UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-8064

February 14,

R. T. Ridenoure
Division Manager - Nuclear Operations
Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
P.O. Box 550
Fort Calhoun, Nebraska 68023-0550

SUBJECT: FORT CALHOUN STATION - MEETING TO DISCUSS CONTROL ELEMENT DRIVE MECHANISM (CEDM) CRACKING ISSUES

Dear Mr. Gambhir:

This refers to the meeting conducted at Arlington, Texas, on February 8, 2002, between your staff and the NRC. The participants discussed the similarities and differences between Fort Calhoun Station and Palisades Station CEDMs.

The discussions included the actions you have taken and plan to take to ensure early detection and corrective action for potential cracks in the CEDM upper housing welds. Your staff agreed to provide the results of the examinations performed on drive housings during your next refueling outage.

The attendance list and presentation slides are enclosed with this summary (Enclosures 1 and 2, respectively).

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Charles S. Marschall, Chief
Engineering Branch
Division of Reactor Safety

Docket: 50-285
License: DPR-40

Enclosures:
1. Attendance List
2. NRC Presentation

cc w/enclosures:
Mark T. Frans, Manager
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Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
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James W. Chase, Division Manager
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/**RA**/ T	/**RA**/			
02/11/02	02/14/02			

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ENCLOSURE 1

ATTENDANCE LIST

Licensee:

D. Bannister, Plant Manager
M. Frans, Manager, Nuclear Licensing
W. Gates, Vice President, Nuclear
R. Lisowyj, Senior Nuclear Design Engineer
J. McManis, Manager, Design Engineering
R. Phelps, Division Manager, Nuclear Engineering
R. Ridenoure, Division Manager, Nuclear Operations
K. Woods, Senior Nuclear Design Engineer

NRC:

L. Berger, Branch Secretary
K. Brockman, Director, Division of Reactor Projects (DRP)
A. Howell, Director, Division of Reactor Safety (DRS)
K. Kennedy, Chief, Projects Branch C, DRP
C. Marschall, Chief, Engineering and Maintenance Branch, DRS
E. Merschoff, Regional Administrator, Region IV
C. Paulk, Senior Reactor Inspector, DRS
W. Walker, Senior Resident Inspector
A. Wang, Project Manager, Office of Nuclear Reactor Regulation
L. Willoughby, Resident Inspector

ENCLOSURE 2

Licensee Presentation

Control Element Drive Mechanism Housing Reliability

A presentation to the NRC
by the Fort Calhoun
Station Staff

February 8, 2002,
Arlington, Texas

Agenda

- Introductions - Gary Gates
- Agenda Review - Ralph Phelps
- Summary of Fort Calhoun Station Initiatives - Joe McManis
- CEDM Housing Mechanics Discussion - Kirby Woods

Agenda

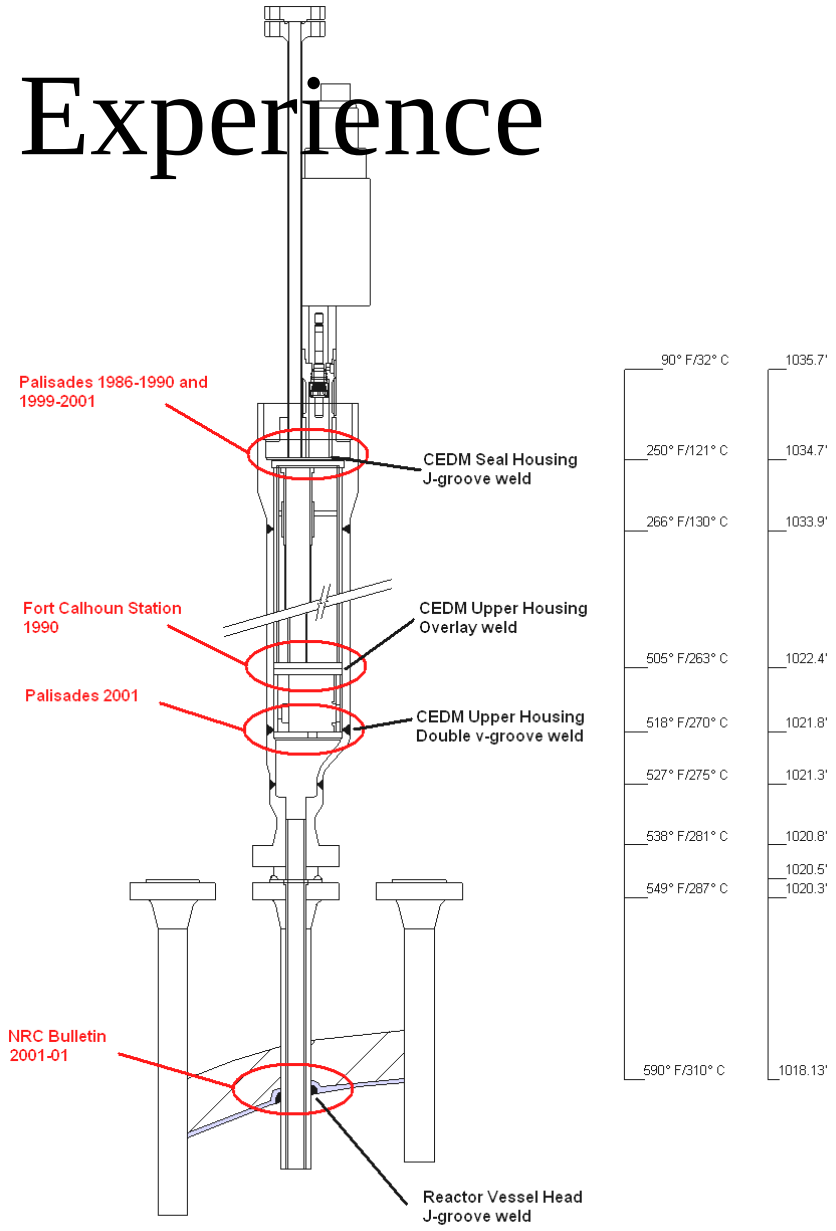
- CEDM Housing Materials Characterization Discussion - Bob Lisowyj
- Conclusions - Ralph Phelps
- Closing - Ross Ridenoure

Joe McManis, P.E. - Manager,
Design Engineering

Summary of Fort Calhoun
Station Initiatives
Regarding CEDM
Reliability

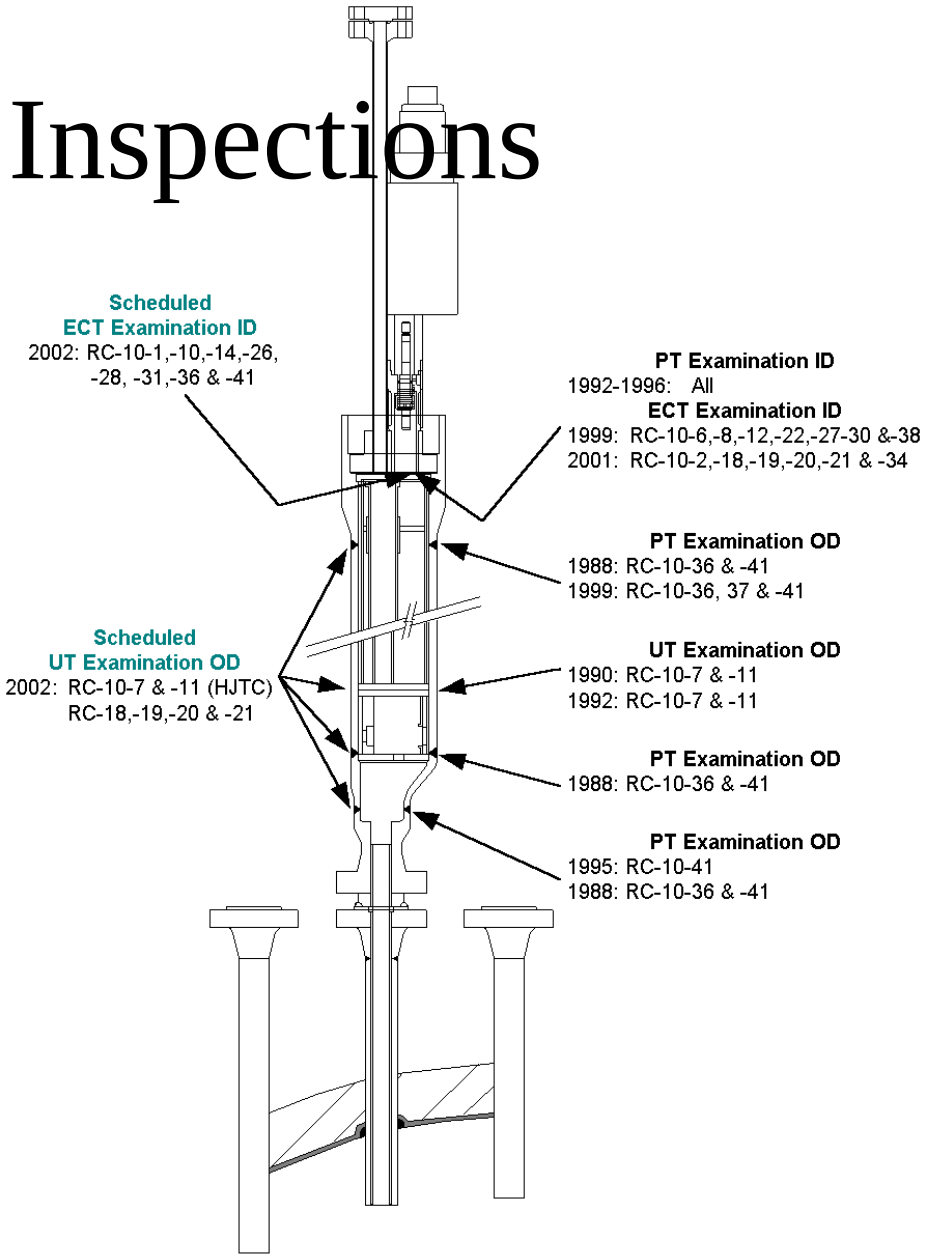
Operating Experience

- CEDM Housing Assemblies
  - Seal Housing
    - J-groove weld
      - Palisades 1986-1990 & 1999-2001
  - Upper Housing
    - Overlay weld
      - FCS 1990
    - V-groove weld
      - Palisades 2001
  - VHP Nozzles
    - J-groove weld
- **-INSIGHT-**



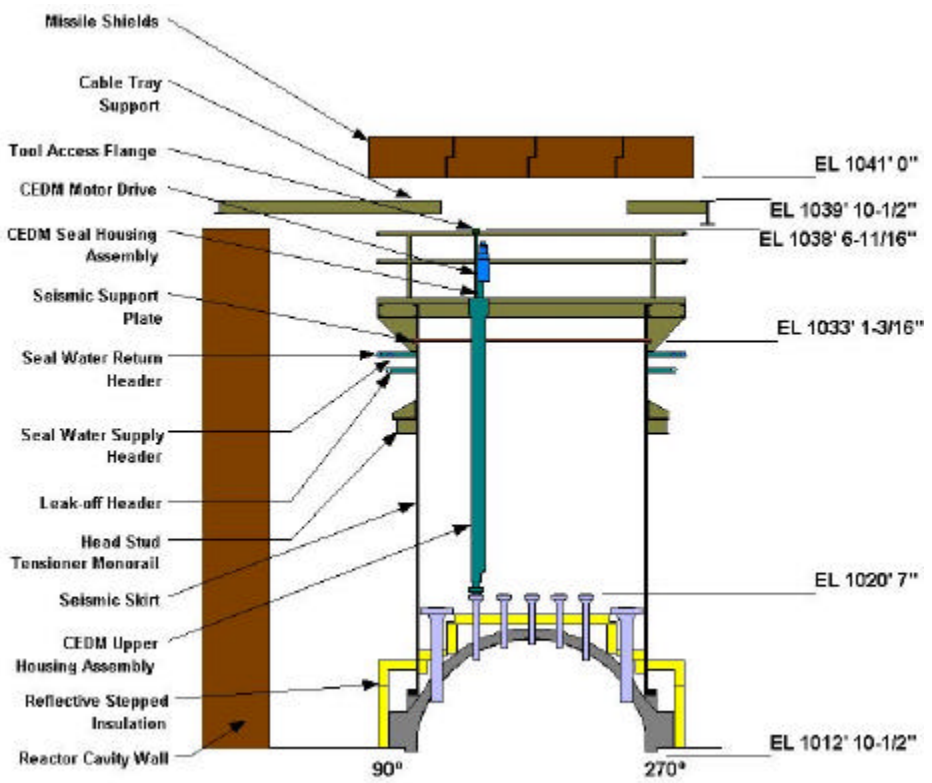
FCS CEDM Inspections

- Performed
  - Seal Housing
  - Upper Housing
- Planned
  - Seal Housing
    - Program plan
  - Upper Housing
    - 10 yr ISI
- Commitments(1991)
  - Perform HJTC housings UT (10 yr ISI)
  - Clean/Visually Inspect RV Head



VHP Nozzle

- Oconee 3 Event
  - Circumferential Cracking
  - Bulletin 2001-01
- Effective Full Power Year
  - Time-at-Temperature Model
  - FCS 17.9 EFPY
- Low Probability of Rupture and/or Excessive Leakage
- Effective Visual Inspection during Max



FCS Susceptibility Assessment

- Environment
  - Chlorides
  - Oxygen
  - Stagnancy
- Residual Stress
  - Longitudinal
  - Circumferential
- Temperature
- Conclusion
  - Seal Housing Highest Risk

Susceptibility Assessment						
Description		**Environment**		**Tensile Residual Stresses**		**Temp.**
Location	**Type**	**Chlorides**	**Oxygen**	**Axial**	**Hoop**	
Seal Housing 1034'-7"	j-groove	High	High	Low	High	Moderate
Upper Housing *Autoclave Flange* 1033'-9"	double v-groove	High	Moderate	Moderate[1]	N/A	Moderate
Upper Housing *Pipe* 1022'-4"	overlay	Low	Low	Moderate[1]	Low	Moderate
Modified Eccentric Reducer *Large Diameter* 1021'-8"	double v-groove	Low	Low	Moderate[1]	N/A	Moderate
Modified Eccentric Reducer *Small Diameter* 1021'-3"	double v-groove	Low	Low	Moderate[1]	N/A	Moderate

Note: 1 - This moderate stress peaks at the weld root and dissipates within the weld area.

