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

February 6, 1991

Docket Nos. 50-390
and 50-391

LICENSEE: Tennessee Valley Authority (TVA)

FACILITY: Watts Bar Nuclear Plant, Units 1 and 2

SUBJECT: MEETING SUMMARY - January 29, 1991 MEETING ON SEISMIC CLASSIFICATION FOR CABLE CONDUIT AND TRAYS (TAC R00508 and R00516)

REFERENCES: (1) Letter, P. S. Tam to O. D. Kingsley (TVA), dated November 29, 1990

(2) Meeting Notice by P. S. Tam (NRC), dated January 10, 1991

On January 29, 1991, the staff (NRC) met with TVA representatives at NRC offices in Bethesda, Maryland to discuss the issue of seismic classification of the Watts Bar electrical cable trays and conduit. Specifically, the staff was concerned that TVA has not classified the trays and conduit as seismic Category I. The staff's concern has been transmitted to TVA by Reference 1. Enclosure 1 is the meeting attendee list. Enclosure 2 is a copy of the slides used by TVA representatives.

For the classification of cable trays in seismic Category I structures and conduit carrying Class 1E cable, TVA proposed to delete its Category I(L) designation. Instead, TVA will consider all cable trays and conduit containing Class 1E cable to be safety-related. All safety-related cable trays and conduit will be designed to withstand normal (i.e., gravity) and safe-shutdown earthquake loads.

TVA proposed to use a combination of analyses, testing and plant walkthrough to demonstrate that the cable trays and conduit meet the guidelines of the Standard Review Plan. Specifically, the trays and conduit will retain their structural integrity and remain functional under loads associated with a safe-shutdown earthquake (SSE).

The staff and its consultants recognized that TVA is proposing to use an inelastic seismic analysis approach not normally used by other nuclear utilities, and therefore stated that TVA should provide additional information to support acceptance of the approach. Staff review effort is expected to be significant. The staff requested that TVA address the following issues:

(1) Identify if Unistrut members are still installed in cable tray supports at Watts Bar.

(2) Justify the applicability of the cable tray interaction (transverse-to-vertical) formula for different ductility ratios.

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(3) Review available literature, including the paper by Mahin and Bertero, "An Evaluation of Inelastic Seismic Design Spectra", ASCE Spring Convention, April 1978, provided by the staff during the meeting to determine whether the limitations expressed in the paper are relevant to TVA's planned application.

(4) Justify the bases for using a ductility ratio of 3 for inelastic seismic analysis in light of the recommendations provided in NUREG/CR-1161.

(5) Address how TVA's proposed use of the inelastic response spectra for cable trays conforms with the recommendations in NUREG/CR-1161 which apply to inelastic building response.

The staff reiterated the request, originally stated in Reference (1), that TVA formally document its approach in a submittal to the NRC staff, taking into account the staff's concerns above.

Original signed by

Peter S. Tam, Senior Project Manager
Project Directorate II-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures: As stated

cc w/enclosures:
See next page

OFC	:PDII-4/LA	:PDII-4/PM	:EMEB/SC	:PDII-4/DD	:PDII-4/D
NAME	:MKrebs MK	:PTam PST	:DTerao	:SBlack SB	:FHebdon
DATE	:2/7/91	:2/5/91	:2/5/91	:2/6/91	:2/6/91

OFFICIAL RECORD COPY
Document Name: WBN MEETING SUMMARY

Meeting Summary, Memorandum for Trip Reports or Site Visits

Docket Files	
NRC PDR	
Local PDR	
F. Miraglia	12-G-18
J. Partlow	12-G-18
S. Varga	14-E-4
G. Lainas	14-H-3
F. Hebdon	
S. Black	
M. Krebs	
P. Tam	
J. Wechselberger	17-G-13
M. Branch	RII
G. Walton	RII
K. Barr	RII
H. Livermore	RII
OGC	15-B-18
E. Jordan	MNBB-3302
B. Wilson	RII
M. Callahan	17-A-3
ACRS (10)	
J. Fair	7-E-23
T. Cheng	7-E-23
D. Terao	7-E-23
T. Chan	7-E-23
J. Donohew	
WB Reading File	
H. B. Wang	9-A-1

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Enclosure 1

NRC-TVA TECHNICAL MEETING ON
WATTS BAR NUCLEAR PLANT

Attendee	Organization
Joseph Braverman	Brookhaven National Laboratory
Paul Bezler	Brookhaven National Laboratory
Gary Hammer	EMEB/NRR/NRC
John R. Fair	EMEB/NRR/NRC
Thomas O. Cheng	ESGB/NRR/NRC
Ruben O. Hernandez	TVA, Watts Bar
David Terao	EMEB/NRR/NRC
Michael Shulman	TVA
Raj Raheja	TVA
Steve Eder	TVA
Wayne A. Massie	TVA Watts Bar site licensing
Peter S. Tam	NRC Project Manager for Watts Bar
Terence Chan	EMEB/NRR/NRC
Steve Pope	NUS Corporation
Jack Donohew	NRC Project Manager for Sequoyah
Tom Ippolito	TVA Washington Office

Enclosure 2

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

INTRODUCTION

- BACKGROUND
- WBN SUBMITTALS & PRESENTATIONS
- NRC RESPONSE
- PRESENTATION PURPOSE

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

OUTLINE OF PRESENTATION

- SUMMARY
- REGULATORY GUIDANCE & QUALIFICATION APPROACH
- DESIGN CRITERIA & BASIS
- EVALUATION PROCESS
- CONCLUSIONS

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

SUMMARY

CONDUIT CARRYING 1E CABLE

- DELETE I(L) DESIGNATION
- QUALIFICATION OF CONDUIT MEETS REGULATORY GUIDANCE AND SRP REQUIREMENTS.

