAL FLAME TEST.

VI. Nuclear Analysis:

N/A

VII. Fire Protection Analysis:

CABLE BEING INSTALLED IS CERTIFIED TO PASS THE IEEE 383 VERTICAL FLAME TEST AND WILL BE PROTECTED, WHERE REQUIRED, BY A FLAMASTIC COVERING PER FSV STANDARD PROCEDURES. A DRIP SHIELD WILL BE PROVIDED TO PROTECT INSTALLED EQUIPMENT.

VIII. Environmental Analysis:

THE EQUIPMENT CABINETS AND THERMAL OPERATING CHARACTERISTICS MAKE THIS EQUIPMENT SUITABLE FOR INSTALLATION PER FSV STANDARDS.

IX. Compatibility of Materials, Equipment and Processes:

ALL MATERIAL SUPPLIED FOR THIS INSTALLATION WILL BE COMPATIBLE PER FSV STANDARDS.

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
SAFETY RELATED DESIGN ANALYSIS - SHEET 3

CN 1332B
BY M. RIGSBY
PAGE B-4B

Form 344-22-4069

X. ACCESSIBILITY FOR IN-SERVICE INSPECTION, MAINTENANCE, AND REPAIR

THE BATT. CHG. (400A DC OUTPUT) WILL BE MOUNTED ON THE FLOOR AND ALONG THE SOUTH WALL IN THE EXISTING 480V SWGR. ROOM. THE IC CHARGER (200A DC OUTPUT), INVERTER AND ASSOCIATED EQUIP. WILL BE INSTALLED ON THE MEZZ. OF BLDG. 10 (4800'-6"). (EQUIPMENT RE-LOCATED FROM GRD. FL. ELEV. 4791'-0 CN-1332B) SUFFICIENT CLEARANCES HAVE BEEN PROVIDED FOR INSPECTION MTCE, AND REPAIR.

XI. SEPARATION AND SEGREGATION ANALYSIS

SEPARATION/SEGREGATION CRITERIA WAS MET DURING ENGINEERING AND LAYOUT PHASE OF THIS PROJECT.

XII. ELECTRICAL ANALYSIS

SEE ATTACHED PG. 4.1B & 4.2B

XIII. ACCIDENT ANALYSIS

NO NEW ACCIDENT MODES ARE CREATED BY IMPLIMENTATION OF THIS CN.

PREPARED BY Murray Rigsby 81-7-23
DATE

(ENG-2)

XII. ELECTRICAL ANALYSIS

THE EXISTING 120V AC NON-INT BUS 3(1C) SYSTEM CONSISTS OF A 125 V DC BATTERY RATED AT 320 AMP/HOUR, A 10KVA BATTERY CHARGER/INVERTER AND A 12 CIRCUIT, 120 V AC (NON-INT) DISTRIBUTION PANEL (BUS 3).

THE POWER TIES TO THE 10KVA BATTERY CHARGER/INVERTER ARE A 3 PHASE, 208V AC FEED FROM INTERRUPTIBLE BUS 3 AND A DIRECT TIE TO THE 125V DC BATTERY. THE BATTERY CHARGER/INVERTER IS THE PRIMARY AC FEED TO THE 120V NON-INT BUS 3 WITH A BACK-UP FEED ALSO COMING FROM INTERRUPTIBLE BUS 3 TO NON-INT BUS 3. THE CIRCUIT BREAKERS ON NON-INT BUS 3 FROM THE BATTERY CHARGER/INVERTER AND FROM INTERRUPTIBLE BUS 3 ARE MECHANICALLY INTERLOCKED TO PREVENT BOTH AC POWER SOURCES FROM BEING TIED TO BUS 3 AT THE SAME TIME. THE BATTERY CHARGER/INVERTER FEED TO NON-INT BUS 3 IS A 50 AMP SERVICE, THE BACK-UP FEED FROM INTERRUPTIBLE BUS 3 IS A 30 AMP SERVICE.

THE RE-WORK OF THE NON-INT BUS 3(1C) SYSTEM INCREASES THE CAPACITY OF THIS SYSTEM BY APPROXIMATELY 50%. THIS INCREASE IS ACCOMPLISHED BY REPLACEMENT OF THE 10 KVA BATTERY CHARGER/INVERTER WITH A 15KVA INVERTER. THE 15 KVA INVERTER IS TO BE USED IN CONJUNCTION WITH THE EXISTING "1D" SWING BATTERY CHARGER (RATED AT 200A DC OUTPUT) WHICH IS BEING REPLACED WITH A 400A DC OUTPUT BATTERY CHARGER. IN ORDER TO TAKE ADVANTAGE OF THE ADDITIONAL INVERTER CAPACITY A 120V NON-INT DISTRIBUTION PANEL (1C-1) OF 24 CIRCUITS IS BEING ADDED IN BUILDING 10. IN ADDITION TO THE INCREASED CAPACITIES OUTLINED ABOVE THE 1C BATTERY, RATED AT 320 AMP/HOUR, IS BEING REPLACED WITH AN 890 AMP/HOUR RATED BATTERY (CN-1391) WHICH IS APPROXIMATELY A 180% INCREASE IN BATTERY CAPABILITY. THIS INCREASE WILL PROVIDE FOR CONSIDERABLY LONGER DEPENDENCE ON THE BATTERY, IF THE SITUATION ARISES. THE NEW "1D" SWING BATTERY CHARGER (400 A DC OUTPUT) WILL ALSO BE TIED INTO THE NON-INT BUS 3(1C) SYSTEM AS AN ALTERNATE DC POWER SOURCE, THIS IS A BACK-UP SYSTEM THAT DOES NOT PRESENTLY EXIST.

CN 1332B
BY M. RIGSBY
PAGE B-4.2B
FORM NO. 372-30-2650

THE PRIMARY AC FEED TO THE NEW 15KVA INVERTER WILL BE THROUGH THE 200A DC OUTPUT BATTERY CHARGER, WITH A DIRECT TIE TO THE 1C (890 AMP/HOUR) BATTERY. THE BATTERY CHARGER WILL BE FED FROM 480V L.C. SWITCHGEAR, BUS 2. THE BACK-UP AC POWER FEED, TO THE INVERTER, IS THROUGH A 480-240/120V POWER TRANSFORMER (1C-1) FED FROM 480V L.C. SWITCHGEAR, BUS 1. THIS ARRANGEMENT WILL PUT 480V L.C. SWITCHGEAR BUSES 1 AND 2 IN THE INVERTER CABINET ON THE STATIC TRANSFER SWITCH. HOWEVER, THE AIR CIRCUIT BREAKER PROTECTION ON THESE CIRCUITS WILL PROVIDE THE NECESSARY BUS PROTECTION IN CASE OF A FAULT ON ONE OR THE OTHER OF THESE CIRCUITS.

CHECK LIST OF DESIGN VERIFICATION QUESTIONS - Cont'd.

YES	NO	N/A		
( )	( )	(✓)	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
(✓)	( )	( )	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
(✓)	( )	( )	18.	Are adequate identification requirements specified?
(✓)	( )	( )	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

Note: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES

UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

No deficiencies found.
Gregory S. Bates
10/26/82

No deficiencies found. Change to Safety Evaluation Only.
Gregory S Bates
4/12/83

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CHECK LIST OF DESIGN VERIFICATION QUESTIONS FOR DESIGN REVIEW METHOD

CN 1332B

BY M. RIGSBY

PAGE 8-7B

Form 344-22-4095

YES	NO	N/A		
☑	☐	☐	1.	Were the inputs correctly selected and incorporated into design?
☑	☐	☐	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
☑	☐	☐	3.	Are the appropriate quality and quality assurance requirements specified?
☑	☐	☐	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
☑	☐	☐	5.	Have applicable construction and operating experience been considered?
☑	☐	☐	6.	Have the design interface requirements been satisfied?
☑	☐	☐	7.	Was an appropriate design method used?
☑	☐	☐	8.	Is the output reasonable compared to inputs?
☑	☐	☐	9.	Are the specified parts, equipment, and processes suitable for the required application?
☑	☐	☐	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
☑	☐	☐	11.	Have adequate maintenance features and requirements been specified?
☑	☐	☐	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
☑	☐	☐	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
☐	☐	☑	14.	Has the design properly considered radiation exposure to the public and plant personnel?
☑	☐	☐	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
☑	☐	☐	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
☑	☐	☐	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
☑	☐	☐	18.	Are adequate identification requirements specified?
☑	☐	☐	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

NOTE: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

1. ELECTRICAL DESIGN ANALYSIS INADEQUATE TO DETERMINE HOW MUCH THE 1C BUS CAPACITY WAS BEING INCREASE.
   RESOLUTION: ELECTRIAL ANALYSIS ON PG B4.1B AND 4.2B WAS ADDED
2. THERMAL, ENVIRONMENTAL, AND COMPATABILITY NOT SHOWN.
   RESOLUTION: ANALYSIS SHOWN IN PREVIOUS REISSUES IS APPLICABLE TO WORK IN REISSUE B,
3. RESOLVED MINOR CHANGE NOTICE MECHANICS ERRORS.

Thomas D. McLean 9/7/83

1-6-83

CN 1332 B
BY M.RIGSBY
PAGE 6-8B
FORM NO. 372-30-2650

TO: MURRAY RIGSBY

FROM: BOB GUNNERSON

SUBJ: BATTERY CHARGER TO BE MOUNTED ON MEZZ. IN BLDG 10 @ ELEV. 4800'-6"; FSV

I CAN FIND NO PROBLEMS WITH THE BATTERY CHARGER BEING INSTALLED AT ELEV. 4800'-6" SINCE THE MAX G-FORCE IS 1.55 IN THE HORZ. DIRECTION & 0.7 IN THE VERTICAL DIRECTION; ALL FOR 3% EQUIPMENT DAMPING.