Key Differences

- Fort Calhoun Station has:
  - Time
    - CEDM through-wall cracks
  - Operation
    - Maintenance outage
  - Thermal Sleeve
    - Palisades extends to their reactor vessel flange
  - Program Plan

Material Reliability Focus

- Operating Experience
  - Seal Housing
  - Upper Housing
- Program Plan
  - Predictive and Environmental Model
  - Inspection, Remediation and/or Repair Plan
- Overview of Issues
  - Responses
  - Actions

Introduction of Program Managers

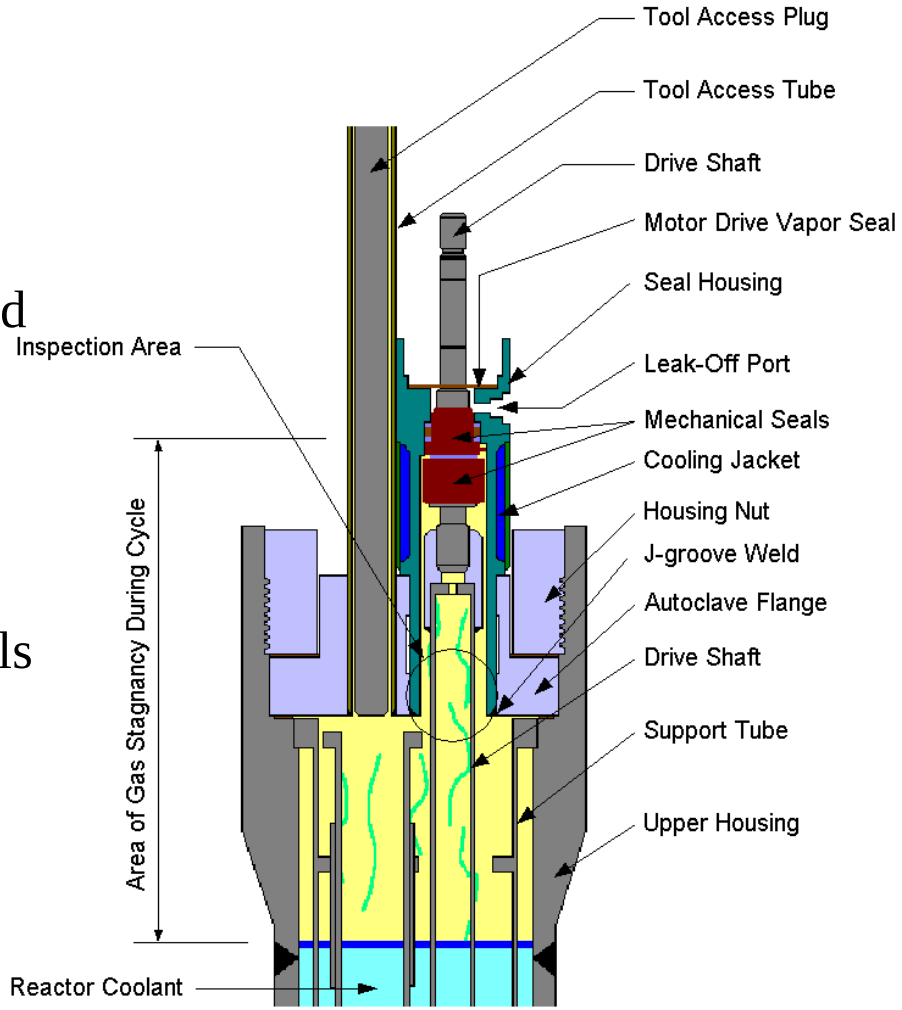
- Two Individuals Providing Oversight of the Issue
- Kirby Woods - PE, MS, Worked on Issue since early 1998
- Bob Lisowyj - PhD, Worked on Issue since 1990

Kirby D. Woods - Senior Nuclear Design Engineer

CEDM Housing
Mechanics Discussion

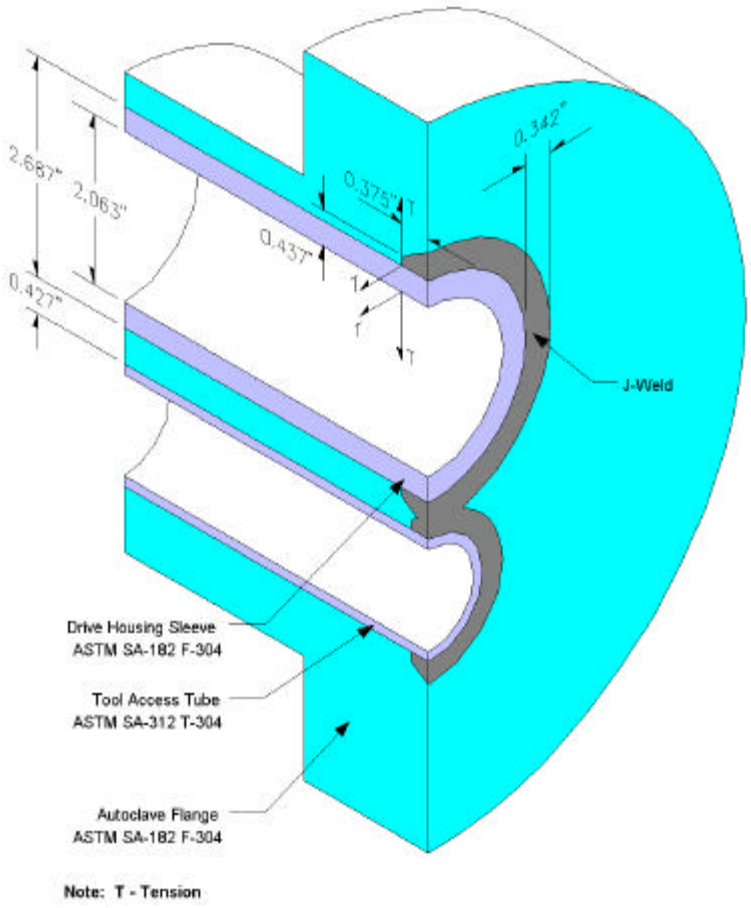
CEDM - Seal Housing Assembly

- Longest Stagnant Area
  - Oxygen
  - Leachable Chloride
    - Flexitallic gasket, o-rings and graphitar (~50 ppm)
- Residual Stress
  - Fabrication Records
    - Residual Stress (33 to 75 mils shrinkage)
- Temperature
- Operating Experience
- **-PRECURSOR-**

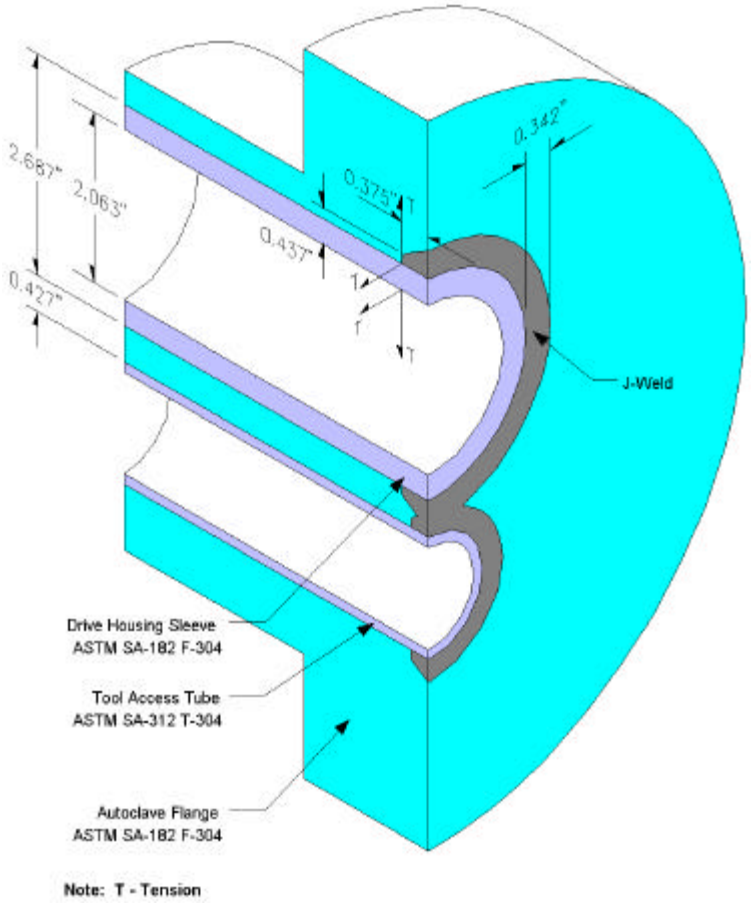


CEDM - Seal Housing Assembly

- Interpretation
  - Residual Stress
    - J-groove weld
    - Transverse shrinkage
      - Axial stress
      - Hoop stress
  - Temperature
    - ~250º F/121 º C
      - Palisades experience
    - Inverted Bath Tub Curve