CABLE TRAYS IN CATEGORY I STRUCTURES

- CABLE TRAY SUPPORTS
- CABLE TRAY TO SUPPORT CONNECTION
- CABLE TRAYS
  - DELETE I(L) DESIGNATION
  - CRITERIA & TESTING
  - EVALUATION METHODOLOGY
- CONCLUSION

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

REGULATORY GUIDANCE & QUALIFICATION APPROACH

REGULATORY GUIDANCE

- USNRC STANDARD REVIEW PLAN (SRP) 3.7.2 SECTION II-1

QUALIFICATION APPROACH - CABLE TRAYS

- CABLE TRAY SUPPORTS - SRP REQUIREMENTS
- TRAY CONNECTORS - SRP REQUIREMENTS
- TRAYS
    - EVALUATE TO LOADS DUE TO SSE
    - INELASTIC METHODS CORRELATED TO TEST DATA
    - MARGINS OF SAFETY EQUIVALENT TO CATEGORY I

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

- CABLE TRAY SUPPORTS → SRP REQUIREMENTS
- CONNECTORS → TESTING → REPLACEMENT → SRP REQUIREMENTS
- CABLE TRAYS → TESTING & ANALYSIS

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

CABLE TRAY SUPPORTS

CRITERIA

SUPPORTS DESIGNED TO STANDARD REVIEW PLAN REQUIREMENTS

ORIGINAL PLANT DESIGN BASIS

- SUPPORT DESIGN BASED ON TRIBUTARY CABLE TRAY SPAN LOADS IN ALL DIRECTIONS.
- SUPPORTS NOT DEPENDENT ON TRAYS FOR LOAD CARRYING CAPACITY
- ALLOWABLE STRESSES BASED ON AISC & SRP REQUIREMENTS