THE EQUIPMENT HAS BEEN QUALIFIED TO 2.0 G's IN THE HORZ. & VERT DIRECTION PER SEISMIC CERT SHEET FOR FQ # N-9240.

CALCULATIONS FOR		CALC. NO.	CN 13328
PREPARED BY J. TESNER	DATE 8/25/83	REF. DOCUMENTS:	BY M. RIGSBY
REVIEWED BY Mark Mullen	DATE 8/26/83		PAGE B-9B
			FORM NO. 372-30-2650

ELECTRICAL EQUIPMENT MOUNTINGS

INFORMATION SUPPLIED BY ELECTRICAL ENGINEERING:

FLOOR MOUNTED { INVERTER 1C N-9279 (DW APPROX. 1900 LBS)
BATTERY CHARGER 1C N-9253 (DW APPROX. 2000 LBS)

FLOOR SLAB T.O.C. ELEV. 4800'-6"

WALL MOUNTED { BACK-UP PWR. TRANSF. 1C N-9269 (DW = 380 LBS)
~~120V DIST. PNL. 1C-1 N-92105 (DW = 65 LBS)~~
120V DC DISCONNECT SW. N-92117 (DW = 145 LBS)

N-9269, N-92105 MOUNTED TO WALL OVER MEZZ. FLOOR
USE ARS FOR ELEV. 4811'-0 (CONSERVATIVE)

N-92117 MOUNTED TO WALL IN EXISTING 480 V ROOM
USE ARS FOR ELEV. 4811'-0 MAIN BUILDING

SEISMIC ARS DATA, OBE, DAMPING = 5% — REF. IEEE-344 1975, SECTION 3.5.3

EQUIPMENT NUMBER	BUILDING	ELEVATION	PEAK HORIZONTAL ACCELERATION, g's	PEAK VERTICAL ACCELERATION, g's
N-9279	10	4800'-6"	~~1.20~~	~~0.55~~
N-9253	10	4800'-6"		
N-9269	10	4811'-0	~~1.40~~	~~0.60~~
N-92105	10	4811'-0		
N-92117	TURBINE	4811'-0	0.58 *	0.28 **

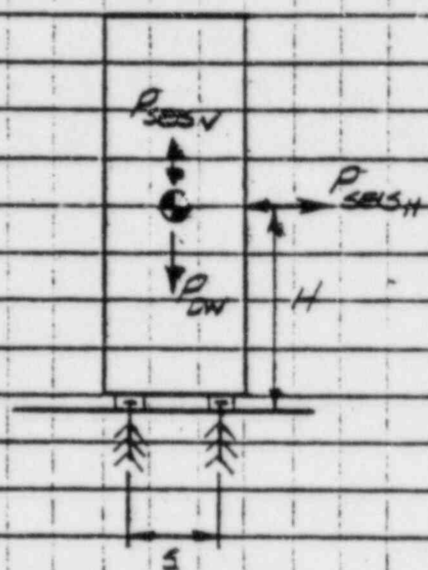
SOURCE FOR BUILDING 10: STONE & WEBSTER CALC. NO. 13569.04-SD-1, REV. 0, "AMPLIFIED RESPONSE SPECTRA FOR THREE ROOM COMPLEX ADDITION"

* FROM SARGENT & LUNDY REPORT 8-11-1-1 (SAD-377), REV. 0, "GENERATION OF SEISMIC RESPONSE SPECTRA", PEAK VALUE FOR SLAB 2 ELEV. 4811'-0, 2% DAMPING (CONSV.)

** VALUE IS 2/3 OF OBE HORIZONTAL GROUND MOTION AS DEFINED IN FSAR FOR 1% DAMPING (CONSV.)

CALCULATIONS FOR		CALC. NO.	CN 1332B
PREPARED BY J. TESNIER	DATE 8/25/83	REF. DOCUMENTS:	BY M. RIGSBY
REVIEWED BY Mark Mullen	DATE 8/26/83		PAGE B-10B
			FORM NO. 372-30-2650

FLOOR MOUNTED



N-9279

P_{DW} = 1900 LBS

P_{SEIS_H} = (1.5 STATIC COEFFICIENT) x (1900 LBS)(1.20g) = 3420 LBS

H = 39" INCHES (ASSUME C.G. AT MID-HEIGHT OF MAIN CABINET)

S = 27 IN MIN SPACING

P_{SEIS_V} = (1.5 STATIC COEFFICIENT) x (1900 LBS)(0.55g) = 1568 LBS

TENSION LOAD IN BOLTS –

PULLOUT IS NOT POSSIBLE SINCE $P_{SEIS_V} < P_{DW}$. NET MINIMUM DOWNWARD LOAD IS 1900 – 1568 = 332 LBS.

$$T_{OVERTURNING} = \frac{(3420\text{ LBS})(39\text{ IN}) - (332\text{ LBS})(\frac{27\text{ IN}}{2})}{(27\text{ IN})(2\text{ BOLTS})}$$

$$= 2387\text{ LBS/BOLT}$$

$$V_{DIRECT} = \frac{3420\text{ LBS}}{4\text{ BOLTS}} = 855\text{ LBS/BOLT}$$

USE 3/4" DIA RED HEAD SELF-DRILLING A.B.

TENSION ALLOWABLE = 3240 LBS/BOLT
SHEAR ALLOWABLE = 3240 LBS/BOLT
} FS = 5, SDCC-Q11 ISSUE 6

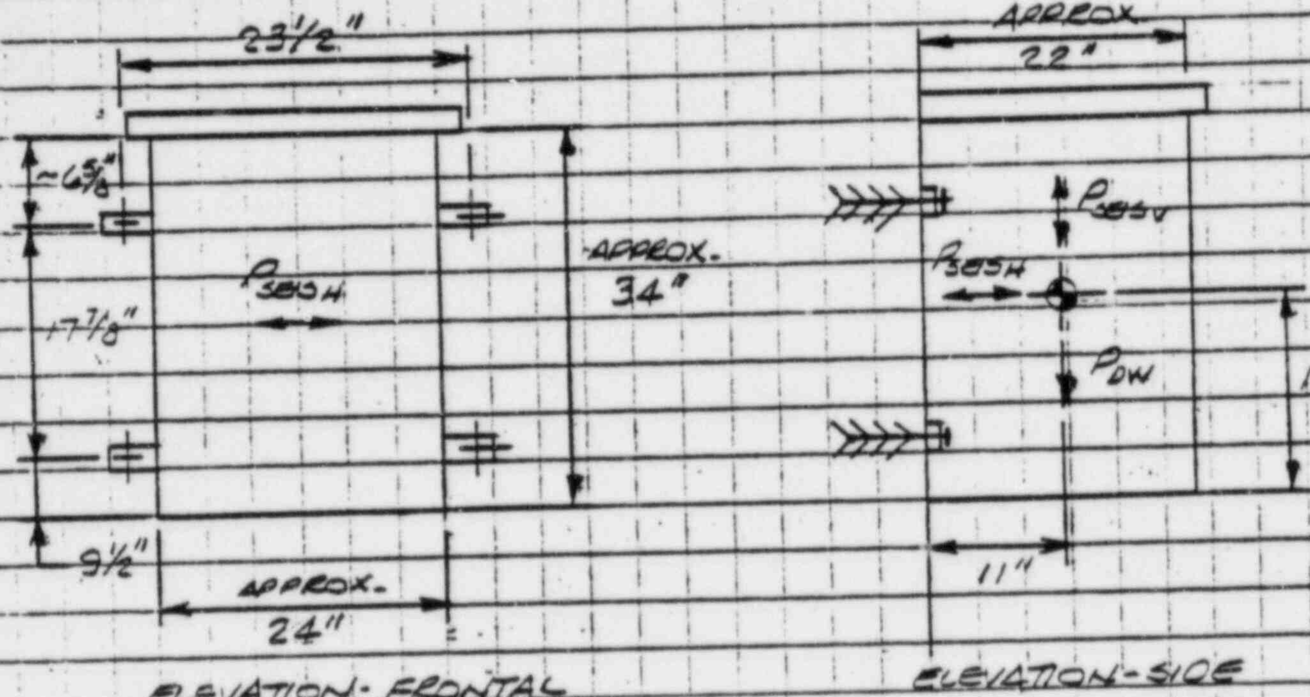
(INTERACTION OK BY ENGINEERING JUDGEMENT)

ALSO USE 3/4" DIA BOLTS FOR N-9253 DUE TO SIMILARITY AND CONSERVATISMS IN ANALYSIS. MINIMUM SPACING IS 7 IN. FOR 100% CAPACITY – OK.