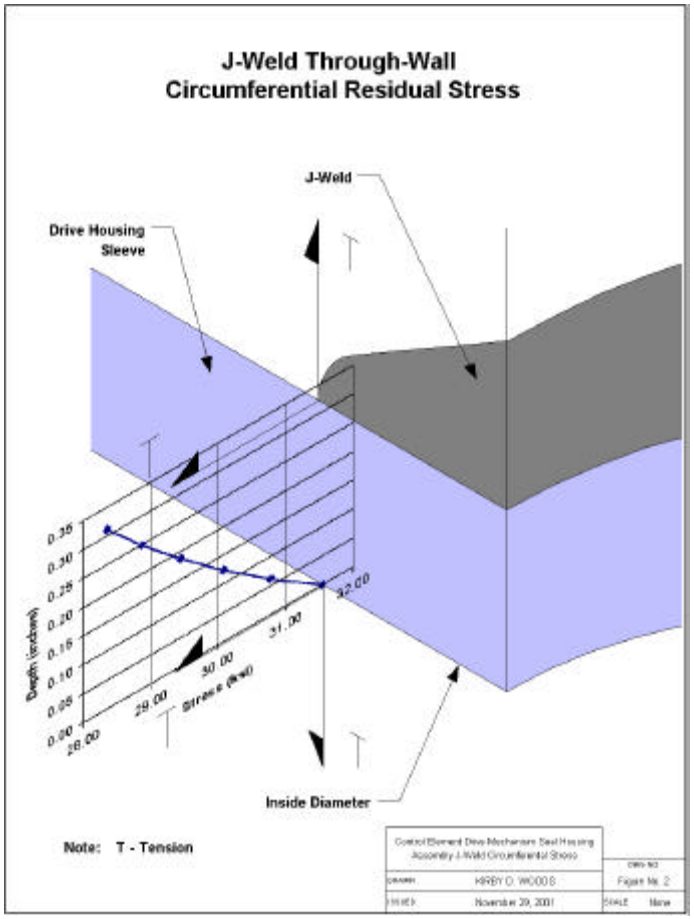


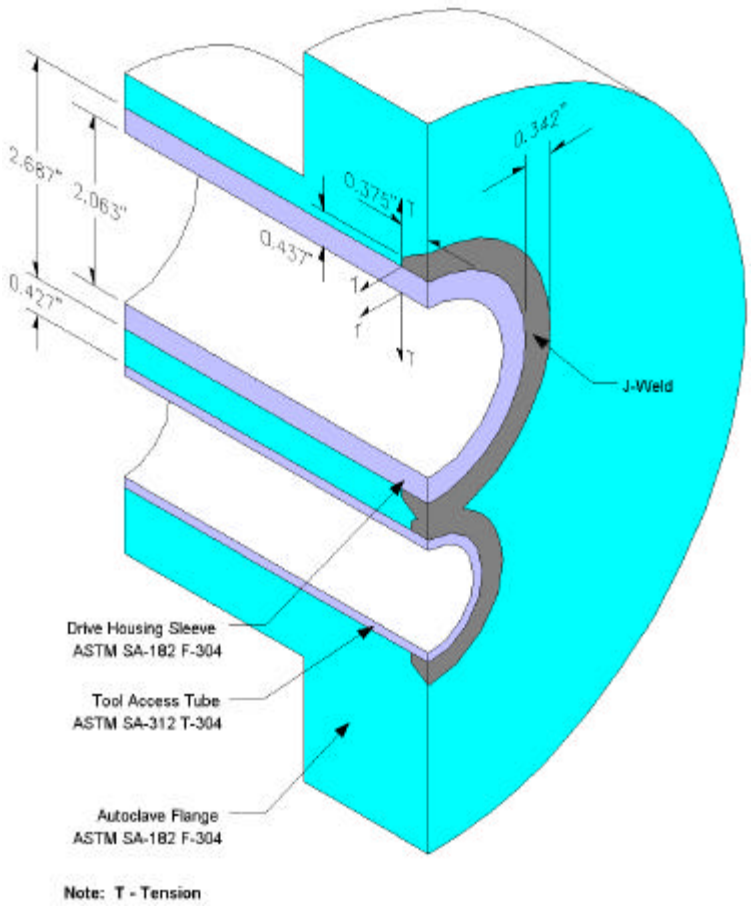
CEDM - Seal Housing Assembly



- Weld Induced Shrinkage

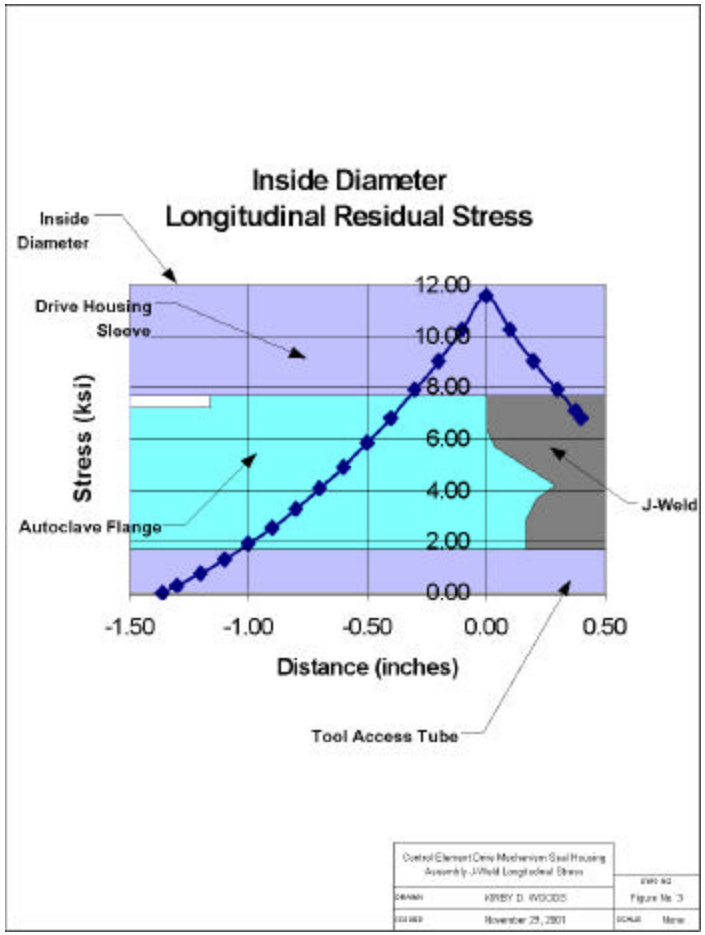
CEDM - Seal Housing Assembly

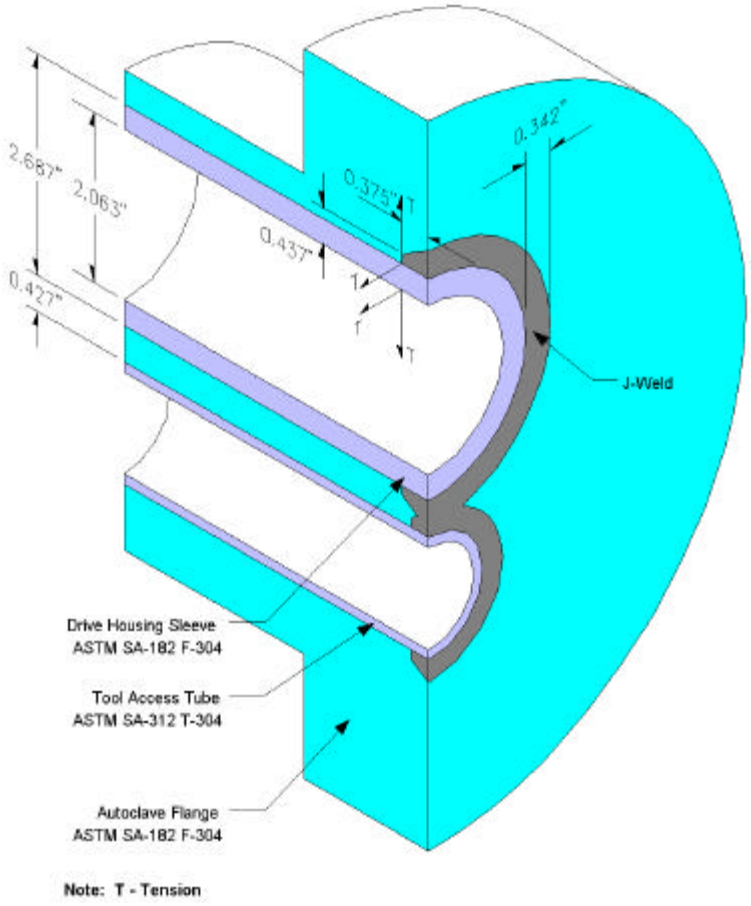




- Longitudinal Driver

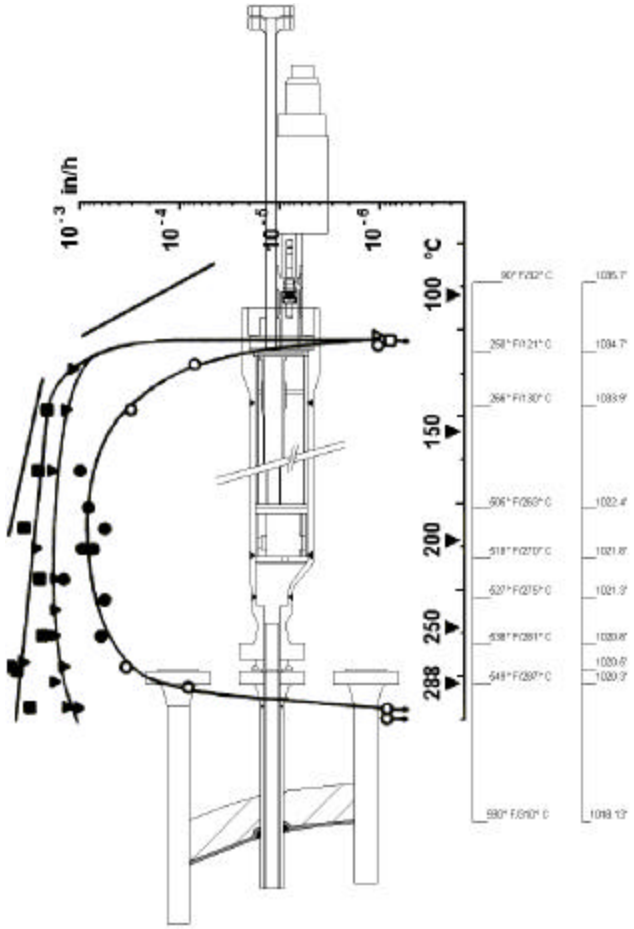
CEDM - Seal Housing Assembly

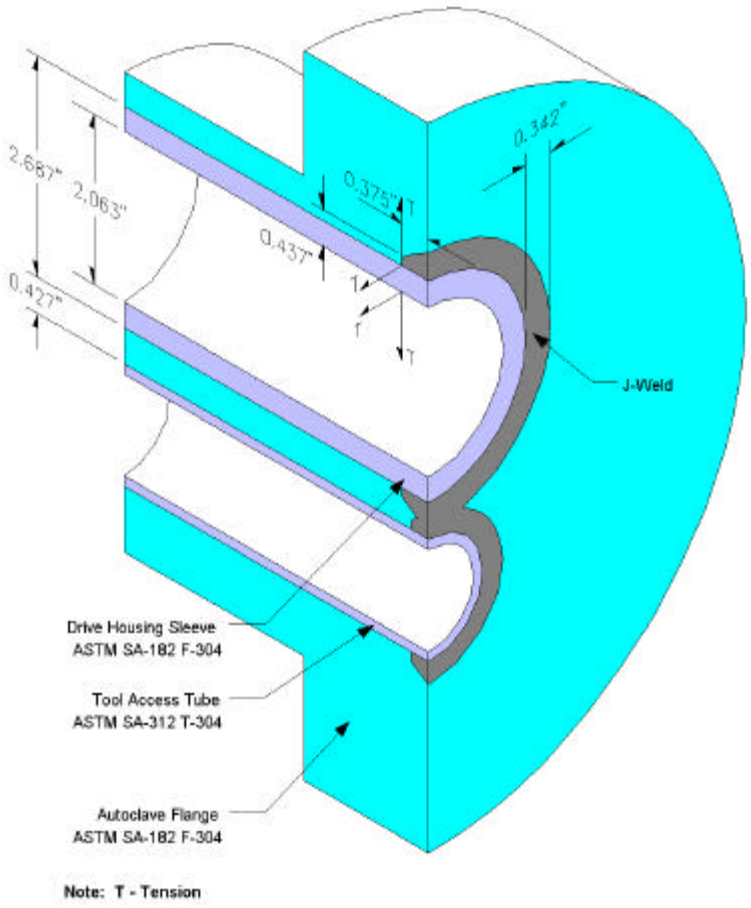




- Circumferential Driver

CEDM - Seal Housing Assembly

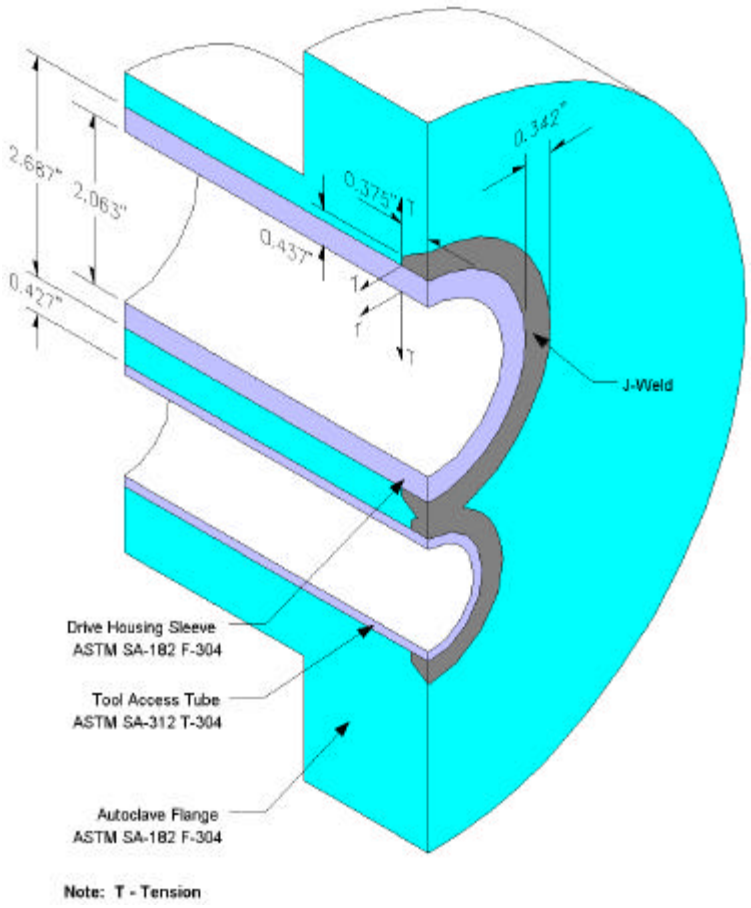




- Temperature Relationship

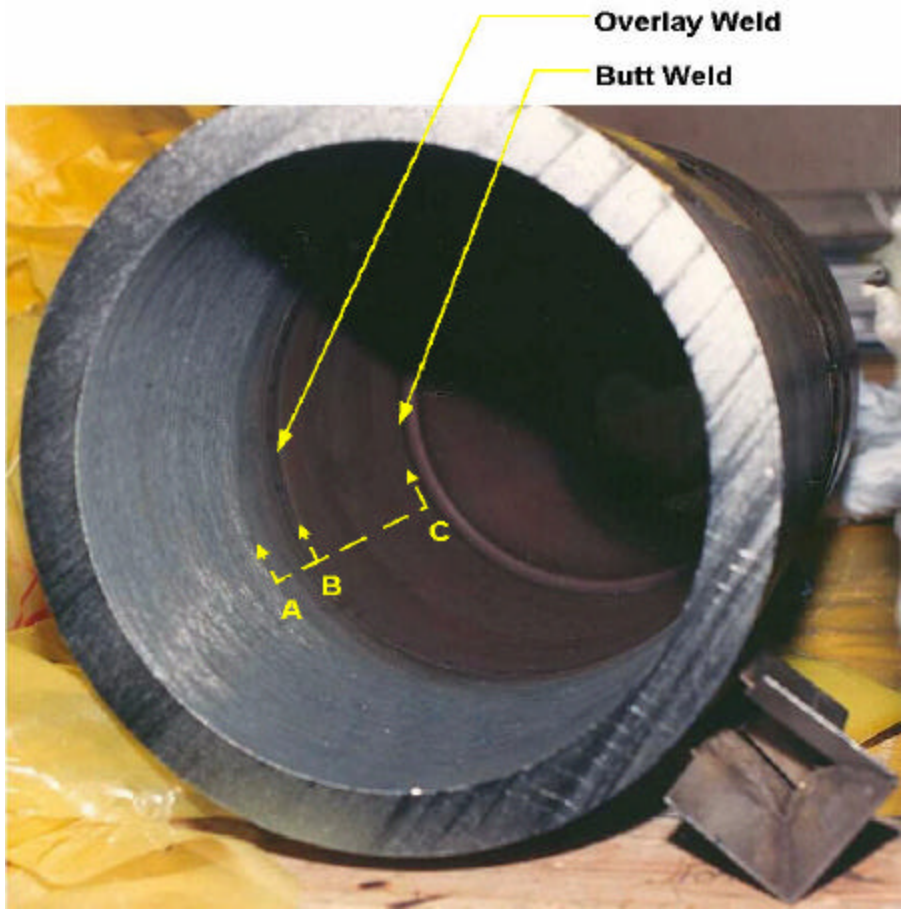
CEDM - Seal Housing Assembly

- Interpretation
  - Residual Stress
    - J-groove weld
    - Transverse shrinkage
      - Axial stress
      - Hoop stress
  - Temperature
    - ~250º F/121 º C
      - Palisades experience
    - Inverted Bath Tub Curve
- High Susceptibility



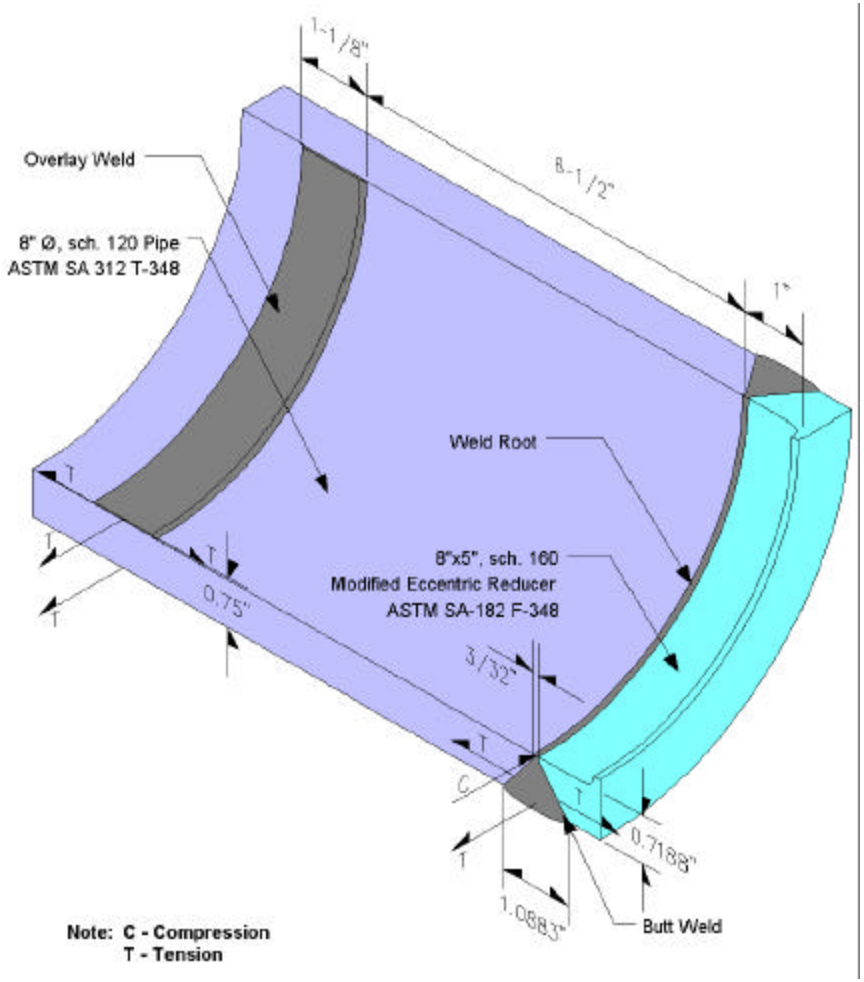
CEDM - Upper Housing Assembly

- Through-wall Crack 1990
  - non-vented housing
    - RC-10-9 & 13 Spare
    - 100% stagnant
    - Line ‘B’ showing maximum level of stagnancy
  - Source of Tensile Stress
    - Overlay Weld
- **-WORST CASE-**