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

CABLE TRAY TO SUPPORT CONNECTORS

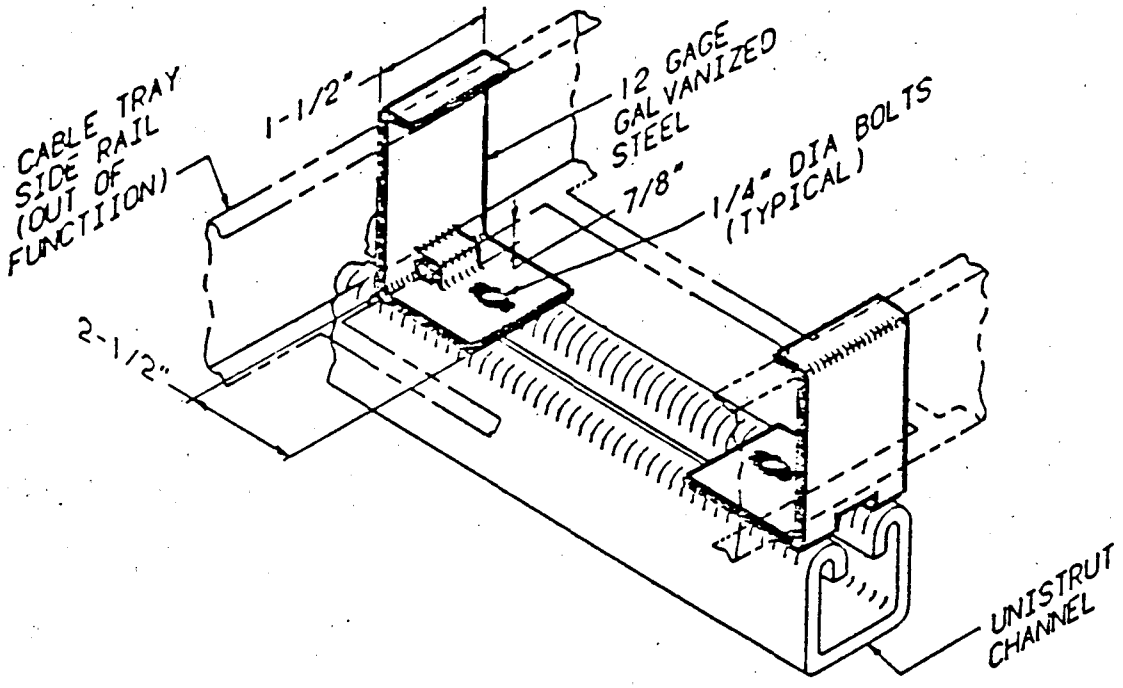
CRITERIA

CONNECTORS DESIGNED TO STANDARD REVIEW PLAN REQUIREMENTS

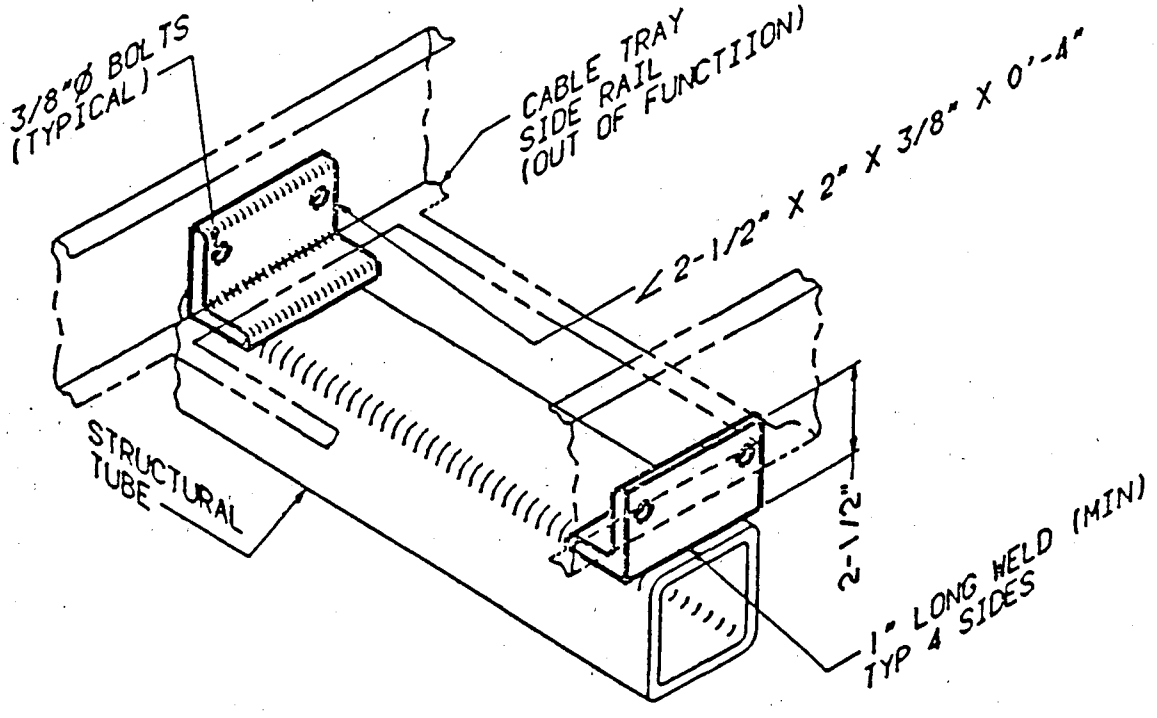
BASIS

- TESTING OF STANDARD CONNECTOR SHOWED NEED FOR REPLACEMENT
- STANDARD CONNECTORS REPLACED WITH STRUCTURAL CLIP ANGLE
- CONNECTOR BOLTED TO TRAYS & WELDED TO SUPPORTS
- CONNECTORS DESIGNED TO SUPPORT TRIBUTARY SPAN LOADS IN ALL DIRECTIONS
- ALLOWABLE STRESSES BASED ON AISC & SRP REQUIREMENTS