CALCULATIONS FOR		CALC. NO.	CN 1332B
PREPARED BY J. TESNER	DATE 8/26/83	REF. DOCUMENTS:	BY M. RIGSBY
REVIEWED BY Mark Mullen	DATE 8/26/83		PAGE B-11B

FORM NO. 372-30-2650

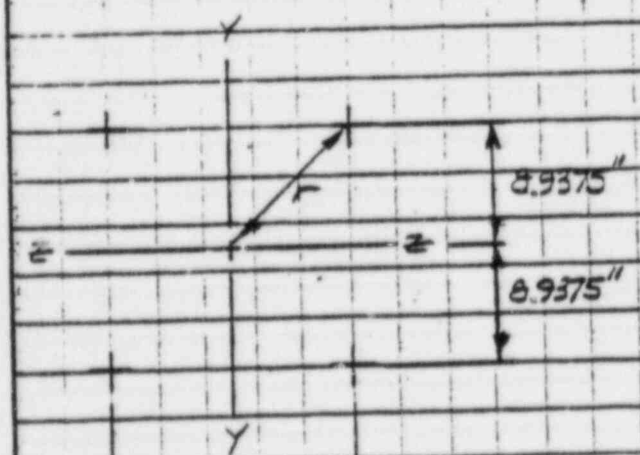
HIGHEST LOAD ON BOLTS FOR WALL MOUNTED EQUIPMENT WILL OCCUR WITH N-9269. ASSUME C.G. APPROXIMATELY CENTERED INSIDE CABINET.



$P_{DW} = 380$ LBS

$P_{SEIS V} = (1.5)(380 \text{ LBS})(0.6) = 342$ LBS

$P_{SEIS H} = (1.5)(380 \text{ LBS})(1.4) = 798$ LBS



$F_x = 798$ LBS

$F_y = 380 + 342 = 722$ LBS

$F_z = 798$ LBS

$M_x = (798 \text{ LBS})\left(9.5 + \frac{17.875}{2} - \frac{34}{2} \text{ IN}\right)$

$= 1147$ IN-LBS

$M_y = (798 \text{ LBS})(11 \text{ IN})$

$= 8778$ IN-LBS

$M_z = (722 \text{ LBS})(11 \text{ IN})$

$= 7942$ IN-LBS

$r = \sqrt{(11.75)^2 + (8.9375)^2} = 14.76$ IN

CALCULATIONS FOR:		CALC. NO.	CN 1332 B
PREPARED BY J. TESNER	DATE 8/26/83	REF. DOCUMENTS:	BY M. RIGSBY
REVIEWED BY Mark Mullen	DATE 8/26/83		PAGE B-12 B
			FORM NO. 372-30-2650

NOTE THAT EFFECTS OF SEISMIC LOADING FOR X, Y & Z DIRECTIONS ARE CONSIDERED SIMULTANEOUSLY (CONSERVATIVE)

$$T_{PULLOUT} = \frac{F_x}{4\ BOLTS} = \frac{798\ LBS}{4} = 200\ LBS/BOLT$$

$$T_{MOMENT} = \frac{M_Y}{(2\ BOLTS)(23.5\ IN)} + \frac{M_Z}{(2\ BOLTS)(17.875\ IN)}$$

$$= \frac{8778\ IN\text{-}LBS}{(2)(23.5)} + \frac{7942\ IN\text{-}LBS}{(2)(17.875)} = 409\ LBS/BOLT$$

$$T_{TOTAL} = 200 + 409 = 609\ LBS/BOLT$$

$$V_{DIRECT} = \sqrt{\left(\frac{F_Y}{4\ BOLTS}\right)^2 + \left(\frac{F_Z}{4\ BOLTS}\right)^2}$$

$$= \sqrt{\left(\frac{722}{4}\right)^2 + \left(\frac{798}{4}\right)^2} = 269\ LBS/BOLT$$

$$V_{MX} = \frac{M_X}{(4\ BOLTS)(14.76\ IN)} = \frac{1147\ IN\text{-}LBS}{(4)(14.76)} = 19\ LBS/BOLT$$

$$V_{TOTAL} \approx 269 + 19 = 288\ LBS/BOLT$$

3/8" DIA RED HEADS ACCEPTABLE BUT USE 1/2" DIA FOR ADDITIONAL MARGIN OF SAFETY.

FOR 1/2" DIA BOLTS:

TENSION ALLOWABLE = 1700 LBS/BOLT
SHEAR ALLOWABLE = 1344 LBS/BOLT
} FS = 5, SDCC-11 ISSUE 6

(INTERACTION OK BY INSPECTION)

SWITCH N-92118 IS MOUNTED TO BLOCK WALL IN BUILDING 10 JUST BELOW ELEV. 4800'-6" AND IS SIMILAR TO N-92117 IN WEIGHT, OVERALL DIMENSIONS AND MOUNTING BOLT LOCATIONS. THEREFORE 1/2" DIA BOLTS WILL BE ACCEPTABLE FOR ALL WALL MOUNTED ELECTRICAL COMPONENTS LISTED.

CALCULATIONS FOR		CALC. NO.	CN 1332B
PREPARED BY J. TESNER	DATE 8/26/83	REF. DOCUMENTS:	BY M. RIGSBY
REVIEWED BY Mark Muller	DATE 8/26/83		PAGE B-13B
			FORM NO. 372-30-2650

UNISTRUT SUPPORTS

ALL UNISTRUT SUPPORTS REVIEWED FOR THIS CN ARE ACCEPTABLE DUE TO SHORT SPANS AND LOW DISTRIBUTED CONDUIT WEIGHT, AND HIGH RATED LOADS ON UNISTRUT COMPONENTS FOR BEAM SPANS USED. BASE ATTACHMENTS (ANCHOR BOLTS/SHELLS, WELDS) AND THREADED RODS ARE ADEQUATE BY INSPECTION.

BUILDING STRUCTURE EVALUATION

HEAVY EQUIPMENT ATTACHED DIRECTLY TO BUILDING 10/TURBINE BUILDING REINFORCED CONCRETE WALLS AND FLOOR SLAB, AND MASONRY BLOCK WALL ARE NOT OF THE MAGNITUDE REQUIRING STRESS CHECKS SINCE THE BUILDING STRUCTURE IS MASSIVE AND AMPLY REINFORCED IN PROPORTION TO THE LOADING. CONDUIT LOADINGS ARE INSIGNIFICANT AND THEIR AFFECTS ON THE MAIN BUILDING ARE NEGLIGIBLE.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) / TCR / SCR / PC / TR
NO. 1391
PAGE 2

CATEGORY

TYPE:

- [X] CN OVERALL
- [ ] CN SUBMITTAL
- [ ] SETPOINT CHANGE REPORT
- [ ] TEST REQUEST
- [ ] TEMPORARY CONFIGURATION REPORT
- [ ] PROCEDURE CHANGE (FSAR)
- [ ] OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

	YES	NO		YES	NO
CLASS I	X		ENGINEERED SAFEGUARD	X	
SAFE SHUTDOWN	X		PLANT PROTECTIVE SYSTEM	X	
SAFETY RELATED	X		SECURITY SYSTEM		X

REMARKS

EVALUATION USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE FSAR OR TECH SPEC? [X] YES [ ] NO

LIST THE APPLICABLE SECTIONS REVIEWED. FSAR sections 8.2.3, 8.2.2.4, 8.3, 8.2.3.4, 8.4; Criterion 24 and 39; Tech Spec's section SR 5.6.2 and LCO 4.6.1

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE FSAR OR TECH SPEC? [X] YES [ ] NO

LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE. Change FSAR section 8.2.3.4 to reflect the new Amp-Hour rating of the batteries being installed with this CN. Page 3 indicates a suggested method for FSAR update.

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE FSAR BEEN INCREASED? [ ] YES [X] NO STATE BASIS: Replacement of existing batteries with batteries of greater capacity can not increase the probability of occurrence or the consequences of any accident or malfunction evaluated in the FSAR.

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE FSAR BEEN CREATED? [ ] YES [X] NO STATE BASIS: Since the only change to the DC system is replacing existing batteries with new batteries of increased capacity, no possibility of a new accident or malfunction has been created.

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE FSAR BEEN REDUCED? [ ] YES [X] NO STATE BASIS: No margin of safety concerning battery capacity is defined. Since this modification is in the conservative direction, increased battery capacity should infer greater protection from overload and therefore less chance of DC system failure.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION [ ] YES [X] NO
BE SAFETY SIGNIFICANT [ ] YES [X] NO

BY Michael G Clower (SIGNATURE) 7/19/83 (DATE) *APPROVED J R Johns (SIGNATURE) 7-19-83 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372-02-3382

two out of four engines was predicted to be .0000041, assuming no disconnect device failure.

Although the Fort St. Vrain installation is provided with a disconnect device rather than a clutch, the clutch experience on the fishing vessels indicated a failure probability of .0001 with a 99% confidence. By adding a clutch failure probability of .0001, the probability of failure to start 2 out of 4 diesel engines increased to .0000042 from .0000041. By assuming the clutch failure probability to be .001, the probability of failure to start 2 out of 4 diesel engines increased from .0000041 to .0000054.

In view of this very low probability of failure to start, it was concluded, on the basis of these data and analyses, that the Fort St. Vrain diesel-generator installation is highly reliable (probability of failure less than 10^{-5}).

To provide performance data on the actual nuclear plant equipment, a reliability demonstration test of the diesel generators at Fort St. Vrain was conducted in accordance with specifications accepted by the AEC/DRL staff. This series of 298 starting reliability tests required by the AEC, resulted in no actual failures to start, and showed that the reliability of these units exceeds 0.99 at a 95% confidence level. Details of the test are presented in Reference 1.

The Fort St. Vrain standby diesel generators are subjected to weekly surveillance tests as required by the Technical Specifications. In these tests, the diesel generator is required to start on command and reach rated speed within a specified time. In April 1980, the test performance records for the period of 1974 through 1979 were reviewed and evaluated. During that time, 549 starts were accomplished with no actual failures to start as defined in the original reliability test criteria. The results of the evaluation indicated that the reliability of the emergency diesels remained equivalent to that demonstrated by the test of Reference 1.