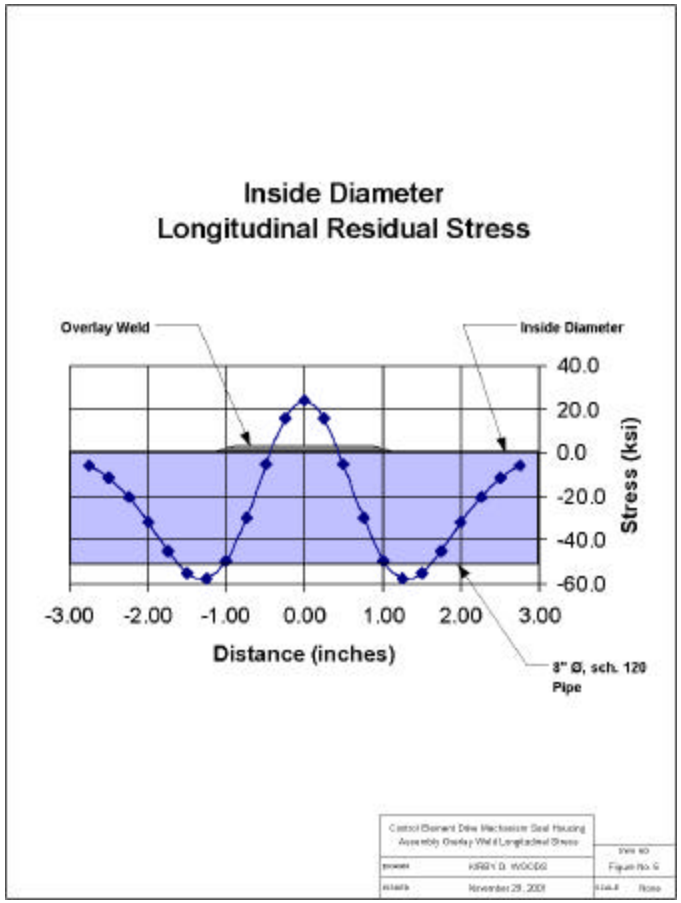


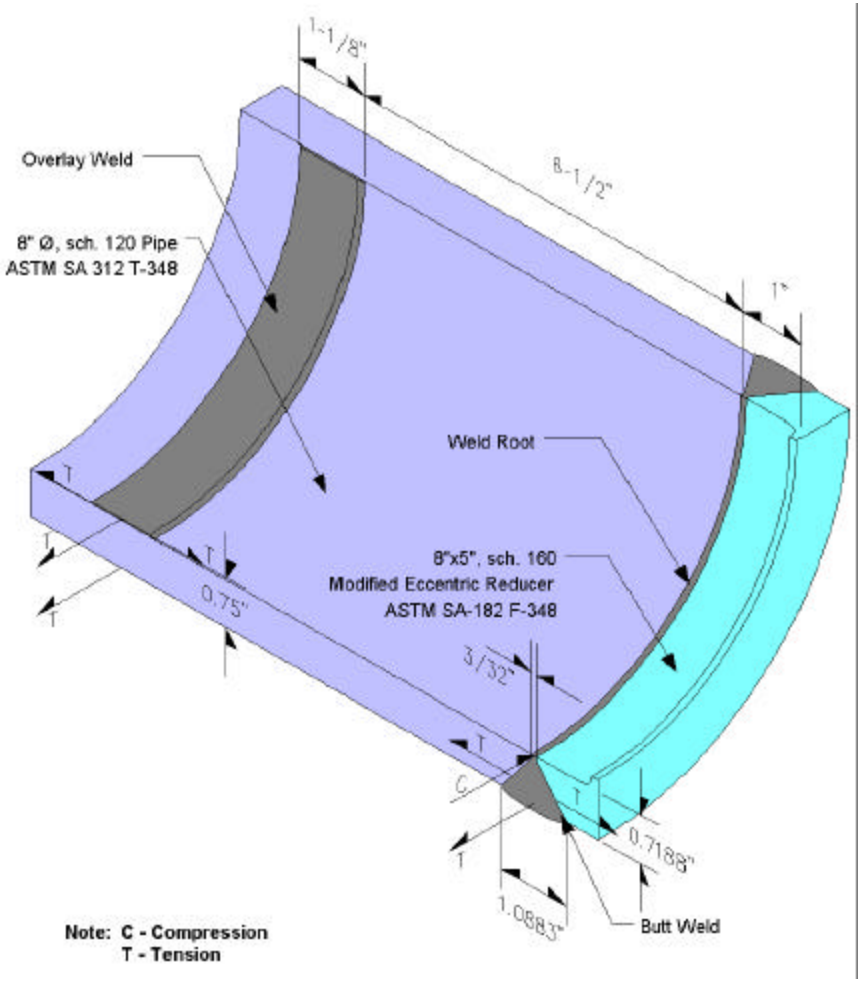
CEDM - Upper Housing Assembly

- Interpretation
  - Residual Stress
    - Overlay weld
    - Double v-groove weld
      - Weld pass
        - » jacketed
  - Temperature
    - ~505ºF/263ºC
      - FCS experience
      - ~50 ºF delta