TYPICAL VENDOR SUPPLIED CABLE TRAY HOLD DOWN CLIP DETAIL



TYPICAL TVA CABLE TRAY SUPPORT CONNECTOR REPLACEMENT DETAIL



WATTS BAR NUCLEAR PLANT

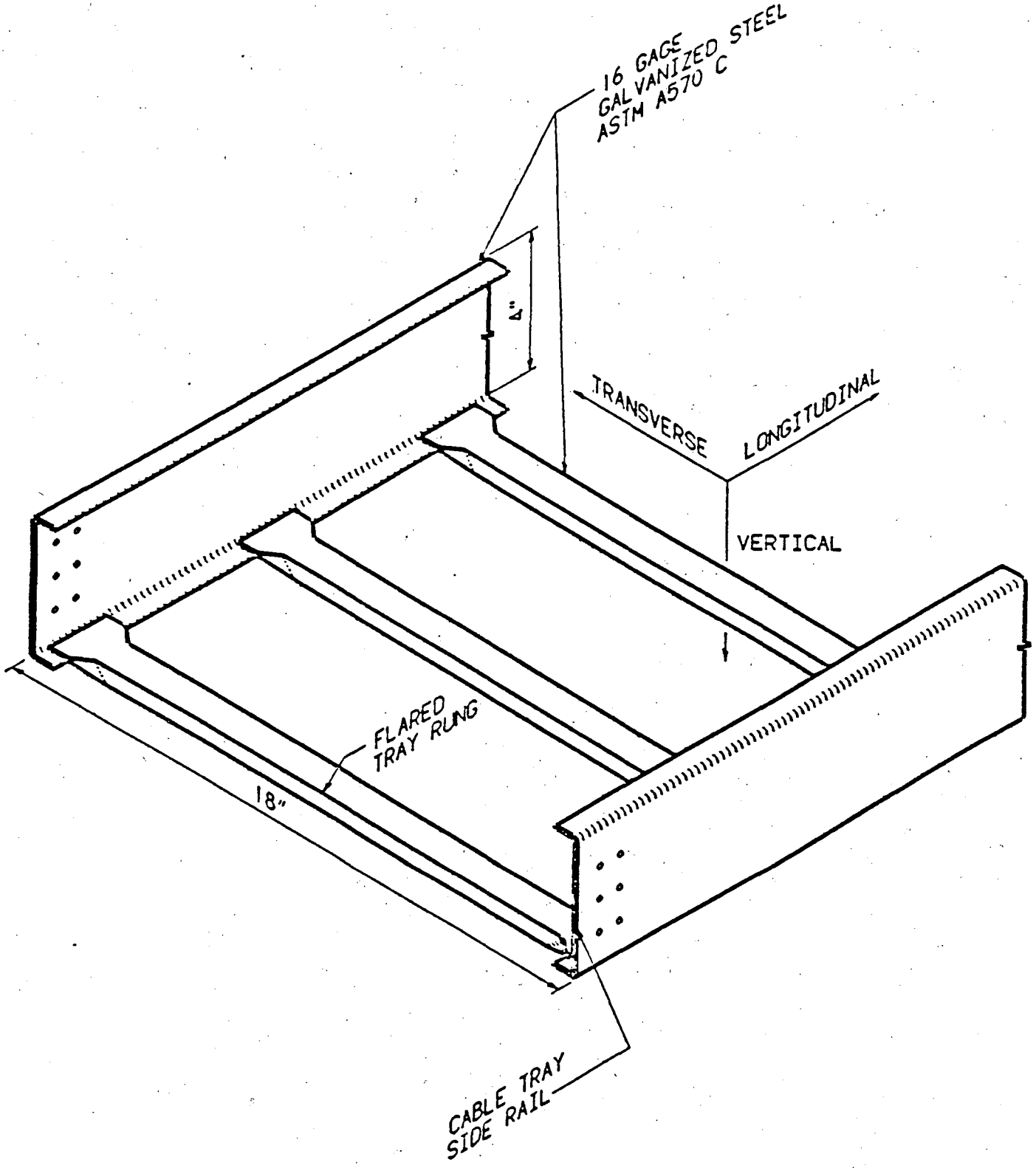
SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

CABLE TRAYS

- SEISMIC LOADS
- DESIGN ALLOWABLES
- CRITERIA COMPARISON

TYPICAL TVA CABLE TRAY



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WATTS BAR NUCLEAR PLANT

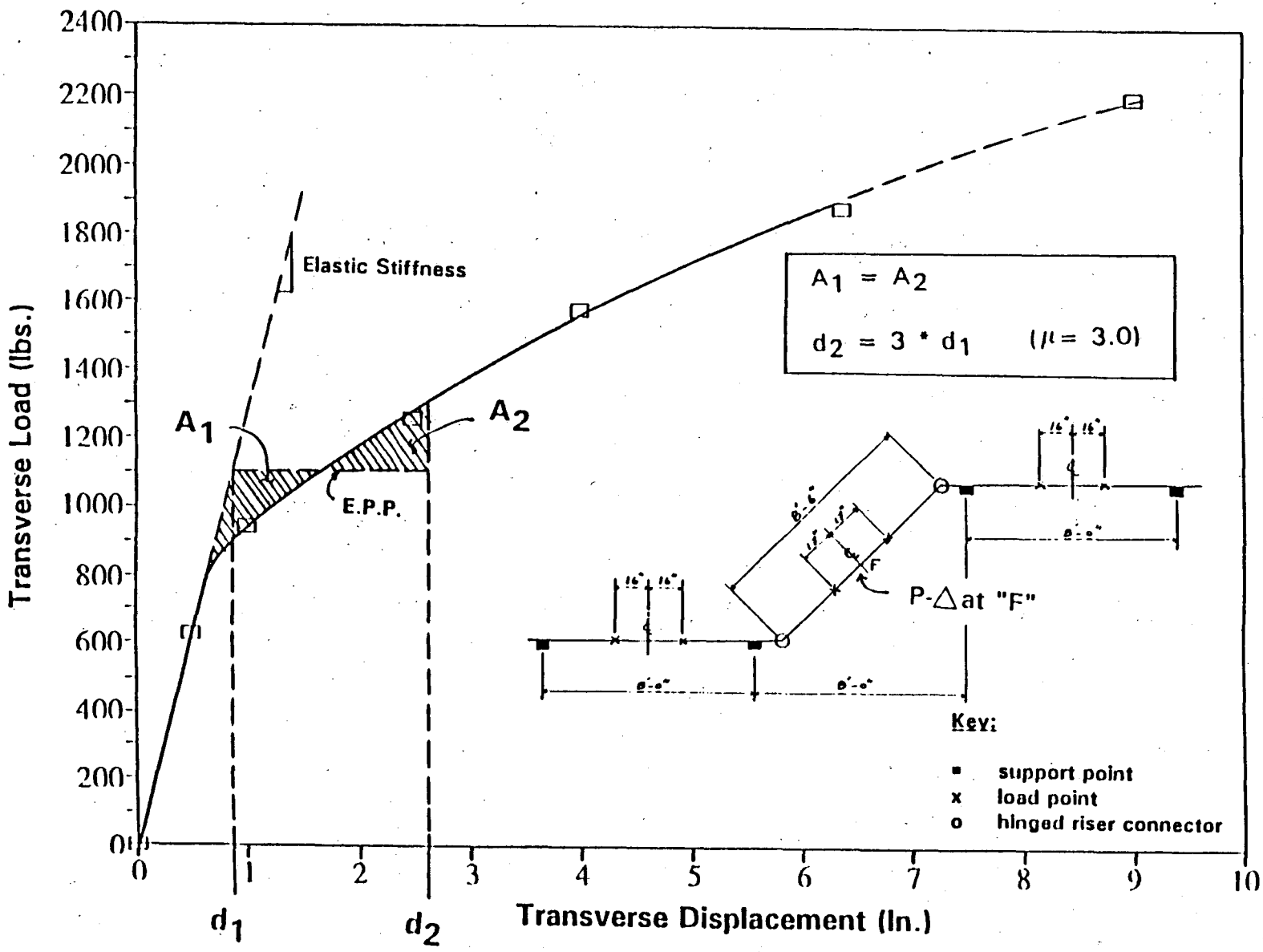
SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

