

June 15, 1990

Docket No. 50-390

APPLICANT: Tennessee Valley Authority

FACILITY: Watts Bar Nuclear Plant, Unit 1

SUBJECT: MINUTES OF MAY 31, 1990, MEETING ON THE STRUCTURAL ADEQUACY OF HVAC DUCT WELDS (TAC R00510)

On May 31, 1990, a meeting was held at the request of the Tennessee Valley Authority (TVA) in Rockville, Maryland between the NRC staff and TVA's representatives. TVA made a presentation regarding the structural adequacy of heating, ventilating and air conditioning (HVAC) welds at Watts Bar, Unit 1. Enclosure 1 is the list of individuals attending the meeting. Enclosure 2 contains the handouts provided by the applicant at the meeting.

Safety-related HVAC ductwork had been installed in 1978 without specific welding requirements from TVA engineering. After engineering requirements were imposed in 1980, subsequent inspections identified partial penetration welds where full penetration welds were required. The staff was concerned that the partial penetration butt welds could fail during and/or following a design basis seismic event.

TVA concluded that the welded ductwork will perform its intended design functions. Additional testing and analyses confirmed the earlier conclusions and TVA will supplement the 50.55(e) final report on this subject by documenting the results of this additional testing. The NRC staff will review this information as part of verification/closure of the unresolved item.

Paul Cortland, Project Engineer  
 Project Directorate II-4  
 Division of Reactor Projects I/II  
 Office of Nuclear Reactor Regulation

- Enclosures:
1. List of Attendees
  2. TVA Presentation Handout

cc w/enclosures:  
 See next page

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OFC	: PDII-4/LA	: PDII-4/PM	: MEB/SC	: PDII-4/PM	: PDII-4/D
NAME	: MKrebs <i>MK</i>	: PCortland <i>PC</i>	: DTerao <i>DT</i>	: PTam <i>PT</i>	: FHebdon <i>FH</i>
DATE	: 6/12/90	: 6/12/90	: 6/14/90	: 6/14/90	: 6/15/90

Meeting Summary, Memoranda for Trip Reports or Site Visits

Docket File

NRC PDR

Local PDR

T. Murley/F. Miraglia

J. Partlow

S. Varga

G. Lainas

F. Hebdon

S. Black

M. Krebs

P. Cortland

P. Tam

B. Wilson, Region II

OGC

R. Auluck

D. Terao

G. Georgiev

D. Smith

ACRS (10)

GPA/CA (M. Callahan) (3)

E. Jordan

B. Grimes

J. Scarborough

G. Marcus

L. Norrholm

C. Ader

J. Gray

R. Borchardt

WBN Rdg. File

cc:

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Honorable Robert Aikman, County Judge  
Rhea County Courthouse  
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Honorable Johnny Powell, County Judge  
Meigs County Courthouse, Route 2  
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Mr. Michael H. Mobley, Director  
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ENCLOSURE 1

ATTENDANCE LIST

MEETING ON STRUCTURAL ADEQUACY OF HVAC DUCT WELDS

AT WATTS BAR NUCLEAR PLANT, UNIT 1

May 31, 1990

Name	Affiliation
R. Auluck	NRC/NRR/TVAPD
P. Cortland	NRC/NRR/TVAPD
G. Georgiev	NRC/NRR/TVAPD
D. Smith	NRC/NRR/TVAPD
P. Tam	NRC/NRR/PD II-4
D. Terao	NRC/NRR/TVAPD
J. Adair	TVA/Watts Bar
R. Alley	TVA/Watts Bar
T. Dean	TVA/Watts Bar
D. Etzler	TVA/Watts Bar
W. Horn	TVA/Watts Bar
T. Ippolito	TVA/Rockville
F. Laurent	TVA/Watts Bar
W. Raughley	TVA/Watts Bar
R. Stevens	TVA/Watts Bar Licensing
T. Woods	TVA/Knoxville
G. Egar	APTECH
P. Bezler	Brookhaven National Laboratory

ENCLOSURE 2

TVA DOCUMENTS PRESENTED AT MEETING

1. "Safety-Related Heating, Ventilating, and Air Conditioning Duct Welding"