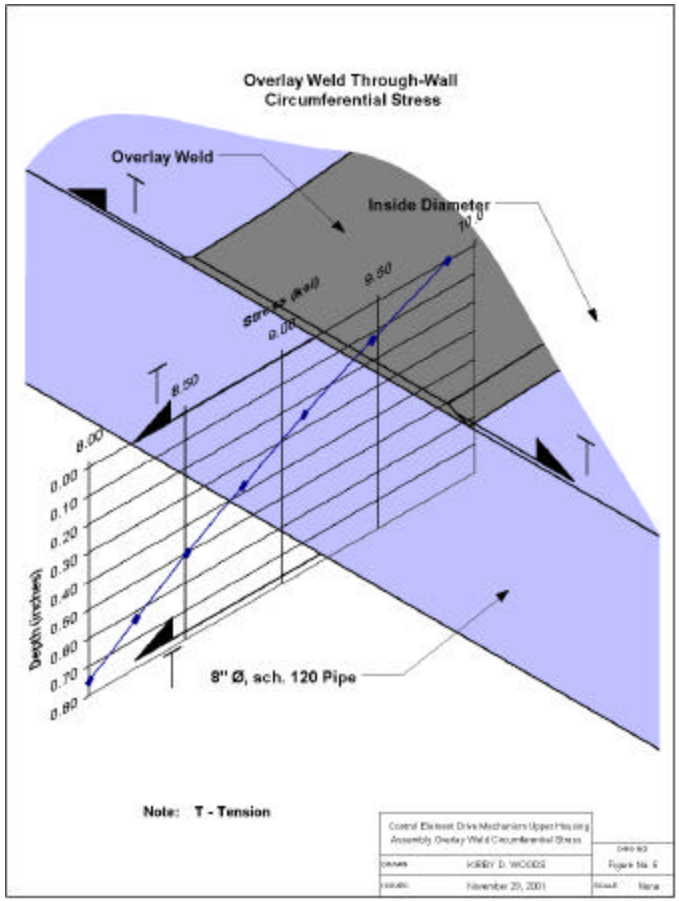
CEDM - Upper Housing Assembly

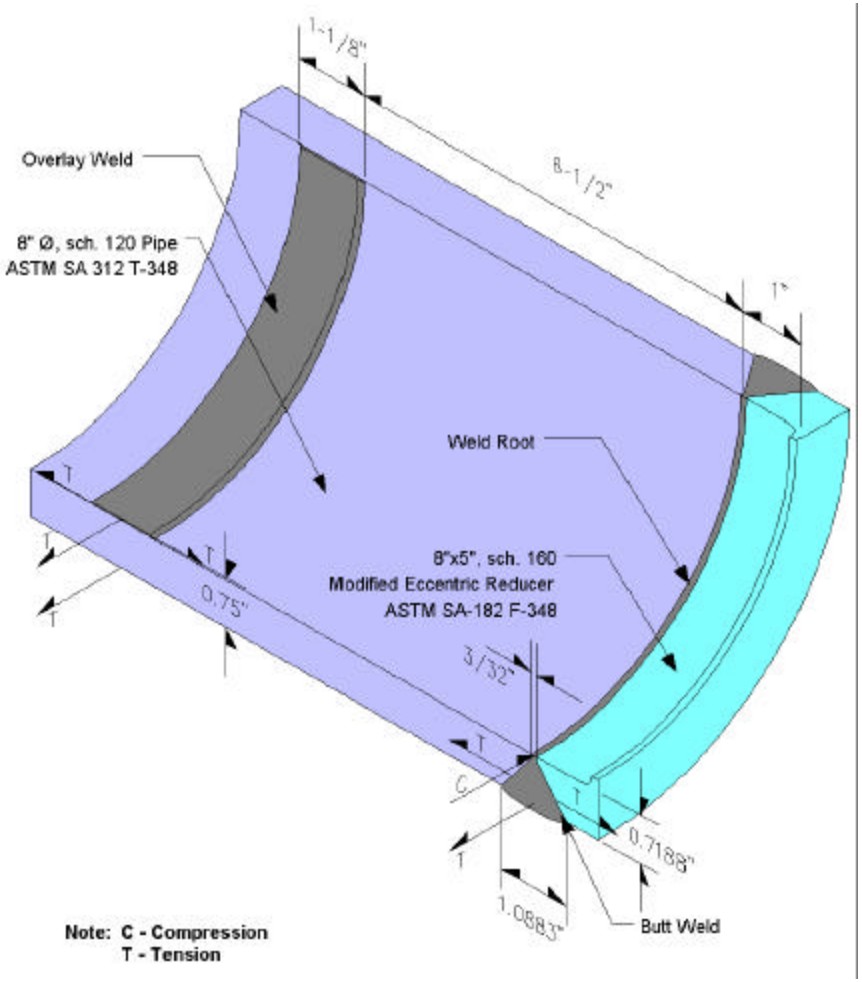




- Circumferential Driver

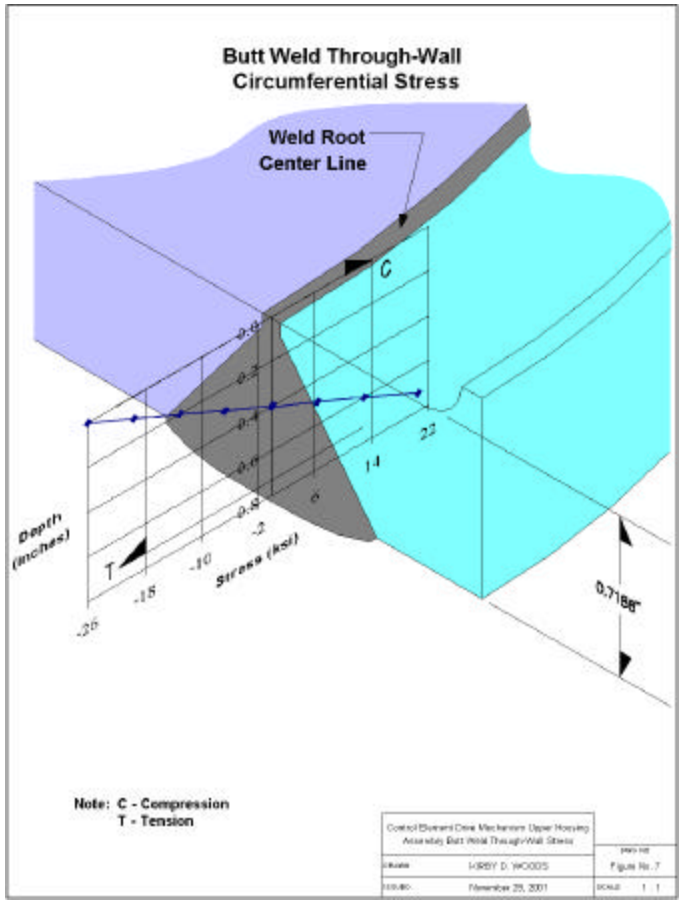
CEDM - Upper Housing Assembly

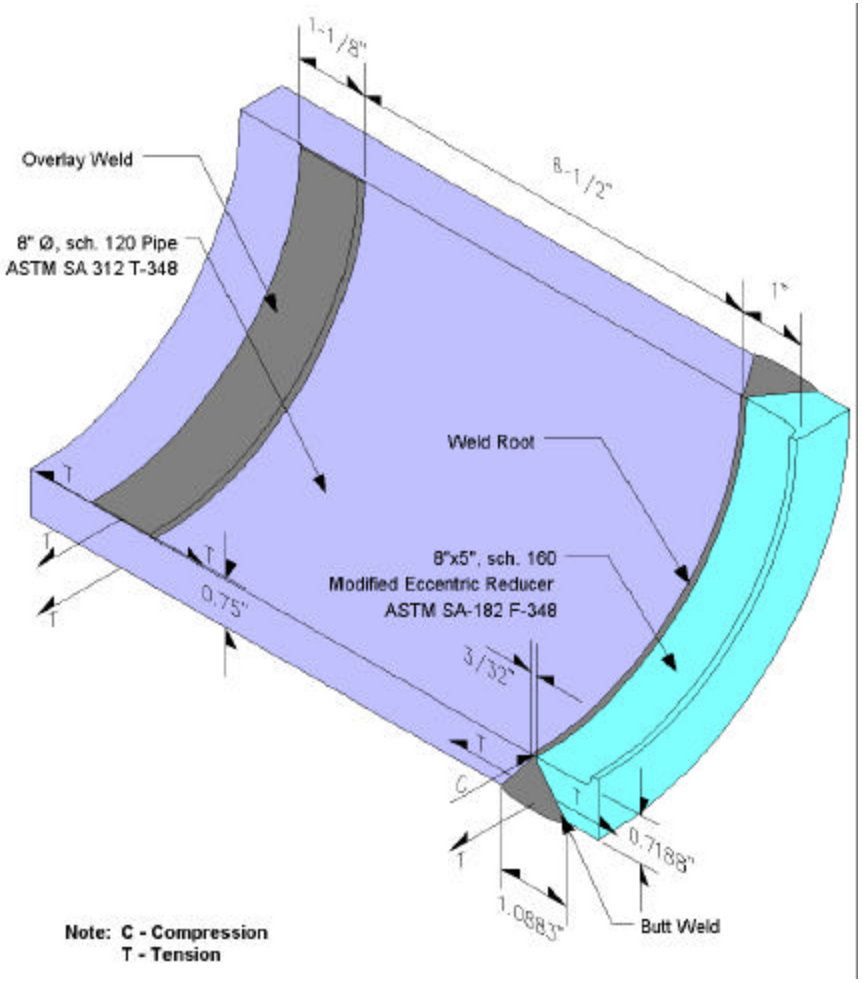




- Longitudinal Driver

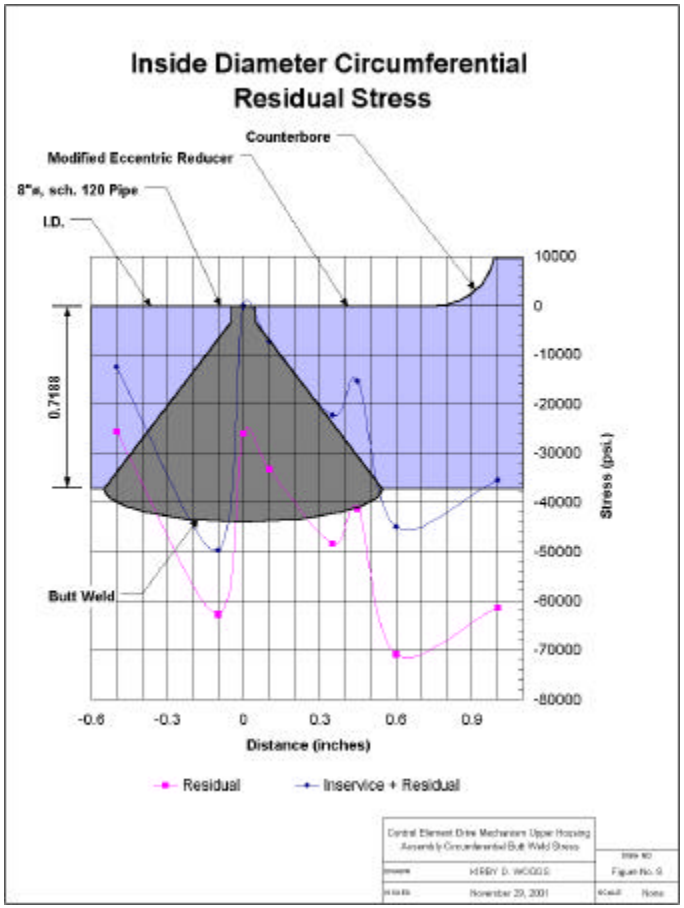
CEDM - Upper Housing Assembly

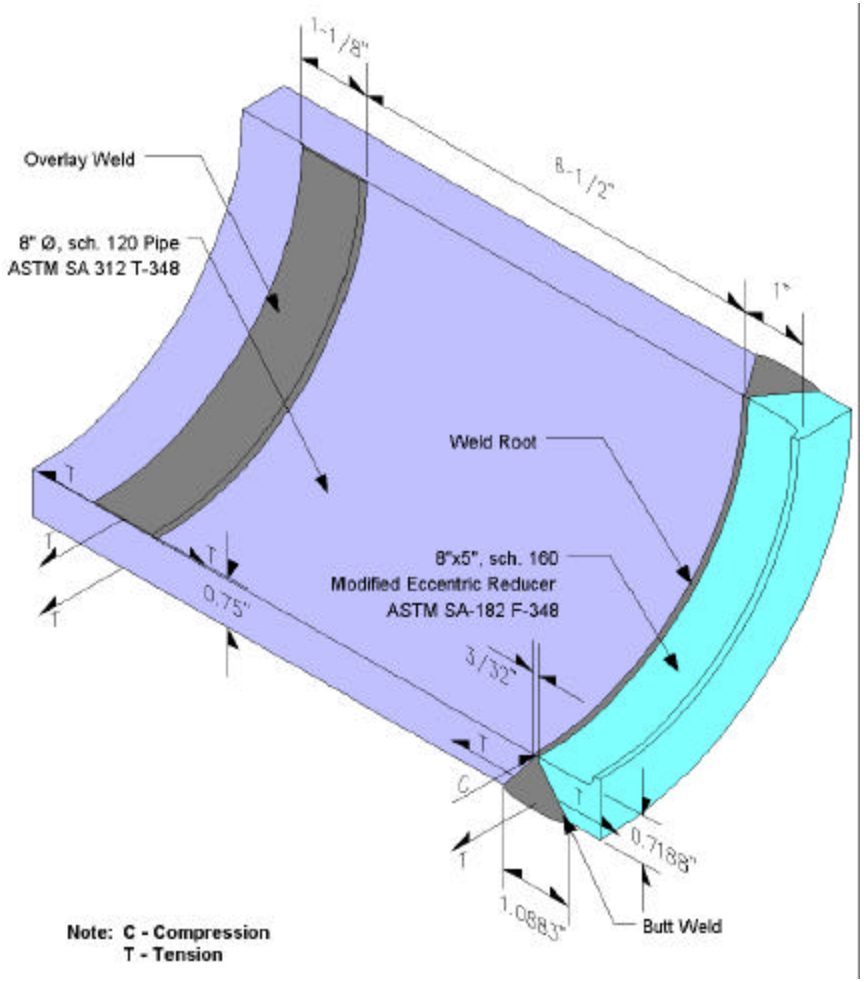




- Through-Wall Affect

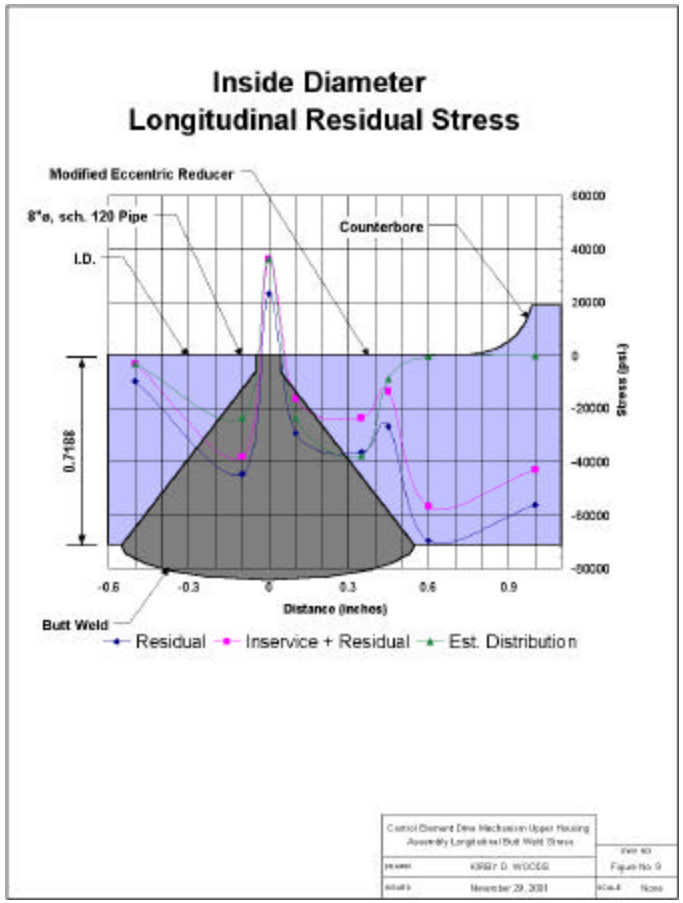
CEDM - Upper Housing Assembly

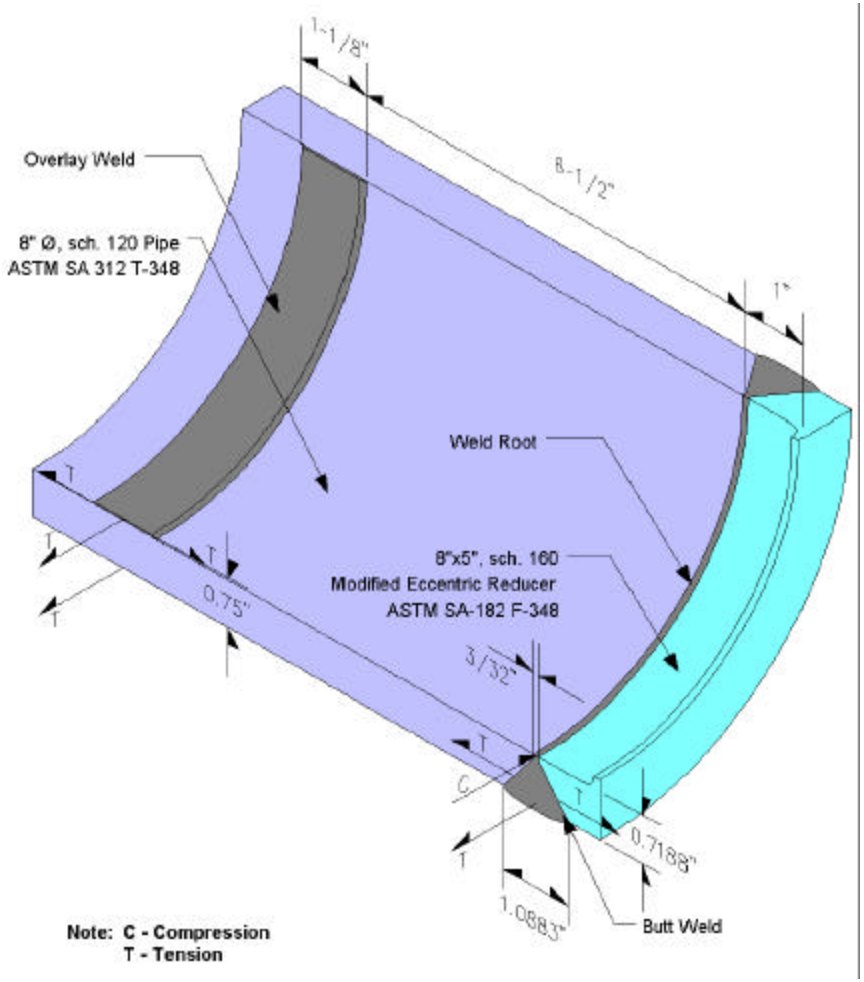




- Longitudinal Driver

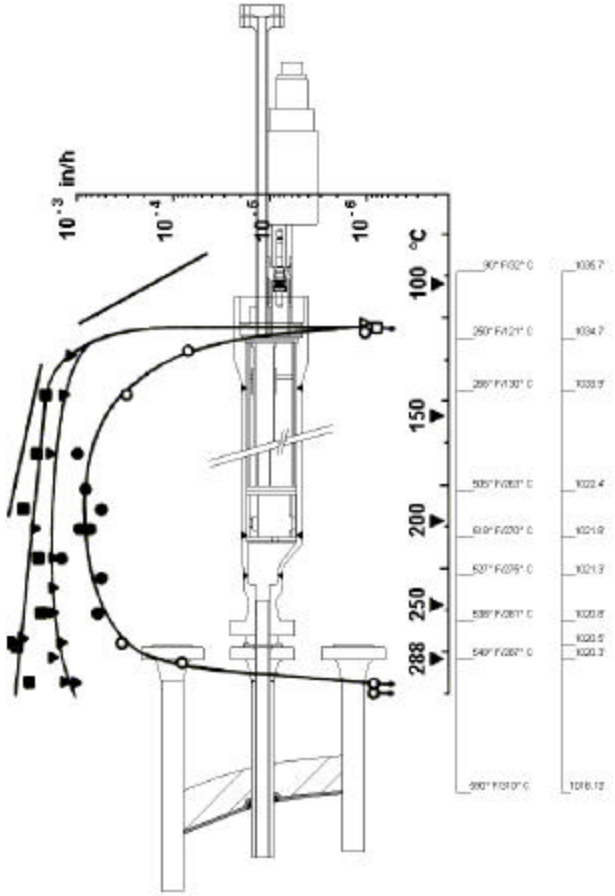
CEDM - Upper Housing Assembly

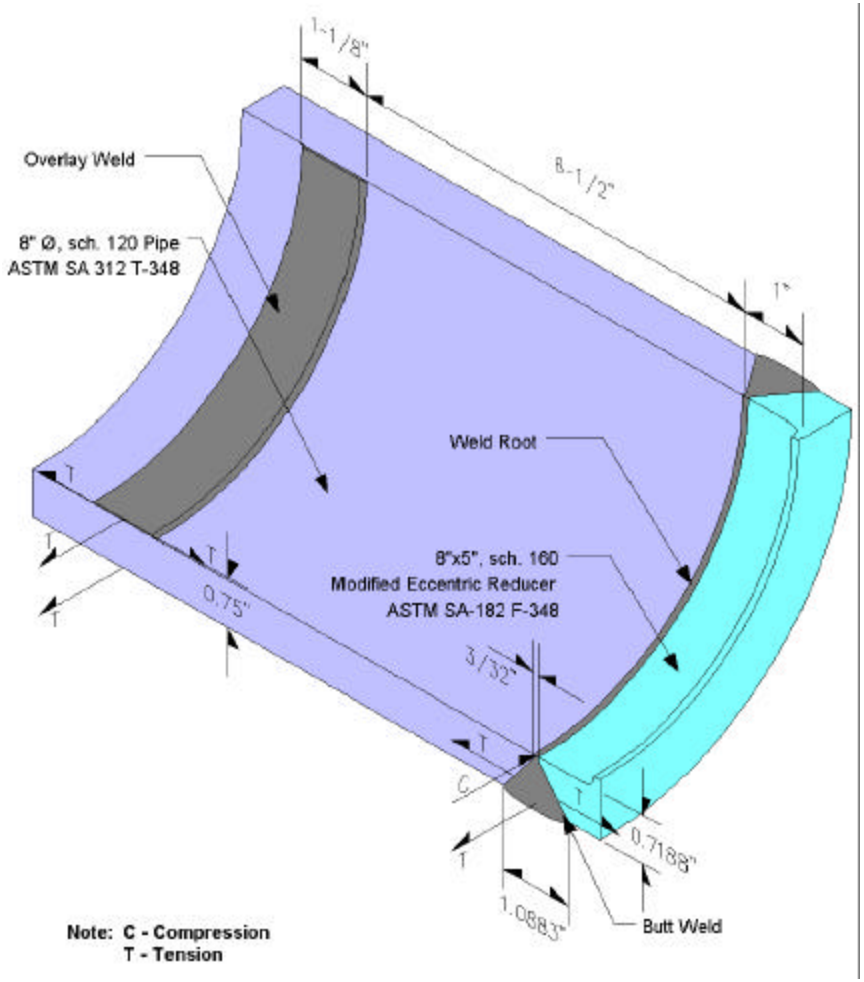




- Circumferential Driver

CEDM - Upper Housing Assembly

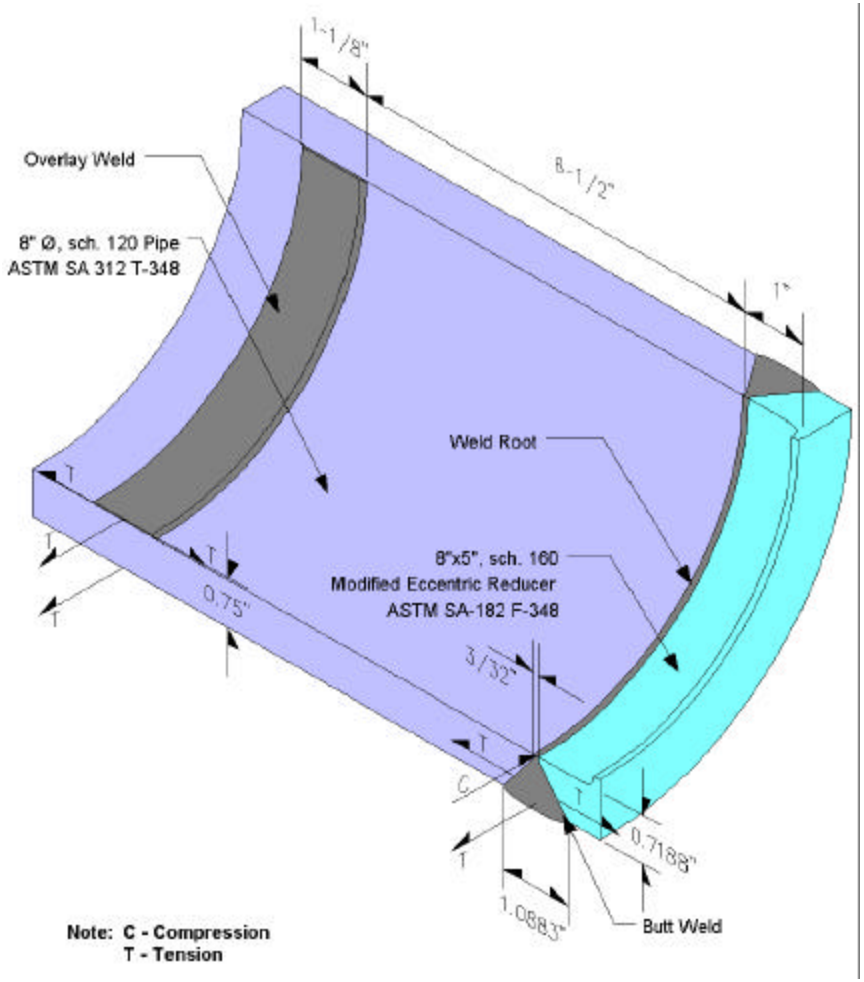




- Temperature Relationship

CEDM - Upper Housing Assembly

- Interpretation
  - Residual Stress
    - Overlay weld
    - Double v-groove weld
      - Weld pass
        - » jacketed
  - Temperature