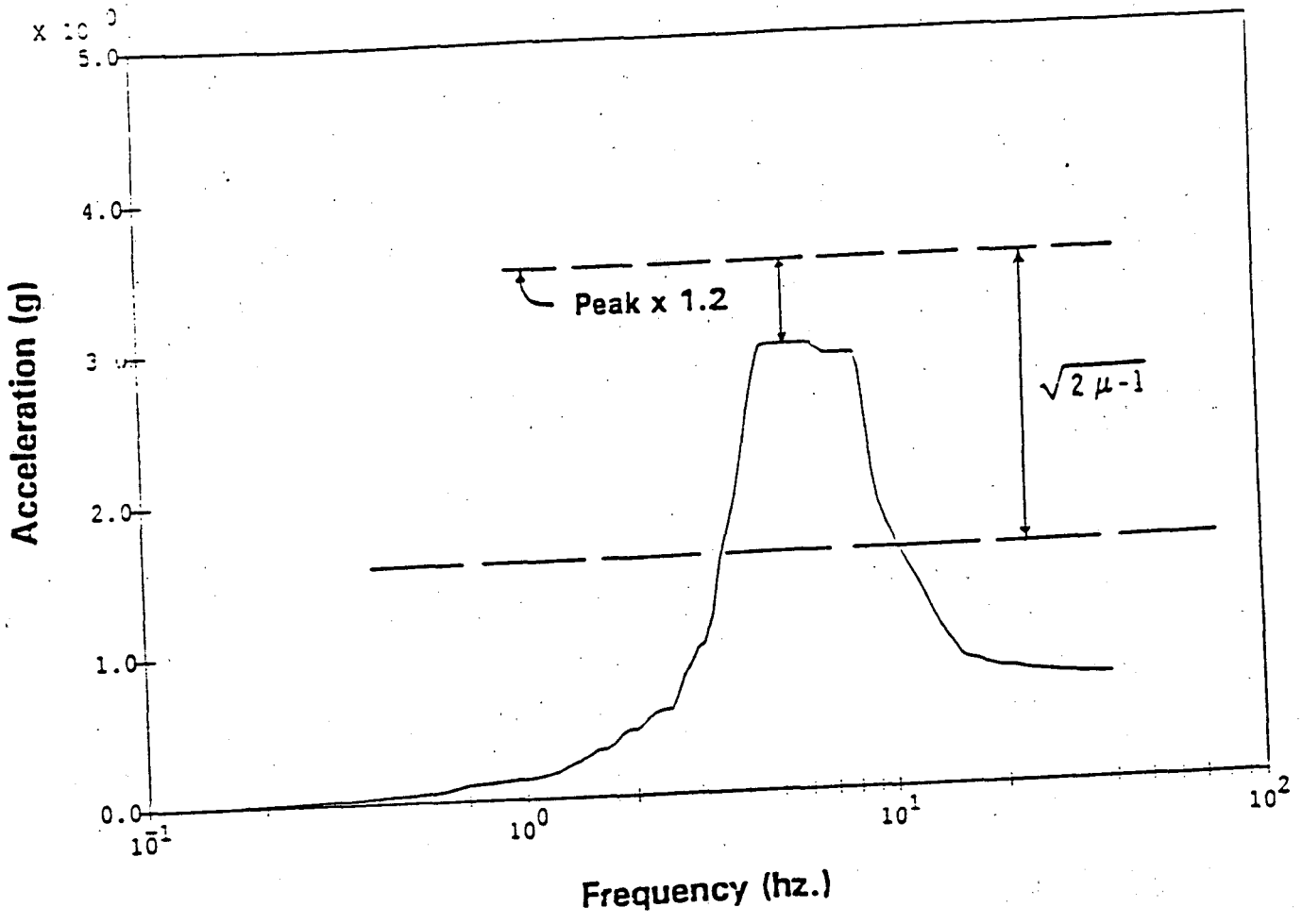
CABLE TRAY - SEISMIC LOADS

CRITERIA	BASIS
• RESPONSE AT THE PEAK OF THE IN-STRUCTURE SPECTRA UTILIZED TO ESTABLISH LOADS.	• COMPATIBILITY WITH WBN FSAR & SEISMIC CRITERIA COMMITMENT
7% DAMPING	
PEAK RESPONSE AMPLIFIED BY MULTIMODE FACTOR	
• TRANSVERSE LOADS BASED ON INELASTIC RESPONSE SPECTRUM ANALYSIS	• "EARTHQUAKE SPECTRA & DESIGN" BY N.M. NEWMARK & W.J. HALL
• ELASTIC - PERFECTLY PLASTIC APPROXIMATIONS OF RESPONSE UTILIZED	• NUREG/CR-1161