**MEETING WITH NRC STAFF  
ROCKVILLE, MD  
MAY 31, 1990**

**SAFETY-RELATED HEATING,  
VENTILATING, AND  
AIR CONDITIONING  
DUCT WELDING**

**WATTS BAR NUCLEAR PLANT**

**TVA**

## PURPOSE

- RESPONSE TO NRC QUESTIONS REGARDING THE STRUCTURAL ADEQUACY OF THE HVAC DUCT WELDS AT WBN.
- PROVIDE AN OVERVIEW OF THE TOTAL WBN PROGRAM FOR ENSURING STRUCTURAL ADEQUACY
- DISCUSS THE MECHANICAL TESTING OF WELD COUPONS AND PROVIDE THE RESULTS TO SUPPLEMENT THE INSPECTION AND ANALYSIS PREVIOUSLY PERFORMED.
- CONFIRM THE STRUCTURAL ADEQUACY OF THE HVAC DUCTWORK.

# AGENDA

- BACKGROUND
- METHOD
- TEST RESULTS
- SUMMARY
- CLOSING COMMENTS

## **BACKGROUND**

### **• PROBLEM STATEMENT**

**INSUFFICIENT QUALITY AND TECHNICAL REQUIREMENTS LED TO CONCERNS ABOUT THE STRUCTURAL ADEQUACY OF HVAC WELDS. THESE CONCERNS WERE RAISED THROUGH CAQs AND EMPLOYEE CONCERNS AND DOCUMENTED TO NRC IN 50.55(e) REPORTS.**

• **SCOPE**

**SAFETY-RELATED CATEGORY I SYSTEMS**

- EMERGENCY GAS TREATMENT SYSTEM
- HYDROGEN COLLECTION SYSTEM
- DIESEL GENERATOR BUILDING BATTERY HOOD EXHAUST
- REACTOR BUILDING PURGE AIR
- AUXILIARY BUILDING GAS TREATMENT SYSTEM DISCHARGE
- POST-ACCIDENT SAMPLING
- CONTROL BUILDING PRESSURIZATION AND SMOKE REMOVAL

• **DUCT PARAMETERS**

- **RECTANGULAR DUCT**  
ASTM A570 GRADE 30 (B)  
e.g., 24" to 28" x 96"  
12 GAUGE (.1046)
  
- **ROUND DUCT**  
**SPIRAL-WELDED DUCT (LOW STRESS)**  
ASTM A211  
8" DIAMETER to 36" DIAMETER  
14 GAUGE (.0747) to .134"

**SCHEDULE PIPE**  
ASTM A106 GRADE B  
6" DIAMETER to 24" DIAMETER  
1/4" (0.250") to 5/16" (0.375")

## **METHOD**

### **TVA ACTIONS TO ASSURE STRUCTURAL ADEQUACY OF SAFETY-RELATED HVAC DUCT**

- **TO DETERMINE WELD PRESENCE**

- **CONSTRUCTION**

**WALKDOWN ALL SAFETY-RELATED WELDS  
(APPROXIMATELY 10,400 DUCT WELDS)**

**WELD PRESENCE**

**NUMBERED WELDS**

**CLASSIFIED TO TYPE OF WELD**

- **QUALITY CONTROL**

**PERFORMED VISUAL SURVEY FOR WELD PRESENCE  
AND NOTED OBSERVED DEFECTS.**

**PERFORMED EDDY CURRENT TESTING FOR WELD  
METAL PRESENCE.**

**TVA**

**SUMMARY :**

**BASED ON THE RESULTS OF THESE EFFORTS, AS  
OUTLINED IN OUR 10 CFR 50.55(e) REPORT, TVA HAS  
REASONABLE ASSURANCE THAT THERE IS WELD  
PRESENCE AT EACH JOINT.**