    - ~505ºF/263ºC
      - FCS experience
      - ~50 ºF delta
- Medium/Low Susceptibility

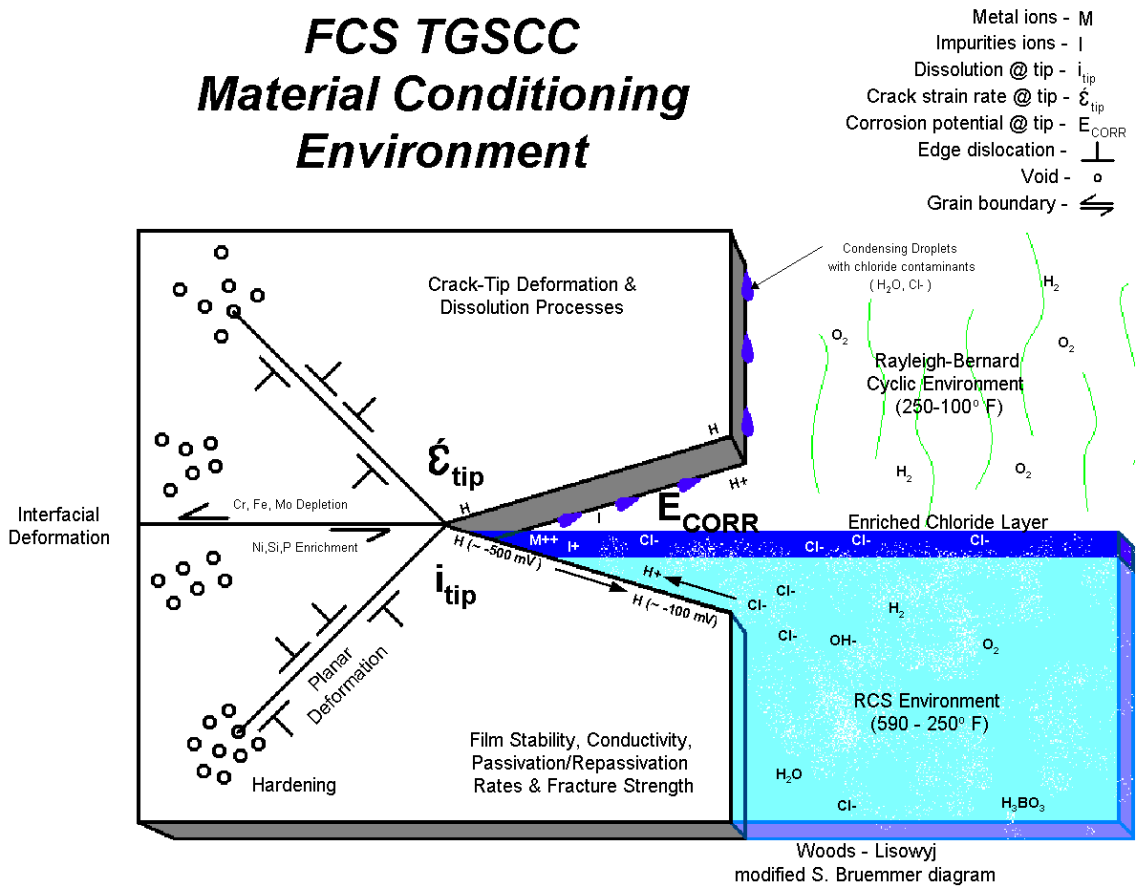


Bob Lisowyj - Senior Nuclear Design Engineer

CEDM Housing Materials Characterization Discussion

Program Plan

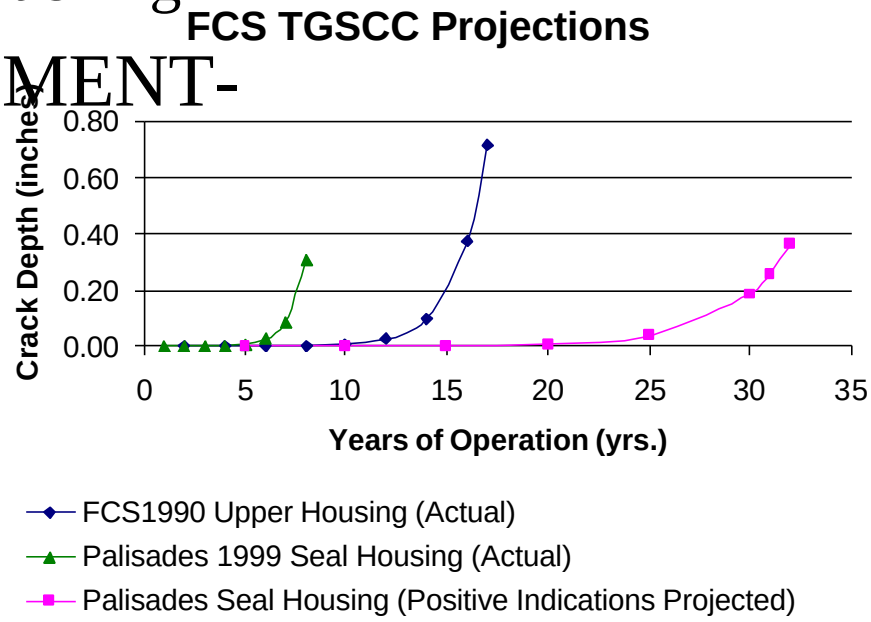
- Predictive
  - Crack Model
  - Environmental Model
- Plan
  - Inspection Criteria
  - Remediation
  - Repair
- **- INNOVATIVE-**



Predictive Crack Model

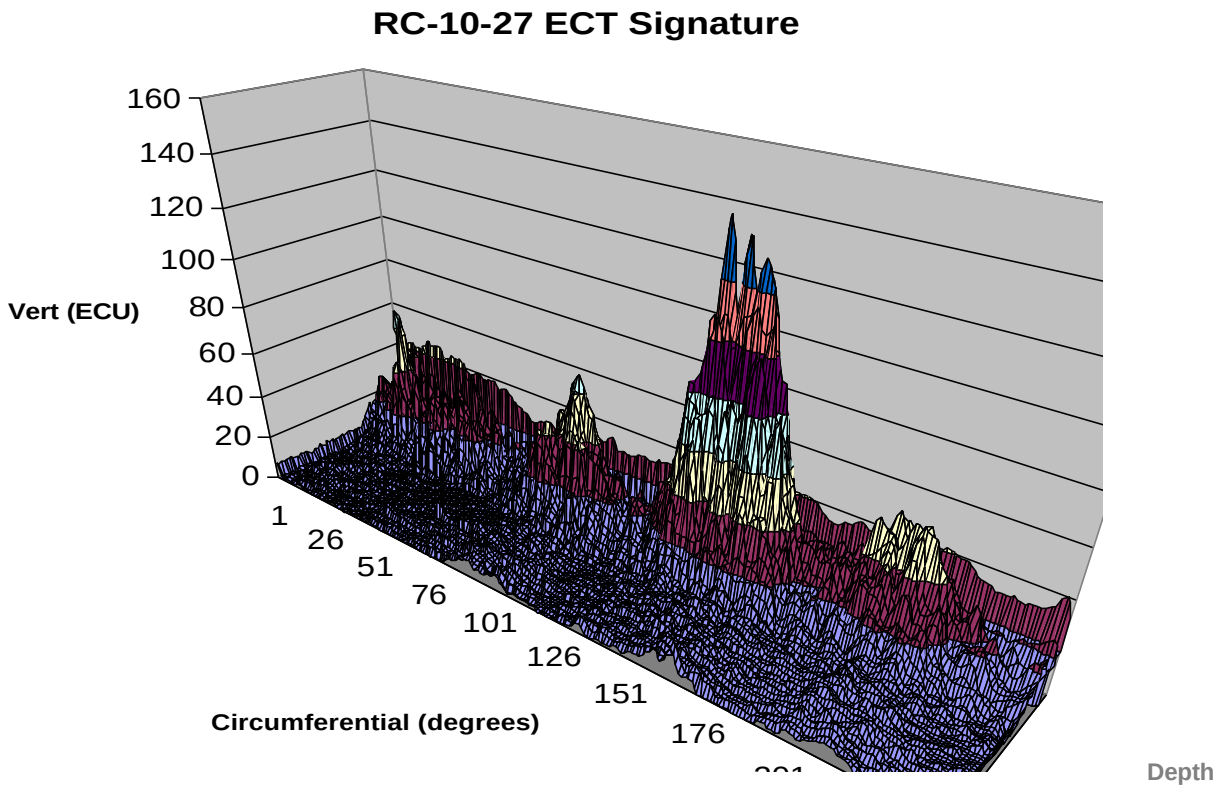
- Palisades and FCS Weibull Curves
  - Material difference Type 304 versus Type 347
- FCS Upper Housing Beachmarks
  - 10 yrs incubation & 7 yrs cracking
- -ANALYTICAL ASSESSMENT-

FCS Weld Overlay Failure



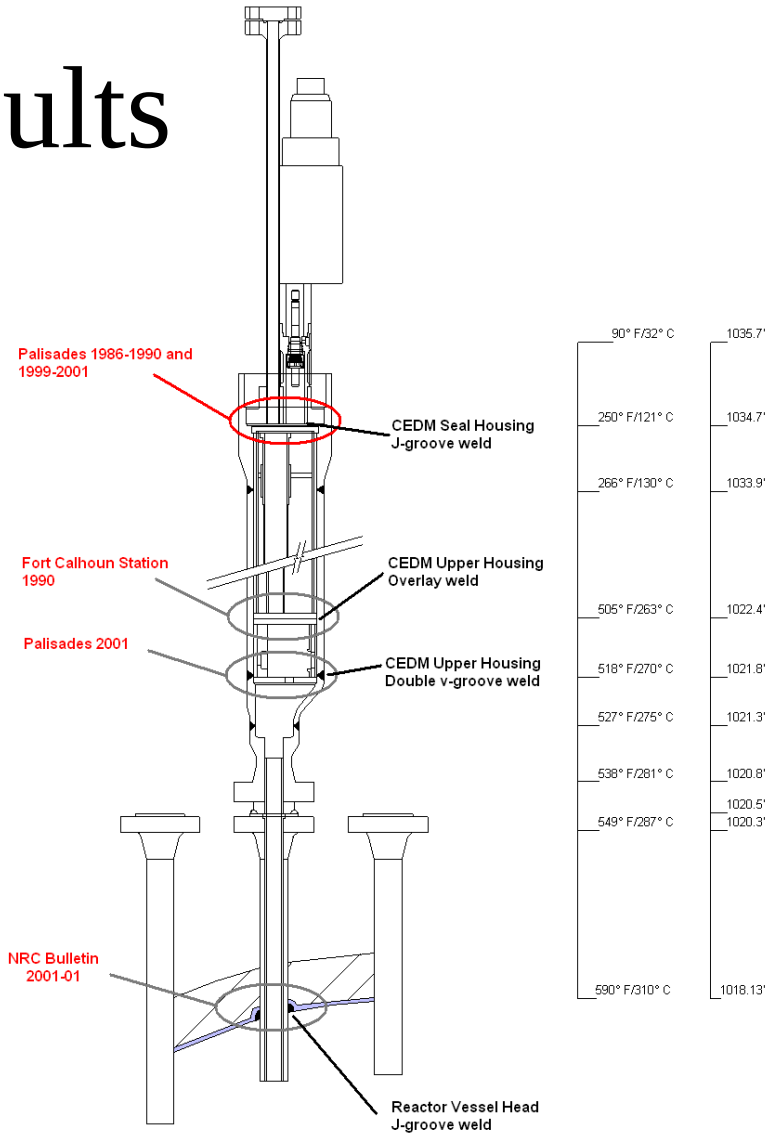
FCS 1999 RFO Signature

- CEDM Seal Hou[illegible]
  ECT Reported
  - Six of Eight Ins
  - Permeability Cl
- FCS and Palisad
  - Similar
    - Geometry
    - Signatures
- Assessment
  - Possible SCC History
- -INSPECTION DATA-