CN-1391

8.2.3.4. DC Batteries

The ~~832~~ 1680 amp-hour station batteries provide separate and normally independent sources of power for essential DC-powered auxiliaries and services. Each battery is adequate to supply shutdown DC loads for not less than one hour following a loss of all AC power. During this outage period, either of the two standby generators may be started, or the reserve power supply may be restored, to ensure continuity of power to DC loads (and initiation of a recharge cycle to the batteries).

These two batteries also provide the source of power, through separate inverter sets, to two of the four AC instrument power buses. A ~~320~~ 890 amp-hour PPS battery provides a source of power to one of the AC instrument power buses through a separate inverter set. This ensures continuity of power for these

CN 1391
BY M. RIGSBY
PAGE B1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS
Sheet 1 of 2

THE REPLACEMENT OF THE 1A-1B STATION BATTERIES AND THE 1C (PPS) BATTERY IS A PORTION OF THE SCHEDULED WORK TO UPGRADE THE INSTRUMENT POWER BUSES. THESE BATTERIES HAVE BEEN IN SERVICE FOR 12 YEARS AND ARE EXPERIENCING CELL FAILURES. [redacted] THE EXISTING 1A-1B STATION BATTERIES ARE RATED 832 AMP-HOUR, THE REPLACEMENT BATTERY IS RATED 1680 AMP-HOUR. THE EXISTING 1C (PPS) BATTERY IS RATED 320 AMP-HOUR, THE REPLACEMENT BATTERY IS RATED 890 AMP-HOUR. THE ADDITIONAL CAPACITY THAT IS BEING INSTALLED WILL PROVIDE FOR FUTURE PLANT REQUIREMENTS. THE UPGRADING OF THE BATTERIES WILL NOT ALTER ANY OF THE REDUNDANCY FEATURES OR OPERATING PHILOSOPHIES OF THE INSTRUMENT POWER BUS SYSTEM.

THE 1A-1B STATION BATTERY CELL REPLACEMENT WILL BE DONE UTILIZING THE EXISTING BATTERY ROOMS, BATTERY RACKS AND WIRING. THE 1C (PPS) BATTERY WILL BE RELOCATED TO THE BATTERY ROOM ON THE GROUND FLOOR OF BUILDING 10 AND INSTALLED ON A NEW BATTERY RACK. NEW WIRING WILL BE REQUIRED BECAUSE OF THE RELOCATION.

THE EXISTING 1C (PPS) BATTERY WILL BE RETAINED AND USED IN CONJUNCTION WITH THE EXISTING 1C BATTERY CHARGER/INVERTER 1C AS A COMPUTER POWER SOURCE. THIS WORK WILL BE DONE IN A FUTURE CN.

Prepared By: /s/ Murray Rigsby 5/31/83 Date   Approved By: /s/ [signature] 5-31-83 Date

CN 1391
BY M. RIGSBY
PAGE B1.1

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

Electrical ☒
Mechanical ☐
Structural ☐
Safety Related ☒
Non Safety Related ☐

DESIGN INPUT REQUIREMENTS

Sheet 2 of 2

THIS CN WILL ONLY BE CONCERNED WITH THE REPLACEMENT AND HOOK-UP OF THE 1A-1B STATION BATTERY CELLS AND THE INSTALLATION OF THE NEW 1C (PPS) BATTERY RACK AND BATTERY CELLS IN THE BATTERY ROOM OF BUILDING 10. THE NEW WIRING REQUIRED FOR THE 1C (PPS) BATTERY IN-STALLATION WILL BE COVERED IN CN-1332.

Prepared By: /s/ MURRAY RIGSBY 3/30/83 Date   Approved By: /s/ [signature] 5-31-83 [initials] 9-16-83 Date

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY RELATED DESIGN ANALYSIS - SHEET 1

CN 1391

BY MRIGSBY

PAGE B2

Form 344-22-4063

- [x] ELECTRICAL
- [ ] MECHANICAL
- [ ] STRUCTURAL

I. SEISMIC ANALYSIS

THE 1A-1B STATION BATTERY CELLS (FTC-21) ARE QUALIFIED PER WYLE LABORATORIES REPORT 43315-1 DTD. MAY 6, 1977, THE ORIGINAL QUALIFICATION ON THE EXISTING BATTERY RACKS IS STILL VALID.

THE 1C (PPS) BATTERY CELLS (GC-21) AND BATTERY RACK ARE QUALIFIED PER WYLE LABORATORIES REPORT 44478-2, DTD. MAY 24, 1980. THE USE OF 1/2" DIA. CONCRETE ANCHOR BOLTS IN LIEU OF 1/2" DIA. SAE GRADE 5 BOLTS (P. G-8 SHT. 1 OF 6) IS AN ACCEPTABLE ANCHORING METHOD FOR SEISMIC LOADING ON BATTERIES (SEE CALCS ON PAGES B-2.3 & B-2.4). RACK LOADINGS HAVE NO SIGNIFICANT EFFECT ON BATTERY ROOM REINFORCED CONCRETE FLOOR.

II. STRESS ANALYSIS

N/A

III. PIPING/HANGER ANALYSIS

N/A

IV. HYDRAULIC/PNEUMATIC ANALYSIS

N/A

(ENG-2)

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY RELATED DESIGN ANALYSIS - SHEET 2

CN 1391

BY M. RIGSBY

PAGE B2.1

Form 344-22-4068

V. THERMAL ANALYSIS

REPLACEMENT BATTERY CELLS ARE CERTIFIED TO OPERATE SATISFACTORILY IN AN AMBIENT TEMPERATURE OF UP TO 120°F. (WORST CASE WITH LOSS OF A/C)

VI. NUCLEAR ANALYSIS

N/A

VII. FIRE PROTECTION ANALYSIS

STATION BATTERIES 1A-1B WILL REMAIN IN THE EXISTING BATTERY ROOMS, THERE WILL BE NO CHANGE TO THE EXISTING FIRE PROTECTION STATUS.
1C (PPS) BATTERY WILL BE RELOCATED TO THE BATTERY ROOM ON THE GROUND FLOOR OF BLDG. 10, ADEQUATE FIRE PROTECTION IS BEING INSTALLED IN THIS BUILDING.

VIII. ENVIRONMENTAL ANALYSIS

REPLACEMENT CELLS MEET ALL ENVIRONMENTAL CRITERIA AS OUTLINED IN SPEC. 92-N-56-2

SEE PG. B2.5 FOR AIR CHANGE CALCULATIONS FOR BATTERY ROOMS/HYDROGEN OUTPUT.

IX. COMPATIBILITY OF MATERIALS, EQUIPMENT, AND PROCESSES

NO CONFLICT WITH STANDARDS.

X. ACCESSIBILITY FOR IN-SERVICE INSPECTION, MAINTENANCE, AND REPAIR

STATION BATTERY ROOMS 1A-1B WILL NOT BE ALTERED, ACCESSIBILITY WILL NOT CHANGE.
1C (PPS) BATTERY ROOM IN BUILDING 10 WAS DESIGNED TO PROVIDE CENTER AISLE ACCESS.

XI. SEPARATION AND SEGREGATION ANALYSIS

EACH BATTERY (1A-1B-PPS) LOCATED IN SEPARATE BATTERY ROOMS. NO CHANGE WILL BE MADE TO 1A-1B STATION BATTERY WIRING.
1C(PPS) BATTERY WIRING WILL BE RUN IN CONDUIT.

XII. ELECTRICAL ANALYSIS

CAPACITY OF STA. BATTS. 1A-1B WILL INCREASE FROM 832 AMP-HR TO 1680 AMP-HR.
CAPACITY OF 1C (PPS) BATT. WILL INCREASE FROM 320 AMP-HR TO 890 AMP-HR.
EXISTING DISCHARGE TESTS WILL NOT BE ALTERED, 1A-1B STA. BATT. TESTS WILL BE BASED ON 832 AMP-HR DISCHARGE, 1C (PPS) BATT. TEST WILL BE BASED ON 320 AMP-HR DISCHARGE.
*

XIII. ACCIDENT ANALYSIS

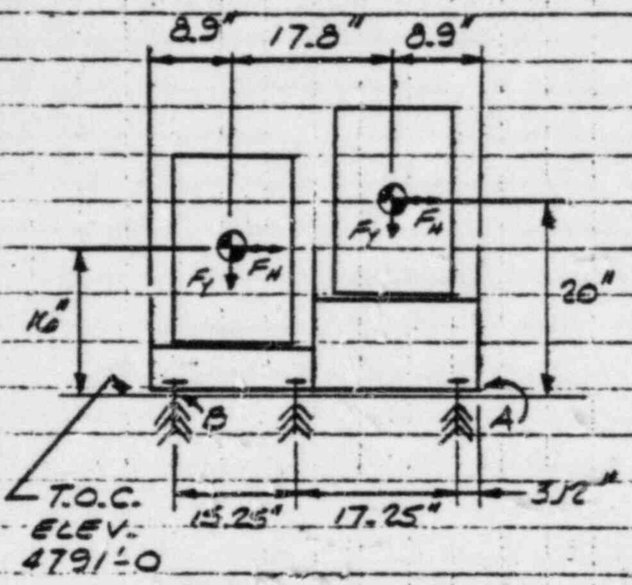
NO NEW ACCIDENT MODES HAVE BEEN CREATED

*. THE ADDITIONAL 1A-1B BATTERY CAPACITY WAS NOT PURCHASED AS A REQUIREMENT. THE CONCERN WAS TO PURCHASE A BATTERY THAT WOULD FIT THE EXISTING RACKS. ENGINEERING ADVANCEMENTS IN THE BATTERY FIELD ACCOUNT FOR THE ADDITIONAL CAPACITY IN COMPARABLE CELL DIMENSIONS.