**TVA**

**• TO DETERMINE STRUCTURAL ADEQUACY**

**- ENGINEERING**

- CONSERVATIVE STRESS ANALYSIS PERFORMED TO DETERMINE MINIMUM WELD REQUIREMENTS**

**HIGH STRESS (WORST CASE) - APPROX. 9.75 ksi**

- REVIEW OF 10,400 SURVEYS TO IDENTIFY ANY CONDITION THAT WOULD REQUIRE MORE DETAILED EVALUATION**

**IDENTIFIED APPROX. 175 RECORDS THAT REQUIRED ADDITIONAL ENGINEERING FIELD EVALUATIONS.**

**ADDITIONAL CALCS PERFORMED USING AS-BUILT CONFIGURATIONS. ALL WERE ENVELOPED BY WORST-CASE EVALUATIONS.**

- COUPON TESTING.**

# WELD SAMPLE COUPONS

- 1988 SAMPLES

VISUAL EXAMINATION

PENETRATION MEASUREMENTS

- 1981 SAMPLES

VISUAL EXAMINATION

PENETRATION MEASUREMENTS

MECHANICAL TESTS

- 1990 SAMPLES

VISUAL EXAMINATION

PENETRATION MEASUREMENTS

MECHANICAL TESTS

# **ASSESSMENT OF STRUCTURAL** **INTEGRITY OF HVAC WELDS**

- **INTRODUCTION AND OBJECTIVE**
- **METHOD OF ANALYSIS**
- **RESULTS OF STRUCTURAL INTEGRITY ANALYSIS**
- **REVIEW OF MECHANICAL TESTS**
- **COMPARISON OF TEST RESULTS WITH PREDICTIONS**
- **REVIEW OF INSPECTION INFORMATION**
- **ESTABLISHMENT OF STATISTICALLY BASED "WORST" CASE FOR WELD ATTRIBUTES**
- **CONCLUSIONS**