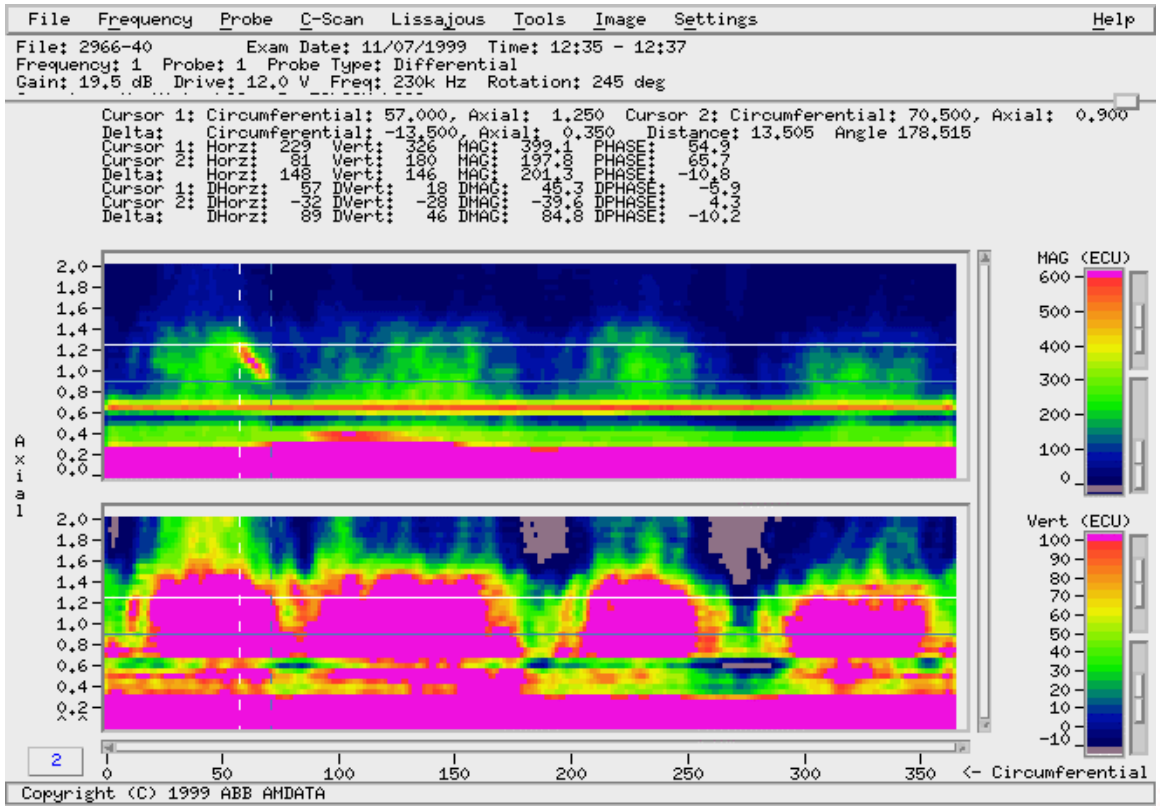


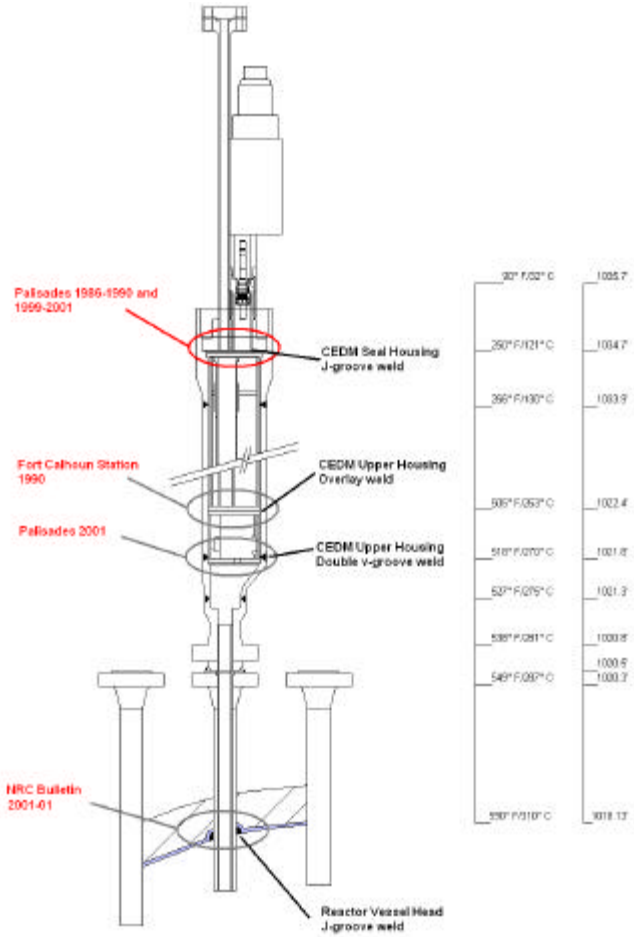
ECT Inspection Results

- Palisades ECT sample
  - Positive Signatures
    - Cracks
    - Permeability Areas
- FCS 1999 ECT examination
  - Positive Signatures
    - Permeability Areas



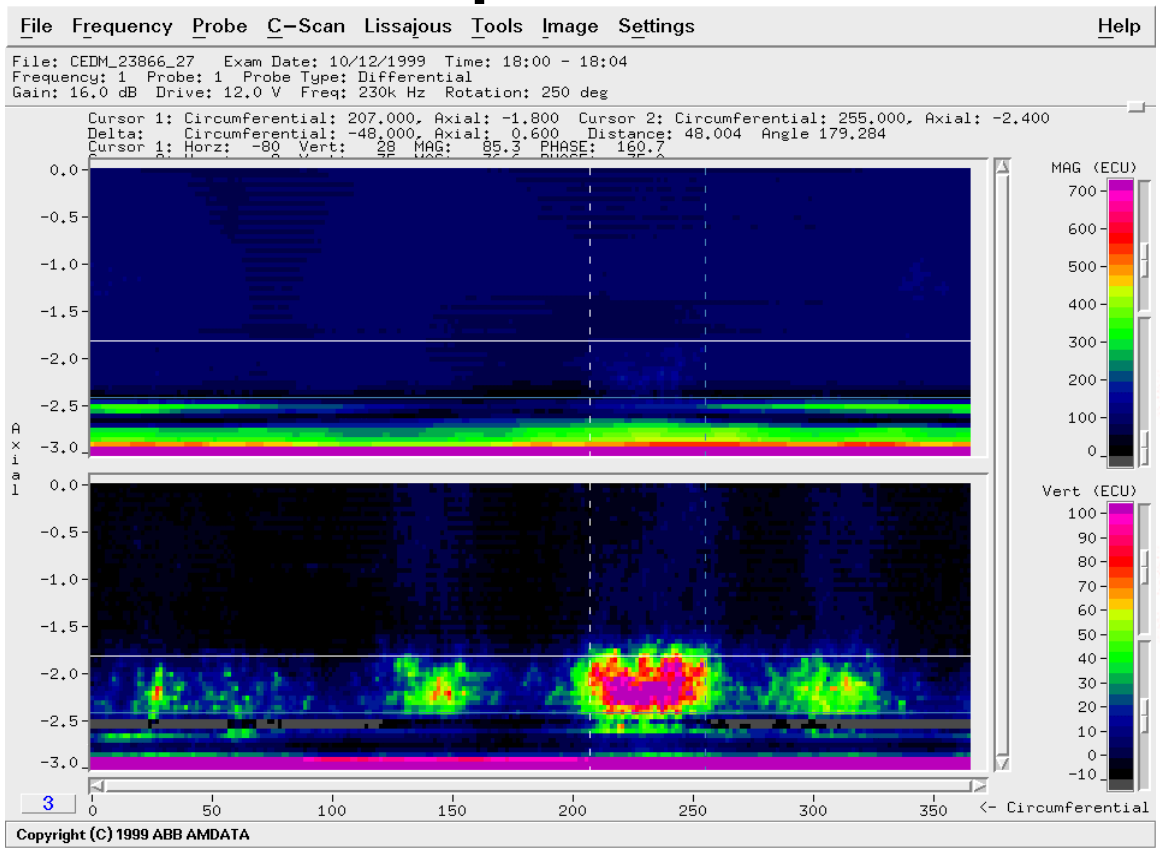
ECT Inspection Results

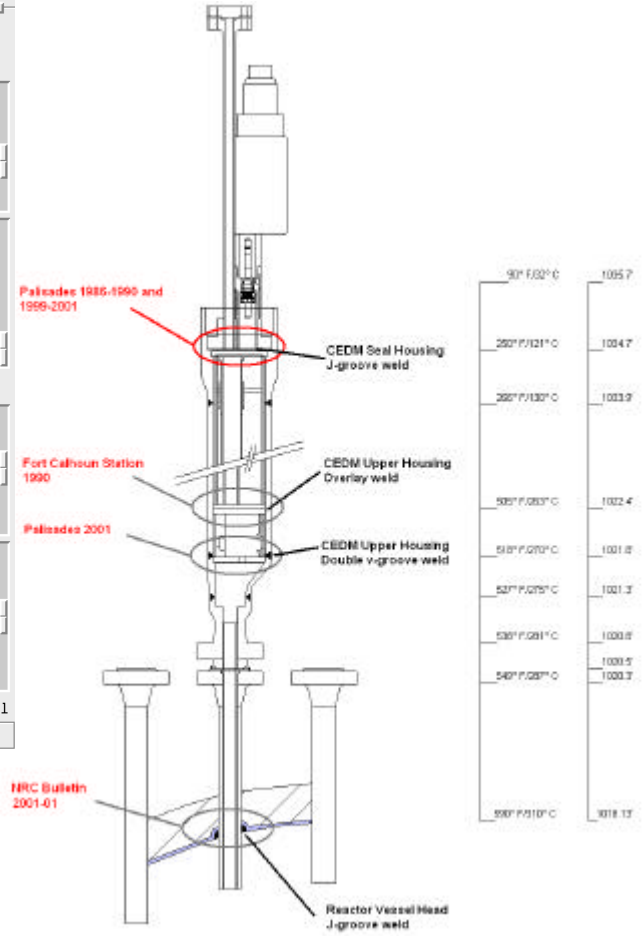




- -Palisades-

ECT Inspection Results

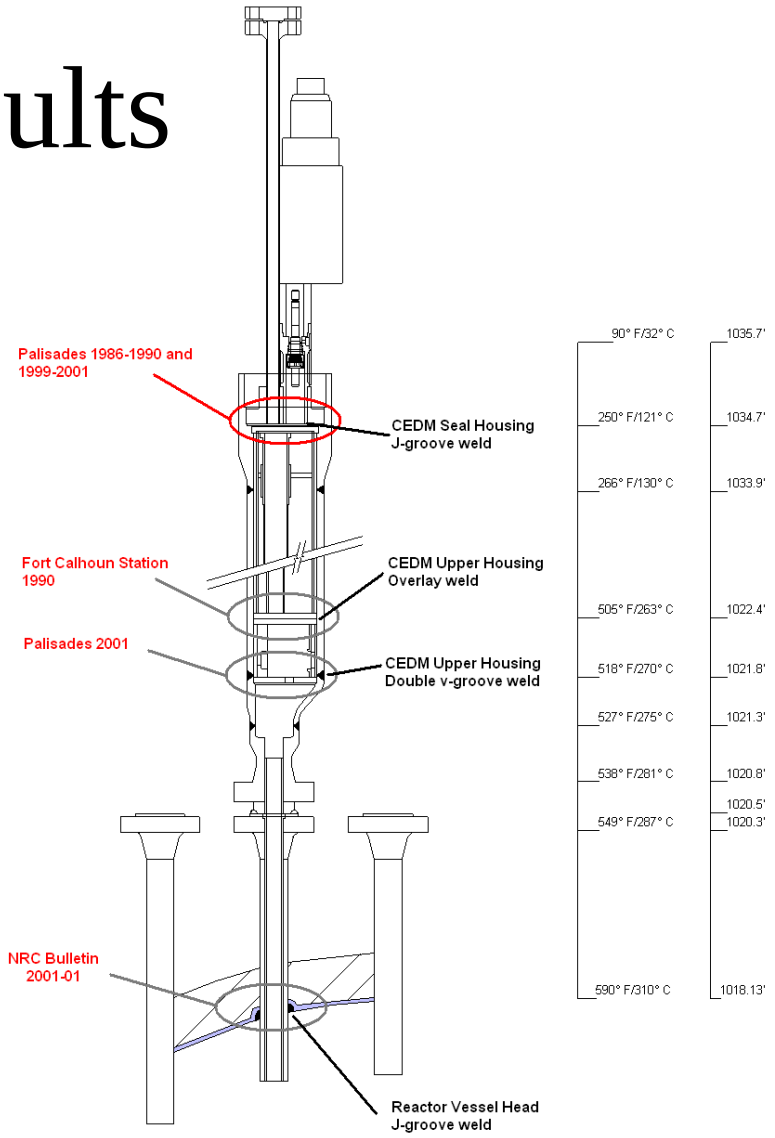




- -FCS's Difference-

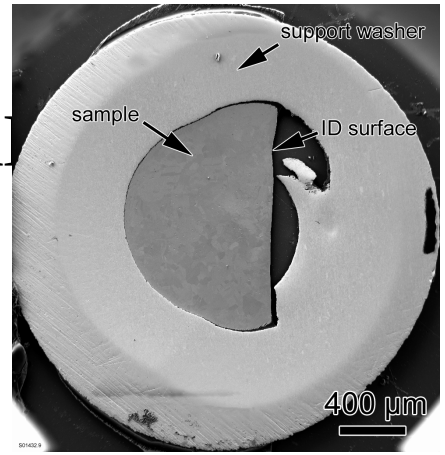
ECT Inspection Results

- Palisades ECT sample
  - Positive Signatures
    - Cracks
    - Permeability Areas
- FCS 1999 ECT examination
  - Positive Signatures
    - Permeability Areas
- -QUESTIONING-