PREPARED BY Murray Rigsby 8/5/83
DATE

CALCULATIONS FOR			CN 1391
		CALC. NO.	BY TESNER
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B-2.3
REVIEWED BY	DATE		FORM NO. 372-30-2650

EVALUATE 1/2" DIA RED HEAD SELF-DRILLING ANCHORS FOR RACK



RACK SECTIONAL VIEW
(DIMENSIONS APPROXIMATE - REFER TO RACK DWGS P. G-9 AND P. G-5)

DW OF 60 CELLS AND BOTH RACKS = 12,800 LBS (REF. EXIDE RACK DWG)

EACH RACK IS 14'-0 LONG, THEREFORE

$DW = \frac{12,800 \text{ LBS}}{(14 \text{ FT/RACK})(2 \text{ RACKS})} = 457 \text{ LBS/FT}$

RACK FRAMES ARE ON 28.25" CENTERS

DW FOR EACH FRAME IS

$(457 \text{ LBS/FT})\left(\frac{28.25}{12} \text{ FT}\right) = 1076 \text{ LBS}$

REFER TO SWEC CALC "AMPLIFIED RESPONSE SPECTRA FOR 3 ROOM COMPLEX ADDITION" CALC. REV. 0, FIGS. 19, 20 & 21, DAMPING = 5% FOR BELOW VALUES (REG. GUIDE 1.61 ALLOWS 7% DAMPING FOR BOLTED STEEL STRUCTURES, 5% IS CONSERVATIVE)

SEISMIC g ACCELERATIONS TO BE AMPLIFIED BY FACTOR OF 1.5 TO ACCOUNT FOR VARIOUS MODES OF VIBRATION

$g_V = 0.53$ PEAK VERTICAL ACCELERATION ELEV. 4791'

$g_H = 0.9$ PEAK HORIZONTAL ACCELERATION ELEV. 4791' (N-S, FIG. 19)

ASSUME TOTAL RACK LOAD IS ORIGINATING EQUALLY FROM THE ASSUMED C.G. OF BATTERIES:

$F_{Y(min)} \simeq (1/2)(1076 \text{ LBS})(1.0 - (1.5)(0.53)) = 110 \text{ LBS}$ (ACTS DOWN)

$F_H = (1/2)(1076 \text{ LBS})(1.5)(0.9) = 726 \text{ LBS}$

SUM MOMENTS ABOUT POINT A FOR OVERTURNING - ASSUME ONLY 1 BOLT (AT B) RESISTS OVERTURNING:

$(T_B)(35.62 \text{ IN.}) + (110 \text{ LBS})(8.9 \text{ IN} + 26.7 \text{ IN}) - (726 \text{ LBS})(20 \text{ IN} + 16 \text{ IN}) = 0$

$T_B = \frac{26136 - 3916 \text{ IN-LBS}}{35.62 \text{ IN}} = 624 \text{ LBS TENSION}$

$V_B = (726 \text{ LBS})(2)/3 \text{ BOLTS} = 484 \text{ LBS SHEAR}$

CALCULATIONS FOR			CN 1391
		CALC. NO.	BY TESNER
PREPARED BY	DATE	REF. DOCUMENTS:	PAGE B-2.4
REVIEWED BY	DATE		FORM NO. 372-30-2650

ALLOWABLE LOADS FOR 1/2" Ø RED HEAD SELF-DRILLING BOLT, FACTOR OF SAFETY = 5, ADJUSTED FOR CONCRETE STRENGTH $f_c' = 3500$ PSI :

$T_A = 1700$ LBS
$V_A = 1344$ LBS
} REF SDCC-011 ATTACHMENT K ISSUE 6

MINIMUM SPACING FOR 100% CAPACITY — 5 IN. OK

→ 1/2" DIA. ANCHORS ARE SATISFACTORY

PREPARED BY: J. TESNER

CN 1391
BY M. Rigsby
PAGE 8-2.5
FORM NO. 372-30-2650

Battery Hydrogen Gas Output Calculation
(Ref. Exide Bulletin Section 58.00 Sh.1 For Formula Fig. G7)

1. Existing Lead-Antimony Batteries (1A-1B Station Batteries)
890 Amp Hour
60 Cells
2.36 VPC charging (Eq. Chg.)
1344 Cu ft. (Battery Room)

$60 \times .700 \times 8.9 \times .016 = 5.98$ Cu Ft H_2 GAS/HR
$5.98/13.4 = .446$ Air Changes/HR (to keep H_2 concentration less than 1%)

2. New Lead-Calcium Batteries (1A-1B Station Batteries)
1680 Amp Hour
60 Cells
2.42 VPC Charging (Eq. Chg.)
1344 Cu. ft. (Battery Room)

$60 \times .058 \times 16.8 \times .016 = .935$ Cu Ft. H_2 GAS/HR
$.935/13.4 = .070$ Air Changes/HR (to keep H_2 concentration less than 1%)

3. New Lead-Calcium Batteries (1C Battery, Bldg. 10)
890 Amp Hour
60 Cells
2.42 VPC Charging (Eq. Chg.)
1344 Cu. ft. (Battery Room)

$60 \times .058 \times 8.9 \times .016 = .496$ Cu ft. H_2 GAS/HR
$.496/13.4 = .037$ Air Changes/HR (to keep H_2 concentration less than 1%)

The above indicates the existing 1A & 1B station Battery Rooms have had and will have sufficient ventilation for the new batteries.
The new Bldg. 10 Battery Room also provides adequate ventilation.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CHECK LIST OF DESIGN VERIFICATION QUESTIONS FOR DESIGN REVIEW METHOD

CN 1391

BY R. Schendorler

PAGE B3

Form 344-22-4095

YES	NO	N/A		
☑	☐	☐	1.	Were the inputs correctly selected and incorporated into design?
☑	☐	☐	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
☑	☐	☐	3.	Are the appropriate quality and quality assurance requirements specified?
☑	☐	☐	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
☑	☐	☐	5.	Have applicable construction and operating experience been considered?
☑	☐	☐	6.	Have the design interface requirements been satisfied?
☑	☐	☐	7.	Was an appropriate design method used?
☑	☐	☐	8.	Is the output reasonable compared to inputs?
☑	☐	☐	9.	Are the specified parts, equipment, and processes suitable for the required application?
☑	☐	☐	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
☑	☐	☐	11.	Have adequate maintenance features and requirements been specified?
☑	☐	☐	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
☑	☐	☐	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
☐	☐	☑	14.	Has the design properly considered radiation exposure to the public and plant personnel?
☑	☐	☐	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
☐	☐	☑	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
☑	☐	☐	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
☑	☐	☐	18.	Are adequate identification requirements specified?
☑	☐	☐	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

NOTE: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES
UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

No design deficiencies found.

R.A. Schendorler 5/25/83

RAS 9/16/85

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY EVALUATION

(CN) / TCR / SCR / PC / TR
NO. 1781
PAGE 2

CATEGORY

TYPE:

☒ CN OVERALL ☐ CN SUBMITTAL ☐ SETPOINT CHANGE REPORT ☐ TEST REQUEST
☐ TEMPORARY CONFIGURATION REPORT ☐ PROCEDURE CHANGE (FSAR) ☐ OTHER

CLASSIFICATION: ARE THE SYSTEM(S) EQUIPMENT OR STRUCTURES INVOLVED, OR DOES THE ACTIVITY AFFECT:

CLASS I	☐ YES	☒ NO	ENGINEERED SAFEGUARD	☐ YES	☒ NO
SAFE SHUTDOWN	☐ YES	☒ NO	PLANT PROTECTIVE SYSTEM	☐ YES	☒ NO
SAFETY RELATED	☒ YES	☐ NO	SECURITY SYSTEM	☐ YES	☒ NO

REMARKS Fire Protection - treat as safety related

EVALUATION USE ADDITIONAL SHEETS IF REQUIRED.

1 IS THE ACTIVITY IDENTIFIED IN THE FSAR OR TECH SPEC? ☐ YES ☒ NO
LIST THE APPLICABLE SECTIONS REVIEWED. FSAR sections 1.6.7, 8.2.5, 8.2.7.1, 8.2.7.4, 8.2.7.5, 8.2.7.7, 9.12.5, 9.12.6, 14.1.4, Criterion 3 Tech Spec LCO 4.10 SR 5.10

2 DOES THE ACTIVITY REQUIRE THAT CHANGE(S) BE MADE TO THE FSAR OR TECH SPEC? ☐ YES ☒ NO
LIST SECTIONS TO BE CHANGED AND THE CHANGES TO BE MADE.

3 DETERMINE WHETHER OR NOT THE ACTIVITY INVOLVED IS AN UNREVIEWED SAFETY QUESTION UTILIZING THE FOLLOWING GUIDELINES.

(A) HAS THE PROBABILITY OF OCCURRENCE OR THE CONSEQUENCES OF AN ACCIDENT OR MALFUNCTION OF EQUIPMENT IMPORTANT TO SAFETY PREVIOUSLY EVALUATED IN THE FSAR BEEN INCREASED?
☐ YES ☒ NO STATE BASIS: Adding a one hour fire rated cable tray wrap to thermally isolate cables in a tray from the outside environment will decrease the probability of occurrence of electrical fires as described in the FSAR.