• VERTICAL LOADS BASED ON ELASTIC RESPONSE SPECTRUM ANALYSIS	
• SIMPLE SPAN AND MULTIPLE SPAN MODELS ANALYZED TO DEFINE SEISMIC BEHAVIOR	• STANDARD ANALYTICAL TECHNIQUES

Elastic Perfectly Plastic Approximation of Load Displacement Curve



Calculation of Spectral Accelerations for Transverse Inelastic Response



7% damped enveloping floor response spectrum at El. 789 ft. of Interior Concrete Structure

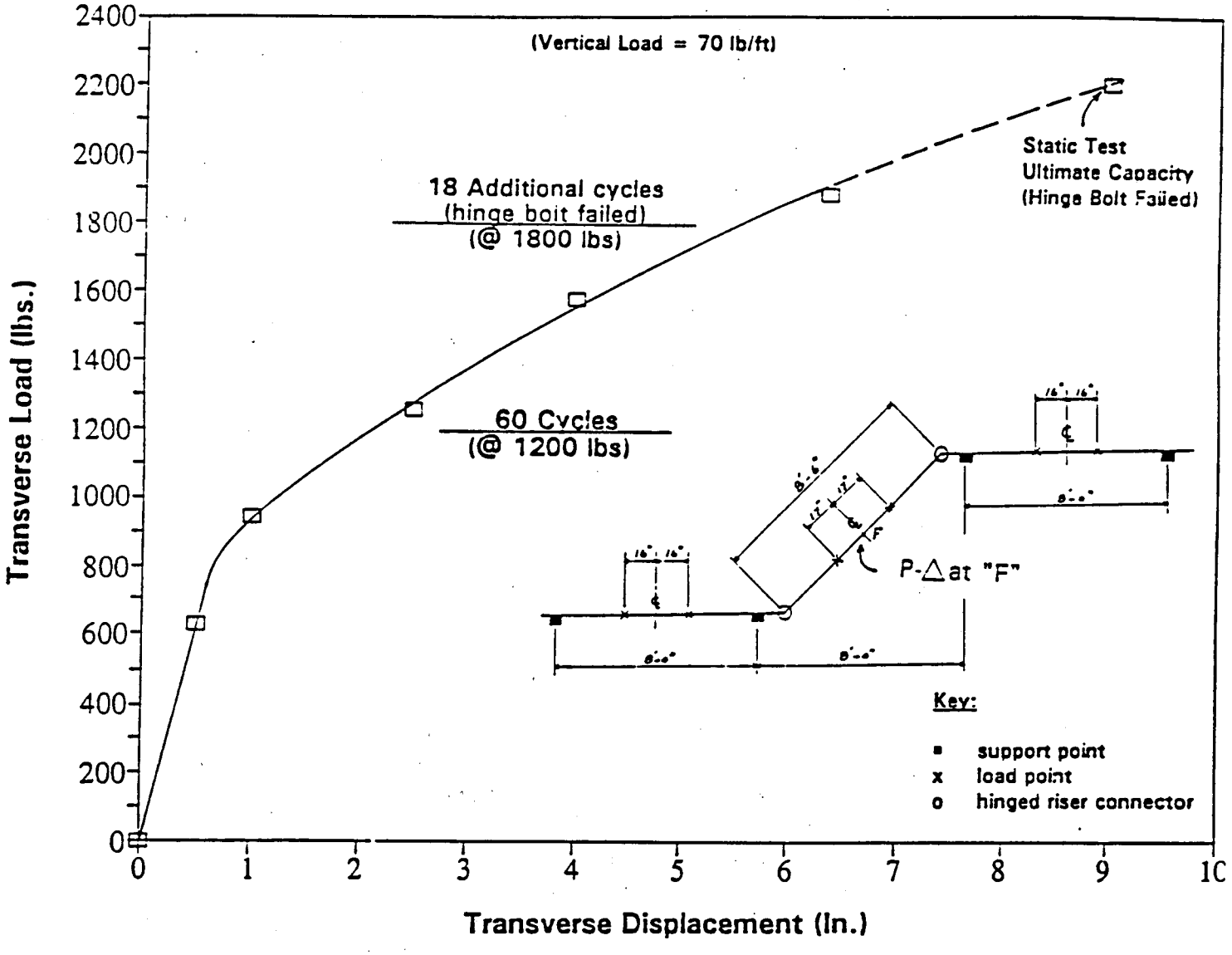
WATTS BAR NUCLEAR PLANT
SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