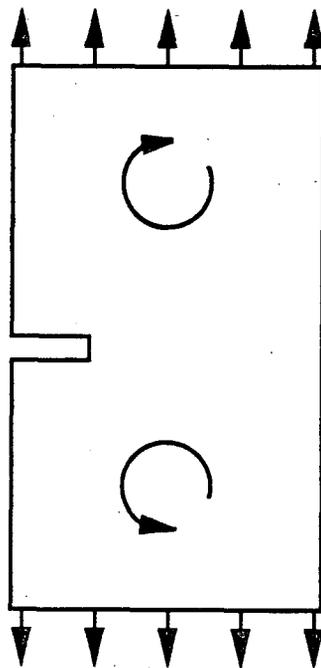
## **OBJECTIVES**

- PERFORMED STRUCTURAL INTEGRITY ANALYSIS
- COMPARE PREDICTIONS WITH TEST RESULTS
- ESTABLISH MARGINS

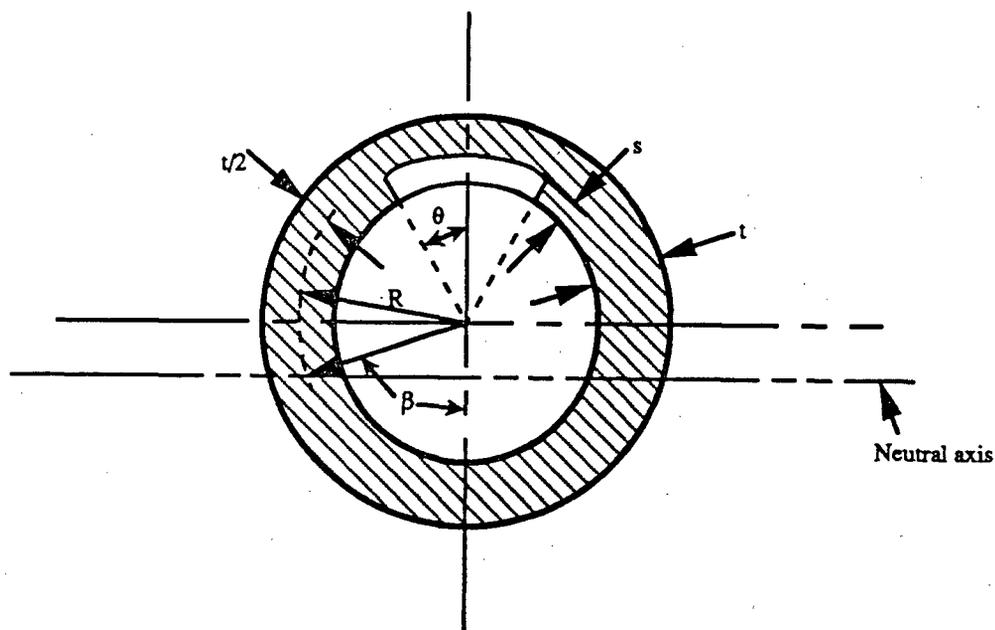
# METHOD OF ANALYSIS

- **LIMIT LOAD IS CONTROLLING FAILURE MECHANISM**
  
- **BRITTLE FRACTURE IS NOT A CONCERN**
  
- **MODELS CONSIDERED :**
  - **LACK OF PENETRATION**
  - **LACK OF WELD**

# MODELS



A. EDGE CRACKED PLATE



B. CIRCUMFERENTIAL CRACK IN A CYLINDER

# **RESULTS**

## **LIMIT LOAD CALCULATIONS BASED ON:**

- A. MINIMUM BASE METAL PROPERTIES**
- B. WELD METAL PROPERTIES**
- C. FIXED END CONDITIONS VERSUS PINNED ENDS**

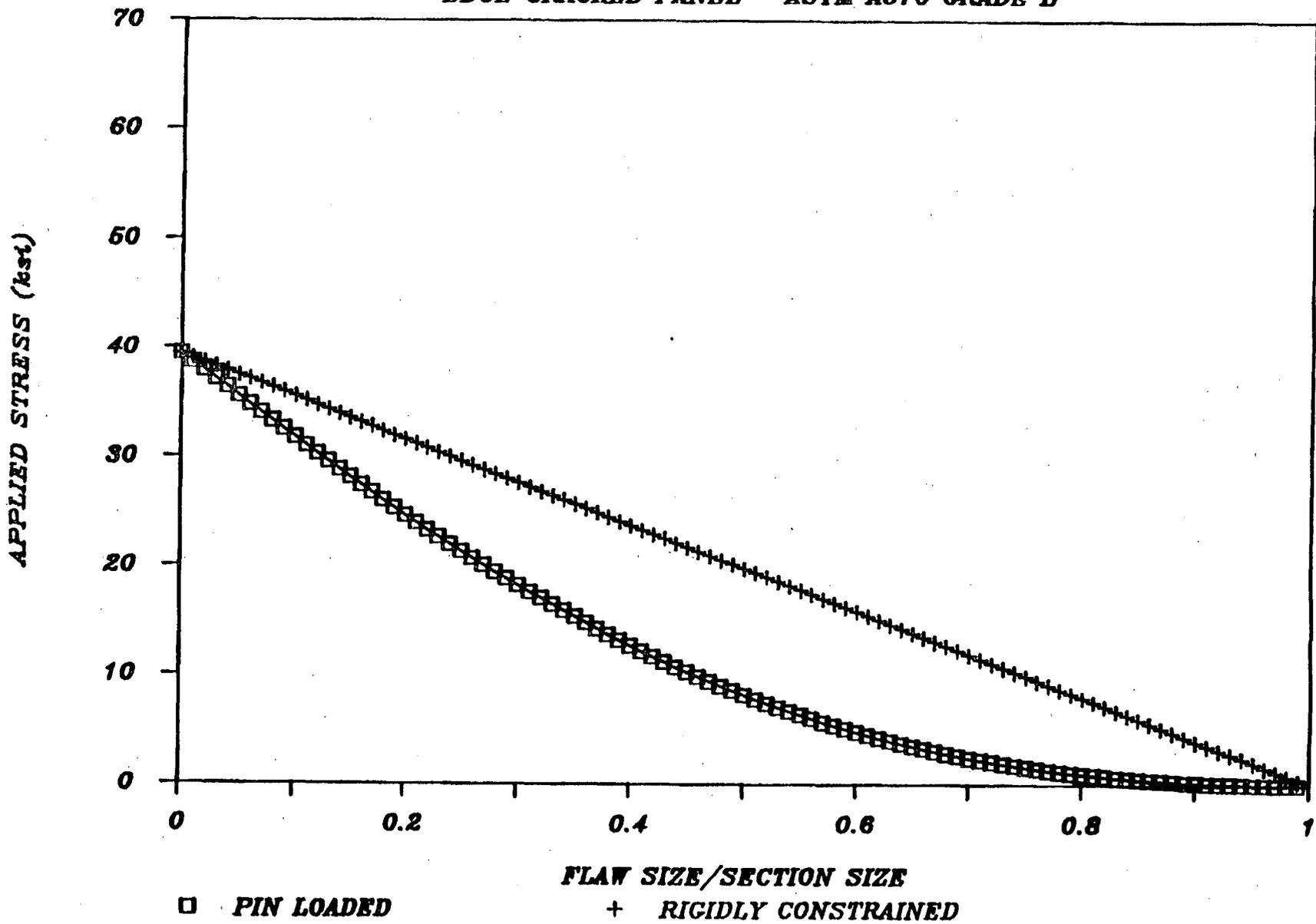
# WORST CASE WELD ATTRIBUTES

95% / 95%

- LACK OF PENETRATION                      53% OF WELD THICKNESS
- LACK OF WELD                                28% OF CIRCUMFERENCE