(B) HAS THE POSSIBILITY OF AN ACCIDENT OR MALFUNCTION OF A DIFFERENT TYPE THAN ANY EVALUATED PREVIOUSLY IN THE FSAR BEEN CREATED? ☐ YES ☒ NO STATE BASIS: The one hour fire blanket only isolates the cables within the tray from a possible thermal environment during a fire and cannot introduce the possibility of a new accident.

(C) HAS THE MARGIN OF SAFETY, AS DEFINED IN THE BASIS FOR ANY TECHNICAL SPECIFICATION OR IN THE FSAR BEEN REDUCED? ☐ YES ☒ NO STATE BASIS: No explicit margin of safety concerning a fire retardant cable tray wrap is given in the technical specifications or FSAR and therefore cannot be reduced. The overall plant margin of safety will be increased due to the increased reliability of the plant inverters.

DOES THE ACTIVITY APPEAR TO: INVOLVE AN UNREVIEWED SAFETY QUESTION ☐ YES ☒ NO
BE SAFETY SIGNIFICANT ☐ YES ☒ NO

BY Michael G Clever (SIGNATURE) 3/23/84 (DATE) *APPROVED J R Johns (SIGNATURE) 3-24-84 (DATE)

*REQUIRED ONLY FOR CHANGE NOTICE

FORM (A) 372-02-3382

PUBLIC SERVICE COMPANY OF COLORADO
· FORT ST. VRAIN NUCLEAR GENERATING STATION
DESIGN INPUT REQUIREMENTS

CN 1781
BY M. MILLER
PAGE B1

Form 344-22-4060

- [x] ELECTRICAL
- [ ] MECHANICAL
- [ ] STRUCTURAL
- [ ] SAFETY RELATED
- [x] NON-SAFETY RELATED

1. AN ANAYLSIS OF BUILDING 10 BY PROTO-POWER, FOUND IN CN-1461, RECOMMENDS THAT A ONE-HOUR RATED FIRE RETARDENT BE ADDED TO A PORTION OF THE CABLE TRAY SYSTEM. THE EXACT LOCATIONS OF THE CABLE TRAYS CAN BE FOUND IN THE G-PACKAGE.

2. BTP 9.5-1, APPENDIX A REQUIRES THAT REDUNDANT SAFETY RELATED SYSTEMS BE SEPARATED FROM EACH OTHER SO THAT BOTH ARE NOT SUBJECT TO DAMAGE FROM A SINGLE FIRE HAZZARD.

3. BOTH B1L1, AND B2L2 CABLES SERVE INVERTERS 1A AND 1B RESPECTIVELY IN THE SAME FIRE AREA IN BUILDING 10. AS A MINIMUM, INVERTER 1A OR 1B IS NEEDED FOR PLANT SHUTDOWN.

4. A ONE HOUR FIRE RATED CABLE TRAY WRAP MATERIAL WILL BE INSTALLED ON A PORTION OF CABLE TRAY IN BUILDING 10 AS RECOMMENDED BY PROTO-POWER IN CN-1461. THE HEMYC SYSTEM CONSISTS OF TWO BASIC COMPONENTS; A LIGHT WEIGHT METAL FRAMEWORK ATTACHED TO THE CABLE TRAY AND A FIREPROOF BLANKET THAT SURROUNDS THE FRAMEWORK.

PREPARED BY Mark A. Miller 1/26/84 — SIGNATURE / DATE
APPROVED BY [signature] 3/23/84 — SIGNATURE / DATE

(ENG-2)

PUBLIC SERVICE COMPANY OF COLORADO
FORT ST. VRAIN NUCLEAR GENERATING STATION
SAFETY RELATED DESIGN ANALYSIS - SHEET 1

CN 1781
BY M. MILLER
PAGE 32

Form 344-22-4083

☒ ELECTRICAL
☐ MECHANICAL
☐ STRUCTURAL

I. SEISMIC ANALYSIS

THE COMBINED WEIGHT OF THE BLANKET AND METAL FRAMEWORK TO THE CABLE TRAY SYSTEM IS CONSIDERED NEGLIBLE.

II. STRESS ANALYSIS

ADDITION WEIGHT TO THE CABLE TRAYS IS CONSIDERED NEGLIBLE.

III. PIPING/HANGER ANALYSIS

THE ADDITIONAL WEIGHT OF THE METAL FRAMEWORK TO THE CABLE TRAY SYSTEM IS CONSIDERED NEGLIBLE.

IV. HYDRAULIC/PNEUMATIC ANALYSIS

DOES NOT APPLY.

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

SAFETY RELATED DESIGN ANALYSIS - SHEET 2

CN 1781

BY M. MILLER

PAGE B3

Form 344-22-4088

V. THERMAL ANALYSIS

THE WRAPPING WILL CONSIST OF A CERAMIC FIBER BLANKET (2300° WORKING TEMPERATURE) SEWN INTO AN ENVELOPE OF FIRE PROOF FABRIC (3000°F TEMPERATURE LIMIT ON EXPOSED SURFACES) USING A QUARTZ THREAD (3600°F TEMPERATURE LIMIT). THESE MATERIALS ARE ADEQUATE TO PROVIDE THE ONE-HOUR FIRE RATED PROTECTION. See additional sheets p-B4.1 & B4.2.

VI. NUCLEAR ANALYSIS

N/A

VII. FIRE PROTECTION ANALYSIS

CABLE TRAY PORTIONS WILL BE WRAPPED WITH A ONE-HOUR FIRE RATED BLANKET TO MEET REQUIREMENTS FOUND ON PAGE B1 OF THIS CN. CERTIFICATE OF CONFORMANCE FOR THE ONE HOUR FIRE RATING WILL BE SUPPLIED BY THE MANUFACTURER.

VIII. ENVIRONMENTAL ANALYSIS

THE BLANKET MATERIAL CONTAINS NO HAZARDOUS MATTER OR CHEMICALS, IS TOTALLY INERT AND DEVELOPS NO TOXIC OR DANGEROUS BY-PRODUCTS AT ANY TIME. IT CONTAINS NO ASBESTOS AND NO CURING TIME IS REQUIRED DURING INSTALLATION.

THE BLANKET IS DESIGNED FOR THE TYPE OF ENVIRONMENT IT WILL BE INSTALLED IN.

IX. COMPATIBILITY OF MATERIALS, EQUIPMENT, AND PROCESSES

THE ENTIRE HEMYC SYSTEM IS COMPATIBLE WITH THE CABLE TRAYS IN BUILDING 10.

X. ACCESSIBILITY FOR IN-SERVICE INSPECTION, MAINTENANCE, AND REPAIR

SHOULD A BLANKET BE DAMAGED, REPAIR CAN BE DONE BY PLANT PERSONNEL WITH A MINIMUM OF TRAINING. NEW CABLE RUNS CAN BE INSTALLED BY REMOVING THE NECESSARY BLANKET, PLACING THE CABLE, AND RE-ATTACHING THE BLANKET. NO CUTTING, DRILLING, OR WELDING TO THE CABLE TRAY IS REQUIRED.

XI. SEPARATION AND SEGREGATION ANALYSIS

PREVIOUS SEPARATION AND SEGREGATION ANALYSIS FOR BUILDING 10 CABLE TRAYS WILL NOT BE AFFECTED BY ACTIVITIES PERFORMED IN THIS CN. SEPARATION AND SEGREGATION OF CABLES WILL BE SECURED BY THE ADDITION OF THE ONE HOUR FIRE RATED BLANKET.

XII. ELECTRICAL ANALYSIS

THE BLANKET WILL NOT AFFECT PERFORMANCE OF CABLES WITHIN THE CABLE TRAY.

XIII. ACCIDENT ANALYSIS

NO NEW ACCIDENTS OR HAZZARDS WILL BE CREATED BY THIS CN. ALSO THE ADDITION OF THE ONE HOUR FIRE RATED BLANKET TO THE CABLE TRAY SYSTEM WILL REDUCE THE PROBABILITY OF AN ACCIDENT.

PREPARED BY Mark A. Miller 1/26/84
DATE

THERMAL ANALYSIS

Wrapping a one-hour fire rated blanket around cable trays in Building 10 will trap heat being dissipated from the power cables, raising the ambient temperatures around the cables.

Table 1 shows data collected from B & B Insulation's Ampacity Test.* Pages B4-3 thru B4.5 show the cable tray layout, thermocouples, and arrangement of cables in the trays. The objective of the cable tray ampacity test was to determine the maximum cable ampacity with a conductor temperature of 90°C with a tray wrapped with the blanket. (HEMYC Fire Protection System.) There are presently 4 circuits in Building 10 cable trays that are affected by the blanket:

	Actual Load Amps	WATTS/FT (I^2R)	TOTAL WATTS/F
△ ca. 5427 3/c #6 480V Feed to 1C XFMR	20	.20	.4
For #6, R = .0005038 Ω/FT.			
○△ ca. 141 3/c #6 480V. Feed to 1A XFMR	0	0	0
ca. 1157 2-1/c 350 125VDC Inverter Input Feed	150	.85	1.7
For 350 MCM, R = .0000378 Ω/FT.			
ca. 143 2-1/c 350 120V AC Inverter Output	125	.60	1.2

TOTAL WATTS/FT = 3.3

The total WATTS/FT for the four circuits is 3.30 watts/ft. The total heat dissipated during the B&B ampacity test was 63.83 ~~watts~~ /ft.