CABLE TRAY DESIGN ALLOWABLES

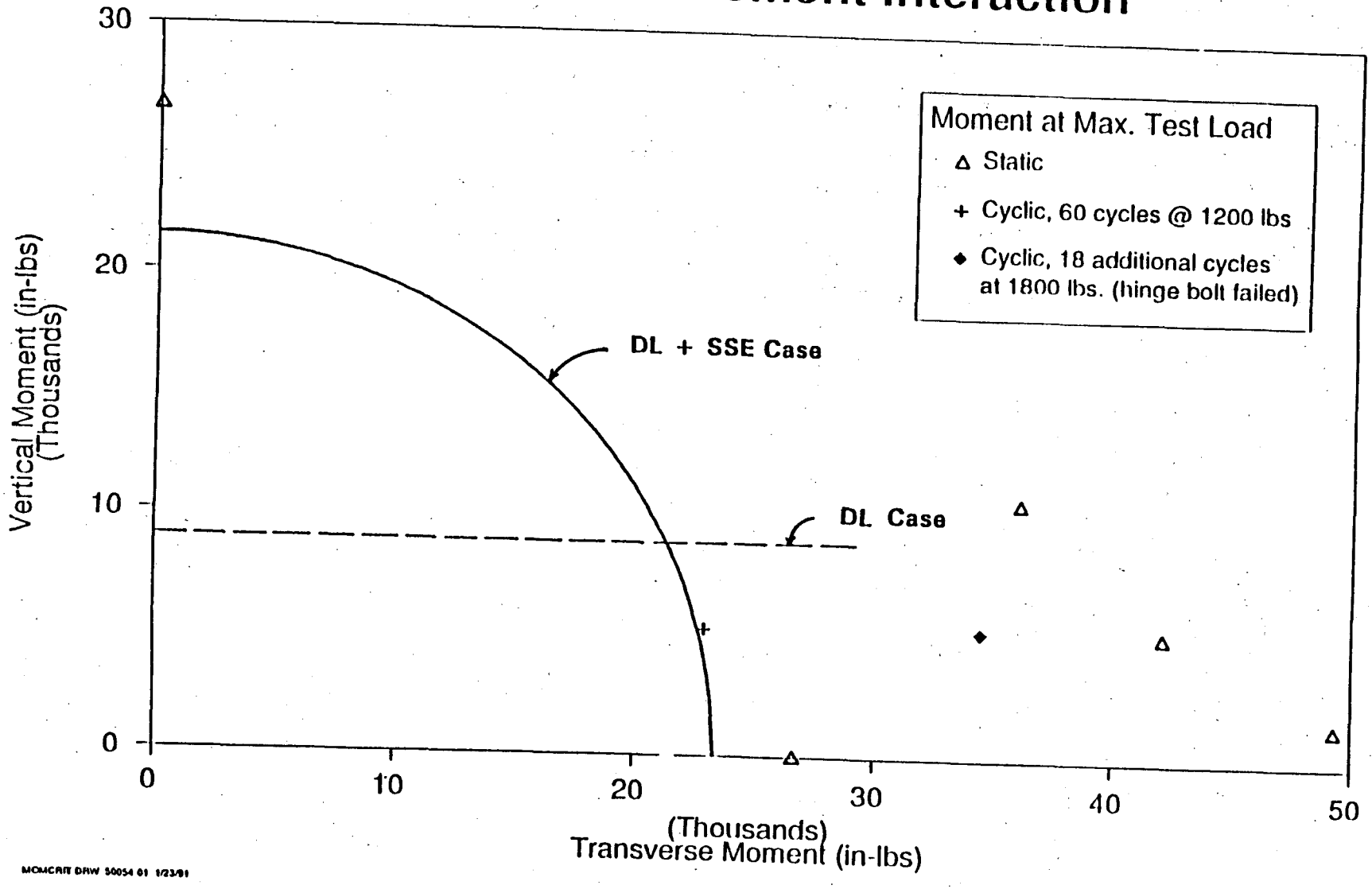
CRITERIA	BASIS
• VERTICAL TRAY ALLOWABLES $M_{ALLOW} = 0.8\ M_{max}$ FOR DL + SSE $M_{ALLOW} = 0.33\ M_{max}$ FOR DL	• VERTICAL LOAD TEST OF SIMPLY SUPPORTED TRAY SPAN TO BUCKLING OF SIDE RAILS
• TRANSVERSE TRAY ALLOWABLES M_{ALLOW} BASED ON EPP YIELD POINT	• TRANSVERSE LOAD TESTS OF SIMPLE AND MULTI-SPAN CONFIGURATION
• TRANSVERSE & VERTICAL ALLOWABLE MOMENTS EVALUATED BY A QUADRATIC INTERACTION EQUATION	• CYCLIC TESTING FOR 60 CYCLES DID NOT RESULT IN FAILURE WITH ACCEPTABLE DEFLECTIONS. • CORRELATIVE ANALYSES PERFORMED ON FINITE ELEMENT MODEL OF THE TESTED CONFIGURATIONS
• CONNECTOR HARDWARE CAPACITIES BASED ON STANDARD CODES OF PRACTICE	• AISI AND SRP REQUIREMENTS.
• ALLOWABLE STRESSES FOR MISCELLANEOUS DETAILS ARE 1.6 TIMES AISI ALLOWABLES	• STANDARD REVIEW PLAN
• X & T INTERSECTION FITTINGS EVALUATED TO A FACTOR OF SAFETY OF 1.25 AGAINST FORMATION OF FIRST PLASTIC HINGE	• COMPATIBILITY WITH VERTICAL LOAD TESTING
• BOLT ALLOWABLES ARE BASED ON 1.6 TIMES AISI ALLOWABLES	• STANDARD REVIEW PLAN