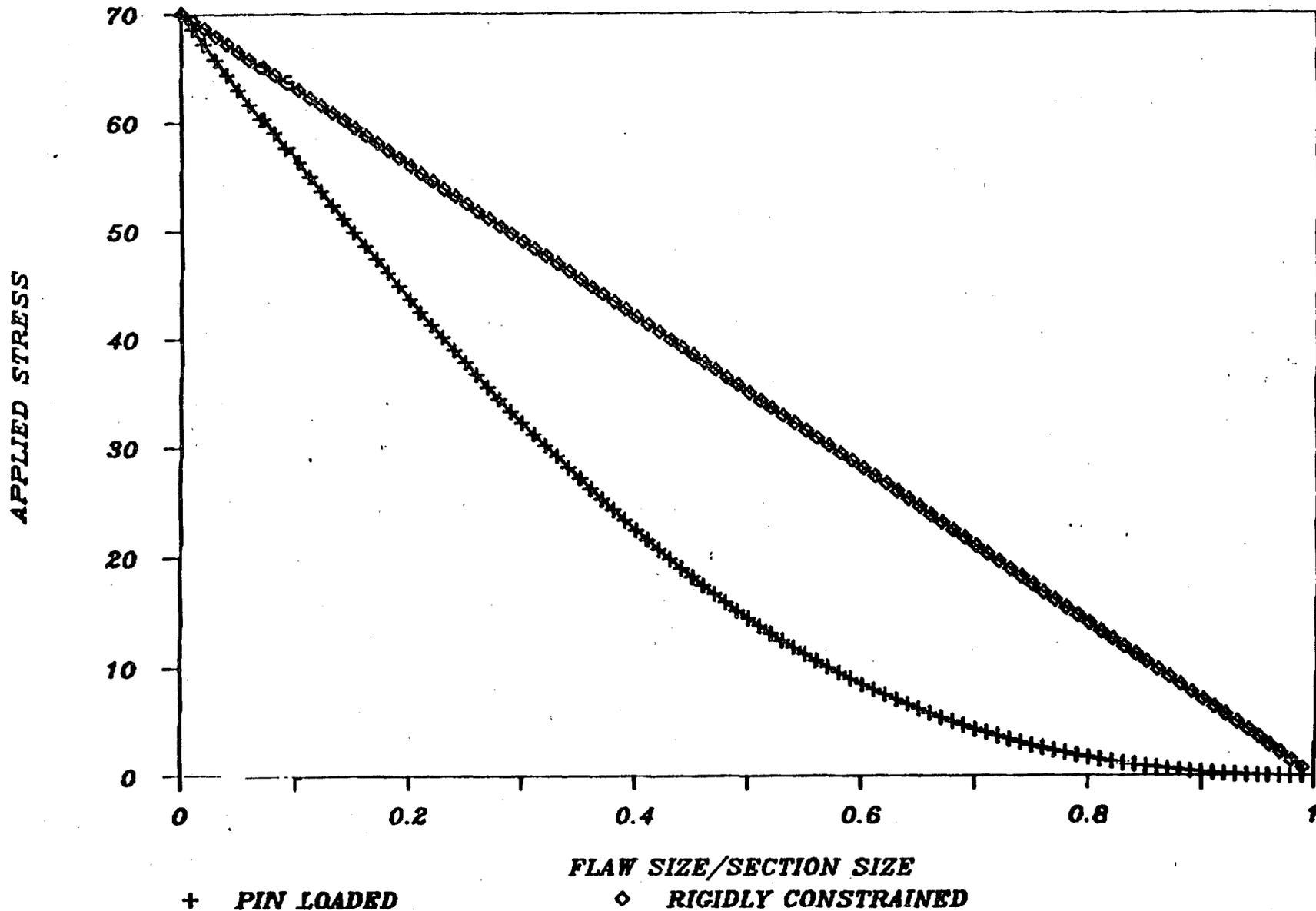
# LIMIT LOAD ANALYSIS

EDGE CRACKED PANEL - ASTM A570 GRADE B



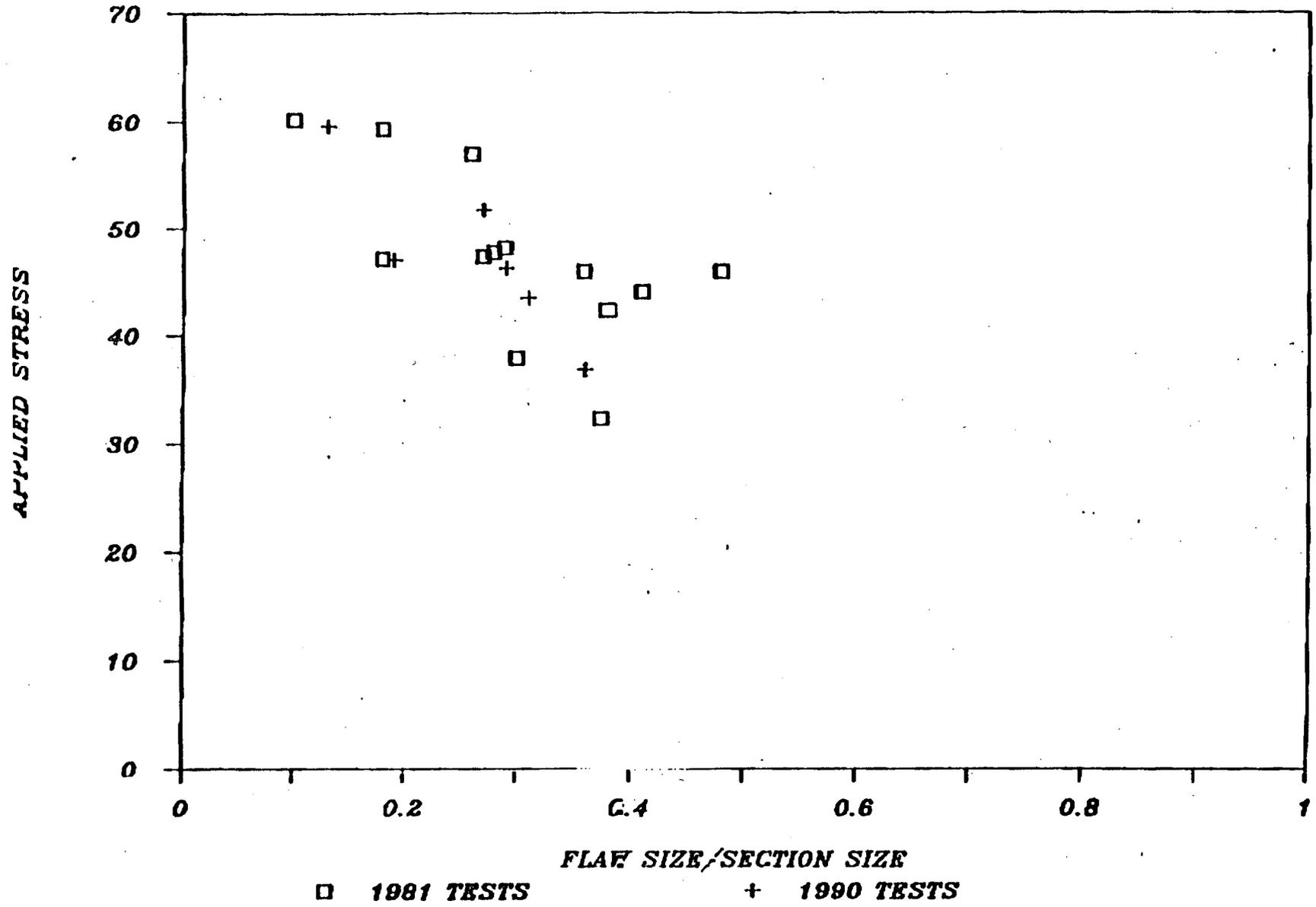
TVA

EDGE CRACKED PANEL -- SIGFLO = 70 KSI



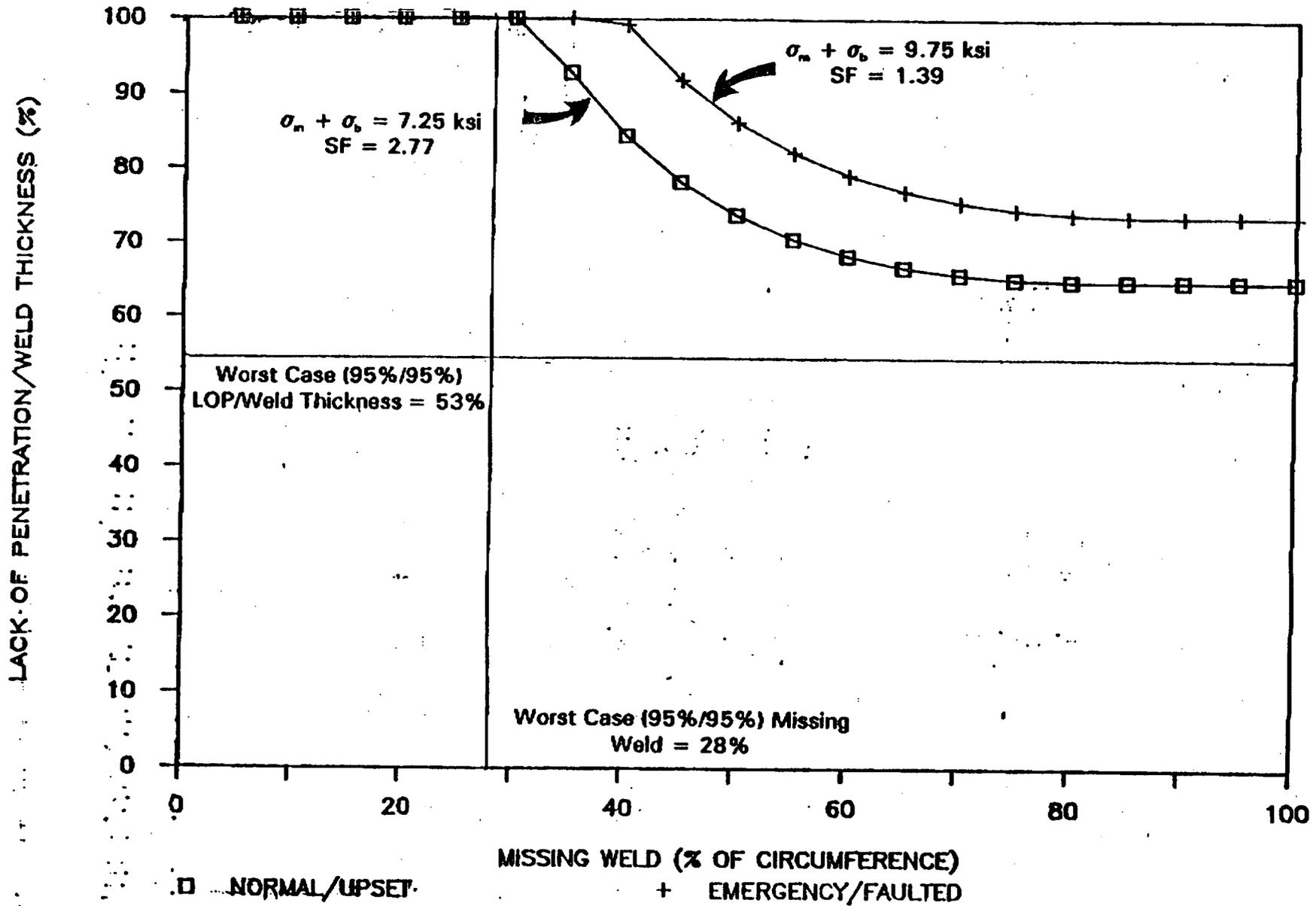
TVA

EDGE CRACKED PANEL



# CIRCUMFERENTIALLY CRACKED PIPE

FLOW STRESS = 35 ksi



## CONCLUSIONS

- SIGNIFICANT MARGINS AGAINST FAILURE STILL RETAINED WITH WORST CASE WELD ATTRIBUTES
- TEST RESULTS CONFIRM THAT PREDICTIVE METHOD IS CONSERVATIVE
- WORST CASE STRESSES FOR OBE AND SSE USED

# SUMMARY

- **50.55(e) FINAL REPORT CONCLUDED THE WELDED DUCTWORK WILL PERFORM ITS INTENDED DESIGN FUNCTIONS.**
- **ADDITIONAL TESTING PERFORMED BY TVA AND THE REVIEW OF PREVIOUS RESULTS REAFFIRMED PREVIOUS CONCLUSIONS.**
- **ANALYSIS OF TEST DATA BY APTECH CONFIRMED TVA CONCLUSIONS.**
- **TVA WILL SUPPLEMENT THE 50.55(e) FINAL REPORT ON THIS SUBJECT TO DOCUMENT THE RESULTS OF THIS ADDITIONAL TESTING**