△ Only two conductors will be ~~energized~~. One is spared.
○ This is a backup cable to Ca. 143.
★ Insulco/B&B's Final Report for Ampacity Test Cable Tray and Conduit Containing 600 Volt Power Cables Protected By A HEMYC FIRE WRAP.

CONCLUSION

The 3.32 WATTS/FT does not exceed the 63.83 WATTS/FT found from the B & B ampacity test. To ensure that 63.83 WATTS/FT are not exceeded, cable tray drawings will log each new cable and the additional WATTS/FT per cable.

TABLE 1

CABLE TRAY RESULTS

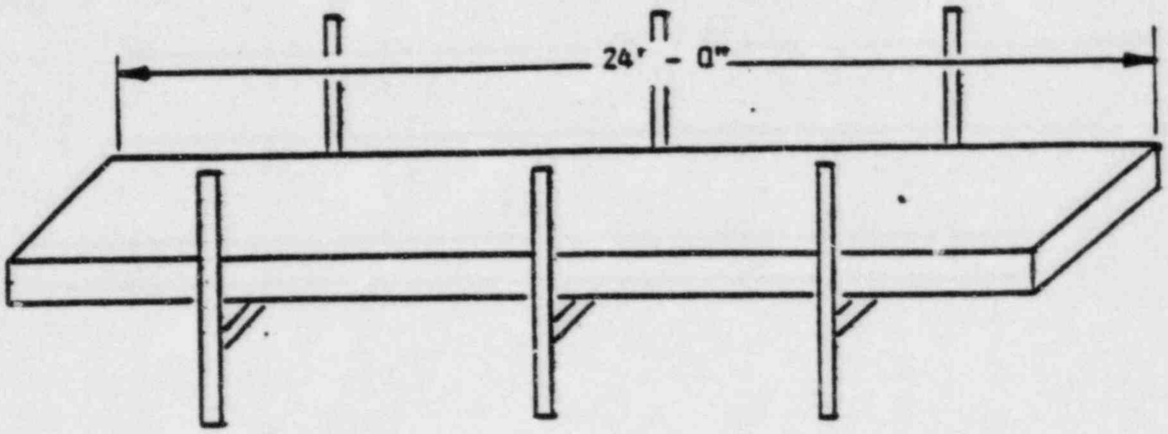
CABLE I.D.	CABLE TYPE	NUMBER OF CABLES IN TRAY	RESISTANCE Ω/FT.	TOTAL NUMBER OF CONDUCTORS	FSV	IPCEA (ICEA) @ 2.0 IN.	TESTED AMPACITIES	WATTS/FT. (I^2R) per conductor	TOTAL (WATTS per FT.)
	1/C 500 MCM		.0000266		277	320	400*	4.24	4.240
E	3-1/C 250 MCM	6	.0000529	18	179	176	199	2.10	37.800
	1/C #1/0		.00001250		102.6	78	88*	.097	.097
D	1/C #4	4	.0003163	4	56	33	36.9	.431	1.724
C	3/C #8	8	.0008013	24	31.6	22	19.8	.314	7.536
B	2/C #10	36	.0012750	72	23	14.28	8.1	.084	6.048
A	4/C #10	19	.0012750	76	23	14.0	8.1	.084	6.384
	Totals	73		194					63.83

*Graph Projection

(See Figure 6)

CN 1781
BY M. MILLER
PAGE B.4.3
FORM NO. 372-30-2680

CN 1781
BY M. MILLER
PAGE B 4.4
FORM NO. 372-30-2660



UNISTRUT
SUPPORT AT INTERVALS
OF 6 - 0 FEET

FIGURE 1

CABLE TRAY SUPPORT FOR TEST

CN 1781
BY M. MILLER
PAGE 134.5
FORM NO. 372-30-2680

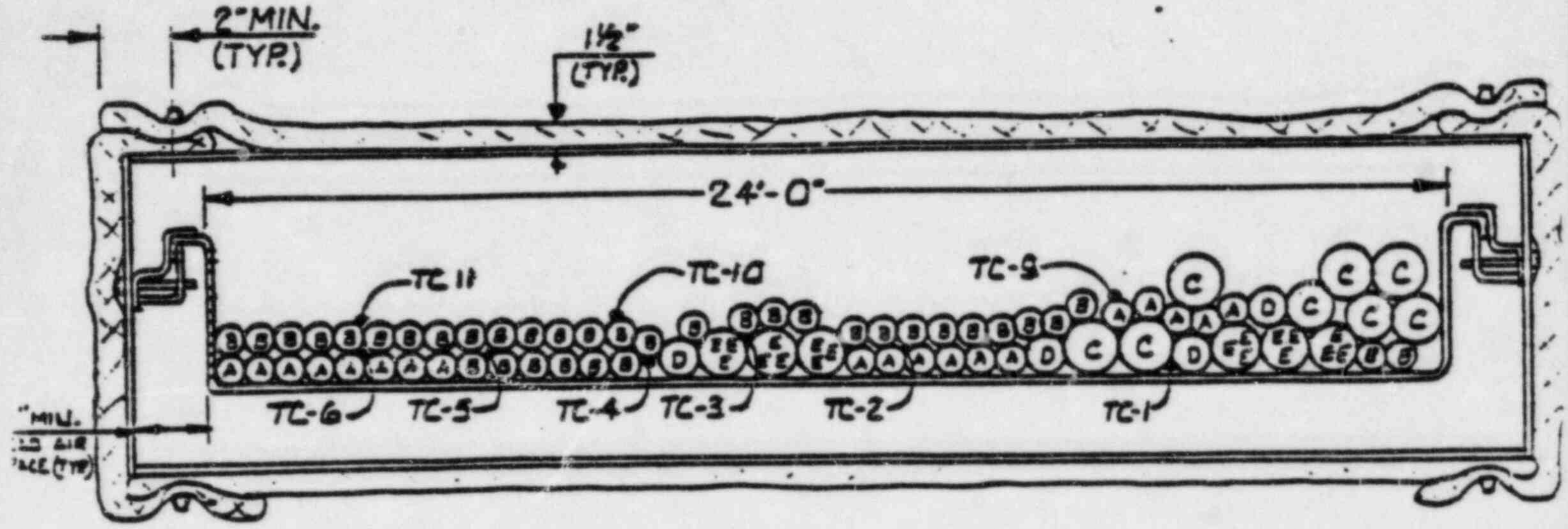


FIGURE 2

CABLE TRAY WITH RANDOM LAY
USED IN THE TESTS

NOTES: The Cable Depth Is Two (2) Inches Using The Formula:

$$\frac{(N_1)(d_1)^2 + (N_2)(d_2)^2 \ldots (N_r)(d_r)^2}{W}$$

CN 1781
BY M. MILLER
PAGE 24.6
FORM NO. 372-30-2650

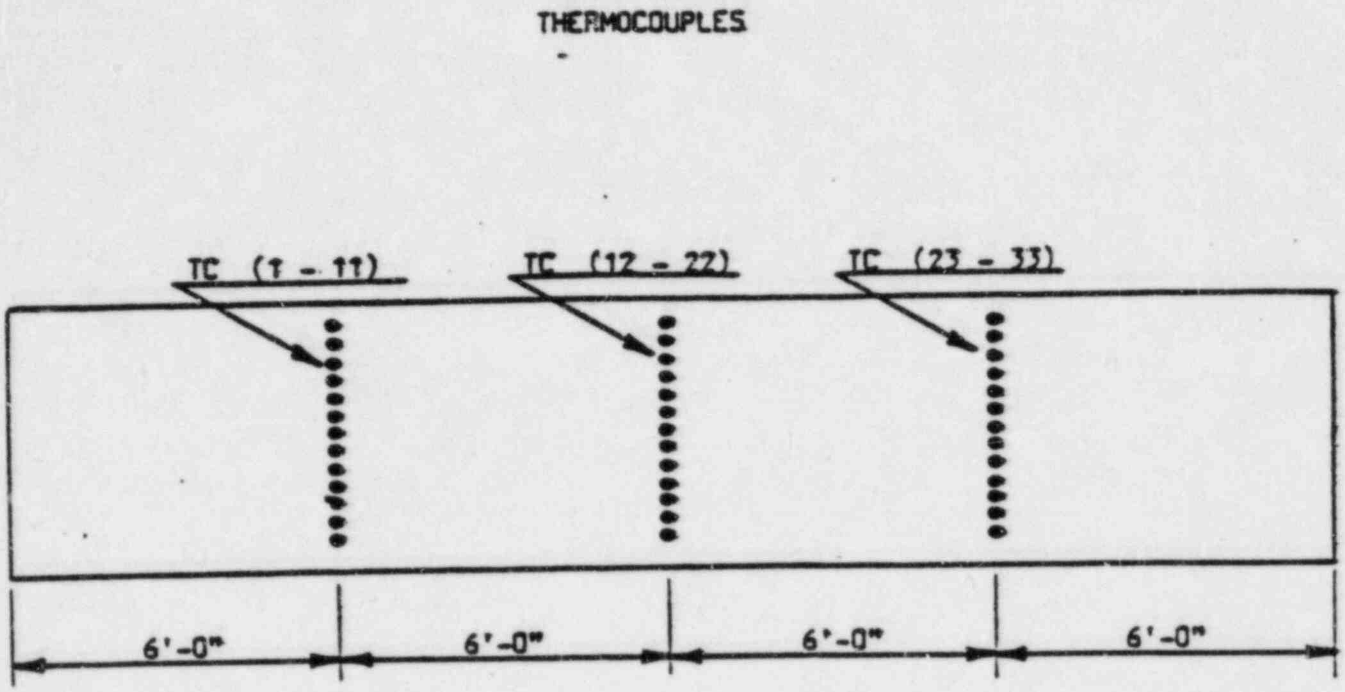


FIGURE 3

THERMOCOUPLE LOCATIONS IN THE

CABLE TRAY FOR TEST

CN 1781
BY M. MILLER
PAGE 134.7
FORM NO. 372-30-2880

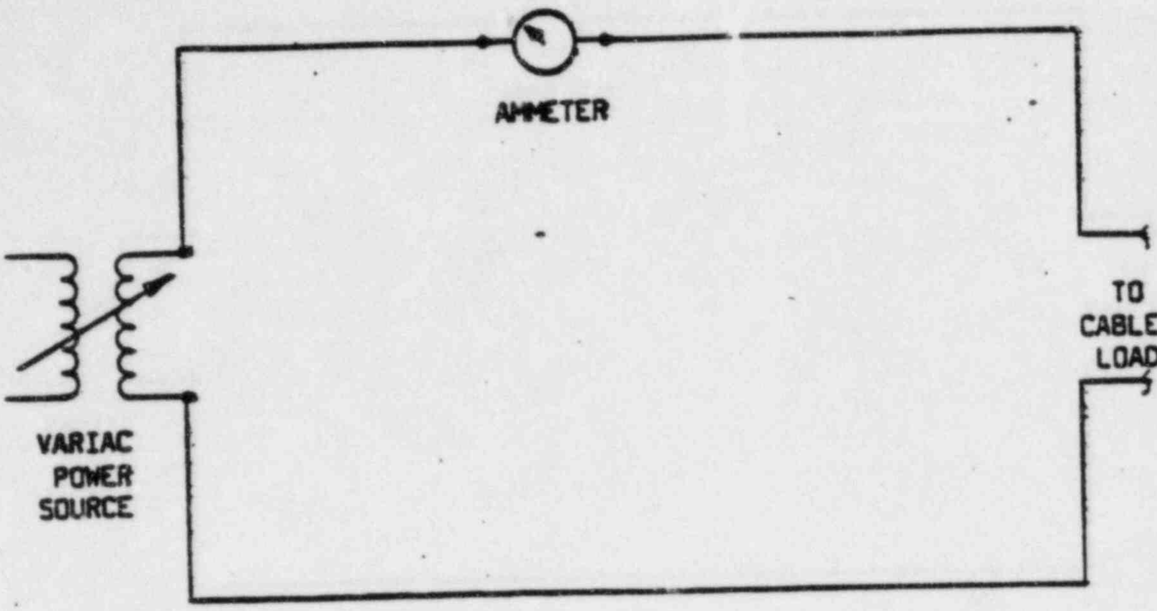


FIGURE 4

ELECTRICAL CIRCUIT USED DURING TEST

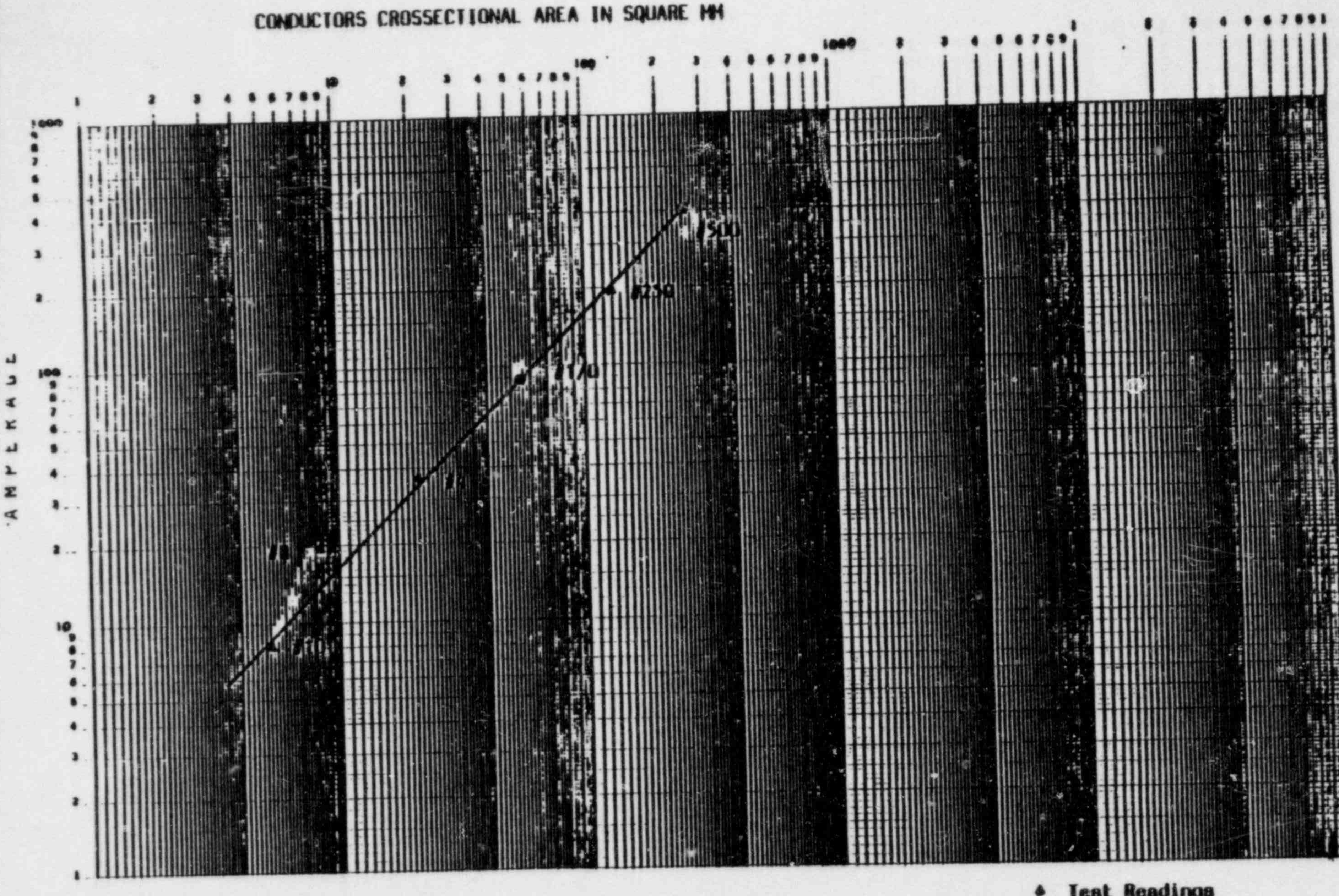


FIGURE 6

PROJECTIONS FOR AMPACITIES

CN 1781
BY M. MILLER
PAGE 84.8
FORM NO. 373-30-2680

PUBLIC SERVICE COMPANY OF COLORADO

FORT ST. VRAIN NUCLEAR GENERATING STATION

CN 1781

BY WALLACE

PAGE B5

CHECK LIST OF DESIGN VERIFICATION QUESTIONS FOR DESIGN REVIEW METHOD

Form 344-22-4095

YES	NO	N/A		
☑	☐	☐	1.	Were the inputs correctly selected and incorporated into design?
☐	☐	☑	2.	Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?
☑	☐	☐	3.	Are the appropriate quality and quality assurance requirements specified?
☑	☐	☐	4.	Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?
☑	☐	☐	5.	Have applicable construction and operating experience been considered?
☑	☐	☐	6.	Have the design interface requirements been satisfied?
☑	☐	☐	7.	Was an appropriate design method used?
☑	☐	☐	8.	Is the output reasonable compared to inputs?
☑	☐	☐	9.	Are the specified parts, equipment, and processes suitable for the required application?
☑	☐	☐	10.	Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?
☑	☐	☐	11.	Have adequate maintenance features and requirements been specified?
☑	☐	☐	12.	Are accessibility and other design provisions adequate for performance of needed maintenance and repair?
☑	☐	☐	13.	Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?
☐	☐	☑	14.	Has the design properly considered radiation exposure to the public and plant personnel?
☑	☐	☐	15.	Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?
☑	☐	☐	16.	Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?
☑	☐	☐	17.	Are adequate handling, storage, cleaning and shipping requirements specified?
☑	☐	☐	18.	Are adequate identification requirements specified?
☑	☐	☐	19.	Are requirements for record preparation review, approval, retention, etc., adequately specified?

NOTE: If the answer to any question is no, provide additional information and resolution below:

RESOLUTION OF DESIGN DEFICIENCIES UNCOVERED DURING THE DESIGN VERIFICATION PROCESS

1. BY WRAPPING THE BLANKETS AROUND POWER TRAYS IT WILL TRAP HEAT BEING DISCIPATED OFF OF POWER CABLES RAISING THE AMBIENT TEMPERATURES AROUND THE CABLES. HAS THE EFFECT OF THIS HEAT BUILD-UP BEEN ADDRESSED AND CABLES DERATED FOR THE RAISED AMBIENT TEMPERATURE? THERMO ANALYSIS HAS BEEN ADDRESSED SEE PAGES B4.1 AND B4.2

Darriel Wallace
2/2/84
DW
3/14/84