Load Displacement Curve



Lateral load-deflection test data for a 45° Riser section. The test configuration is shown in the inset. The plots indicate inelastic deformation capability far exceeding the ductility factor of three. The 1/4" riser connector bolt failed when the total transverse load to the riser section reached 2199 lb.

Allowable Transverse Moment and Vertical Moment Interaction



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WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

DESIGN CRITERIA & BASIS

CABLE TRAY - CRITERIA COMPARISON

ELEMENT	TVA DESIGN CRITERIA	SRP BASED DESIGN
1. SEISMIC LOAD DETERMINATION	ELASTIC & INELASTIC ANALYSES	SRP SECTION 3.7.2
2. VERTICAL TRAY ALLOWABLE	DL + SSE: 0.8 M_{max} (34 ksi)	S = 32 ksi
	DL: 0.33 M_{max} (14 ksi)	S = 20 ksi
3. TRANSVERSE TRAY ALLOWABLE	MAXIMUM ALLOWABLE DUCTILITY EQUAL TO 3	
	DEFLECTION AT ALLOWABLE DUCTILITY APPROXIMATELY 2" FOR STANDARD 8' SPAN	
4. CONNECTOR HARDWARE & MISC DETAILS	AISI & SRP REQUIREMENTS	SAME

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

EVALUATION PROCESS

- ESTABLISH CRITERIA AND METHODOLOGY.
- DEVELOP QUALIFICATION OF STANDARD CONFIGURATIONS.
- DEFINITION OF PARAMETERS FOR PLANT WALKTHROUGHS
- PLANT WALKTHROUGHS & CRITICAL CASE IDENTIFICATION
- CRITICAL CASE EVALUATIONS, EVALUATION OF OUTLIERS, AND MODIFICATIONS
- PROGRAM CLOSURE DOCUMENTATION

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

- GUIDELINES FOR PLANT WALKTHROUGH -

- ADEQUATE FLEXIBILITY FOR SAM
- PROTECTION OF CABLE INSULATION
- RACEWAY SAG
- DAMAGED OR MISSING COMPONENTS
- NON-STANDARD OR ALTERED HARDWARE
- RATTLESPACE
- POTENTIAL INSTABILITIES DUE TO MULTIPLE HINGES
- NON-DUCTILE COMPONENTS
- CRITICAL CASE PARAMETERS

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUITS & CABLE TRAYS

- CRITICAL CASE IDENTIFICATION -

THE CRITICAL-CASE IDENTIFICATION WILL CONSIDER CRITICAL PARAMETERS:

- PLANT ELEVATION
- SPAN LENGTH
- MULTIPLE SPLICES
- LONG RISERS FROM HINGED JOINTS
- ELBOWS, TEES, CROSSES WITHOUT INDEPENDENT SUPPORT
- LONG CANTILEVERS
- HEAVY ATTACHMENTS
- UNUSUAL CONFIGURATIONS THAT MAY EXHIBIT NON-DUCTILE BEHAVIOR
- OVERFILLED CABLE TRAYS

WATTS BAR NUCLEAR PLANT

SEISMIC QUALIFICATION OF CONDUIT & CABLE TRAYS

CONCLUSIONS

- CABLE TRAY I(L) DESIGNATION WILL BE REMOVED FROM FSAR. SEISMIC QUALIFICATION OF SAFETY-RELATED CABLE TRAYS:
  - IS BASED ON TESTING AND ANALYSES OF WBN TRAY CONFIGURATIONS WHICH MEET REGULATORY GUIDANCE
  - ENSURES TRAYS REMAIN FUNCTIONAL UNDER SSE LOADS
  - PROVIDES MARGINS EQUIVALENT TO THOSE OBTAINED BY SRP REQUIREMENTS