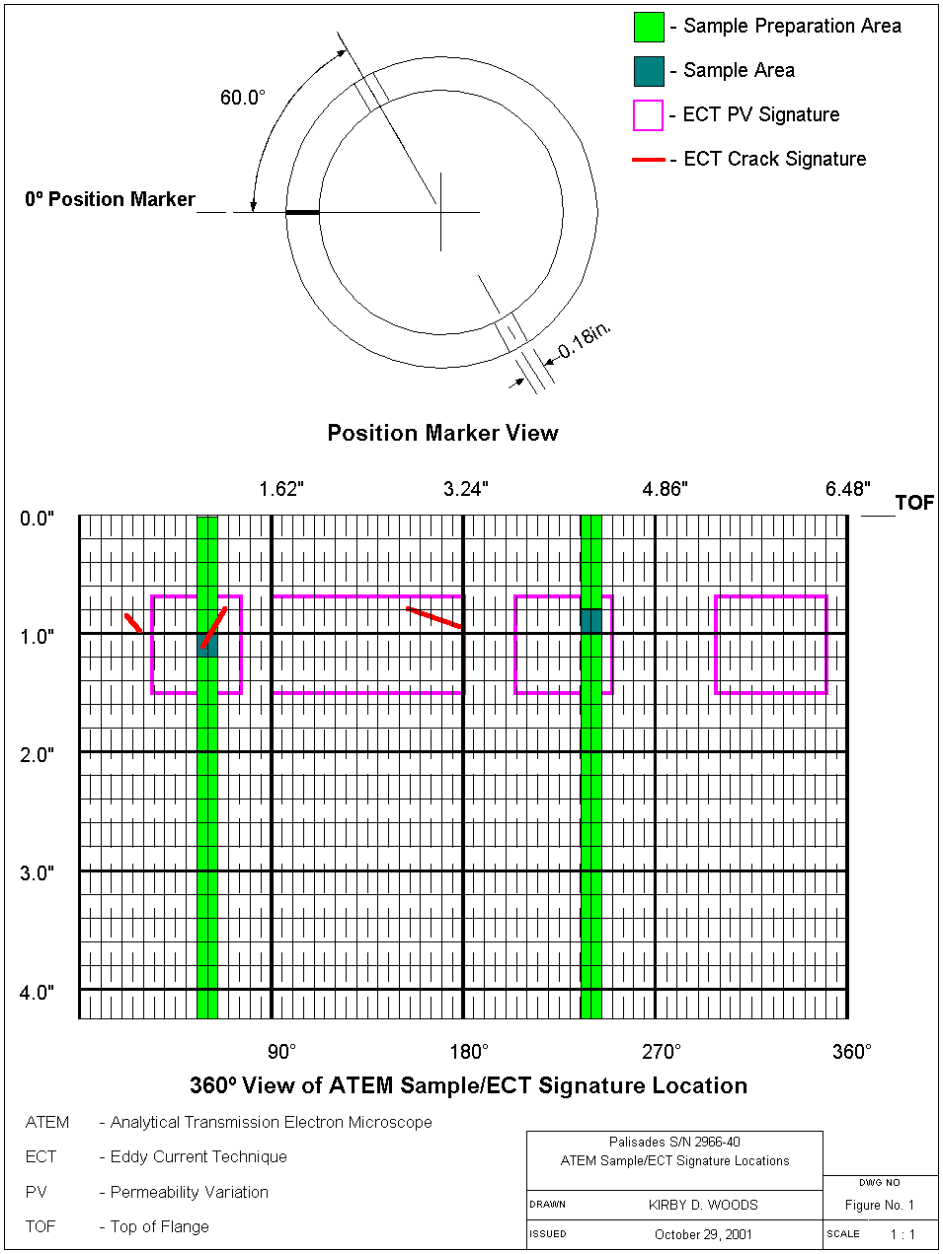


Sample

- EPRI assistance
- Validation of ECT technique
- Drive Housing Sleeve preparation for ATEM

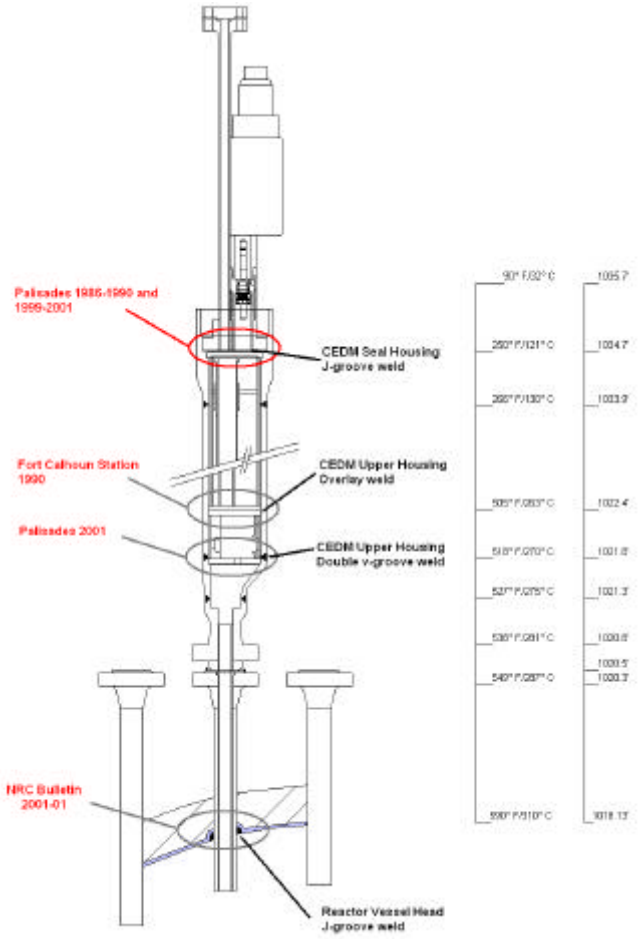


Palisades Drive Housing Sleeve

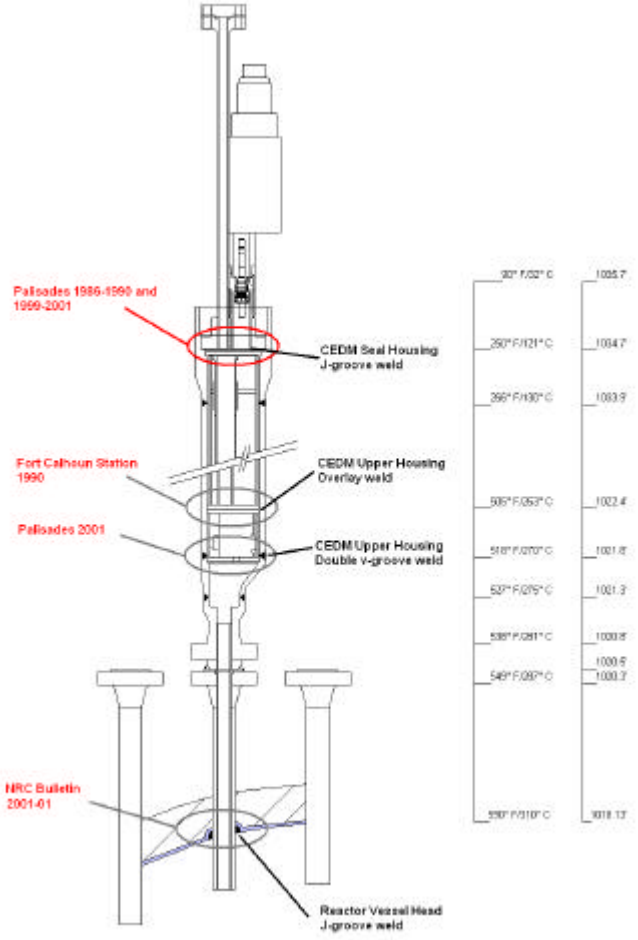


Pacific Northwest Division (Battelle)

- Palisades Sample
  - Seal housing
    - SA312 F304
  - Scanning Electron Microscope
    - Transgranular
      - Small Branching
    - 0.095” deep
  - Energy Dispersive Spectroscope
    - Cl & S contaminants
    - Fe,Cr & Ni oxides

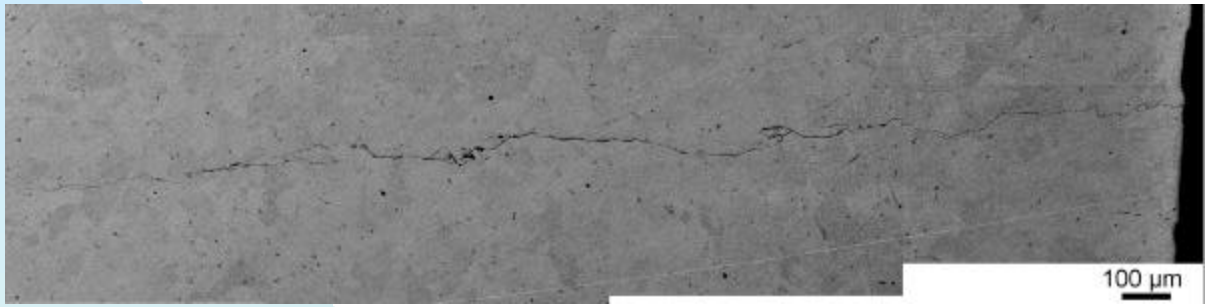


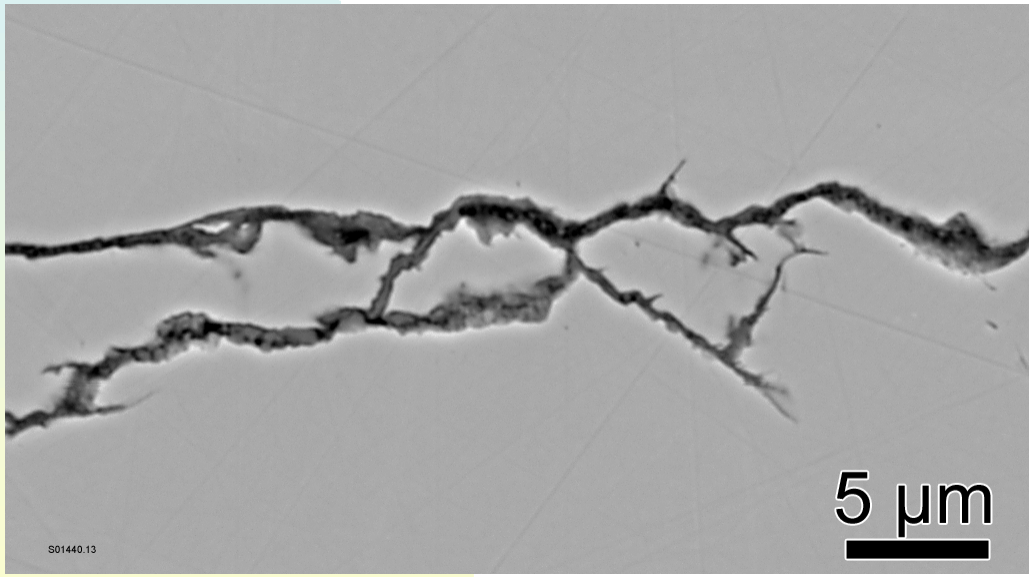
Pacific Northwest Division (Battelle)

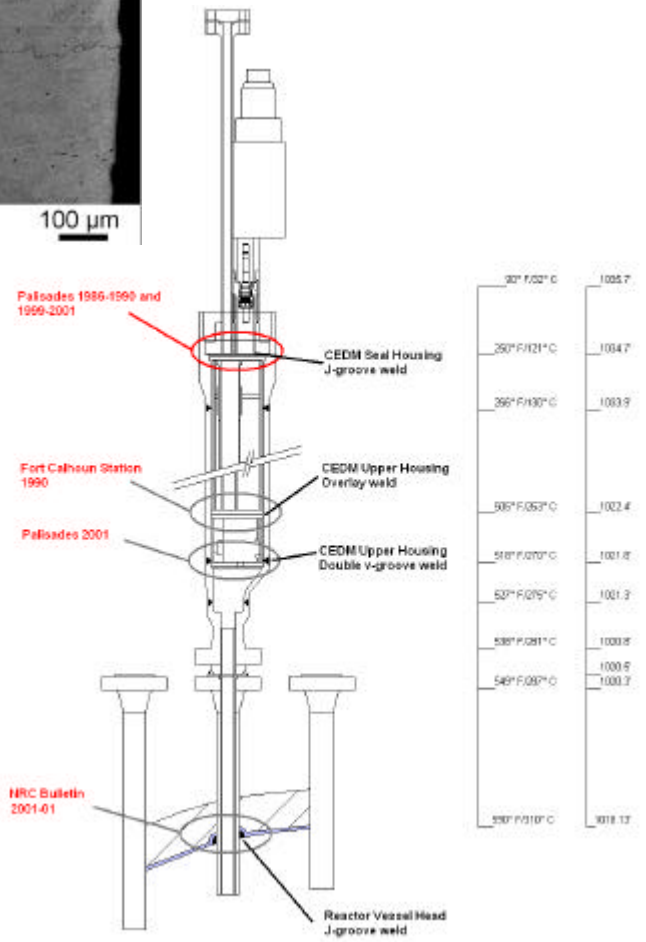


- Palisades active housing

Pacific Northwest Division (Battelle)



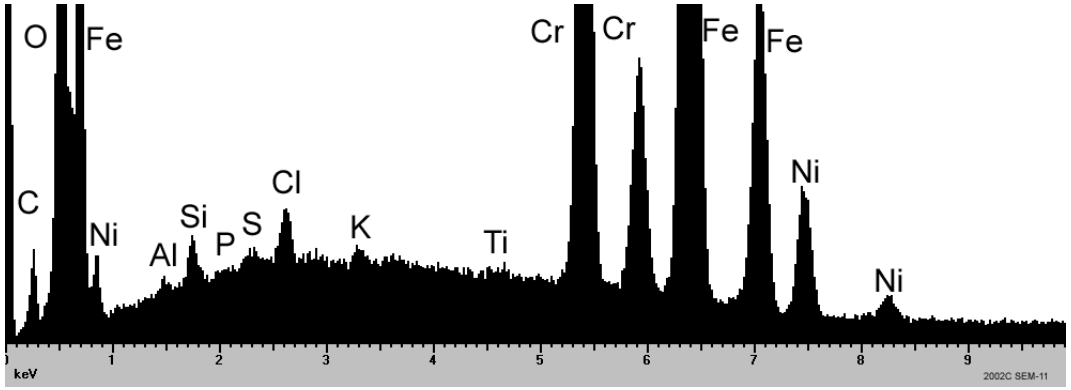


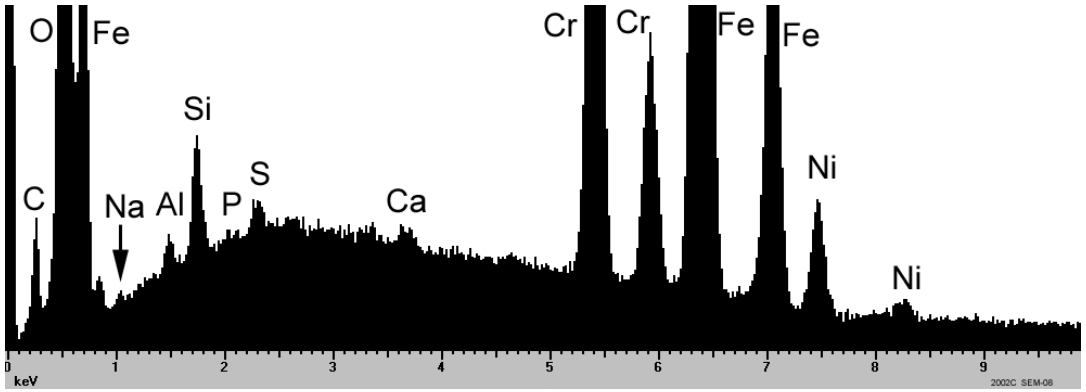


- Palisades active housing

Pacific Northwest Division (Battelle)

- SEM/EDS Analyses
  - Impurities
    - Na, Al, Si, Ca, K and Cl in spots
  - Oxides
    - Si, S and Cl near crack tip





- Palisades active housing

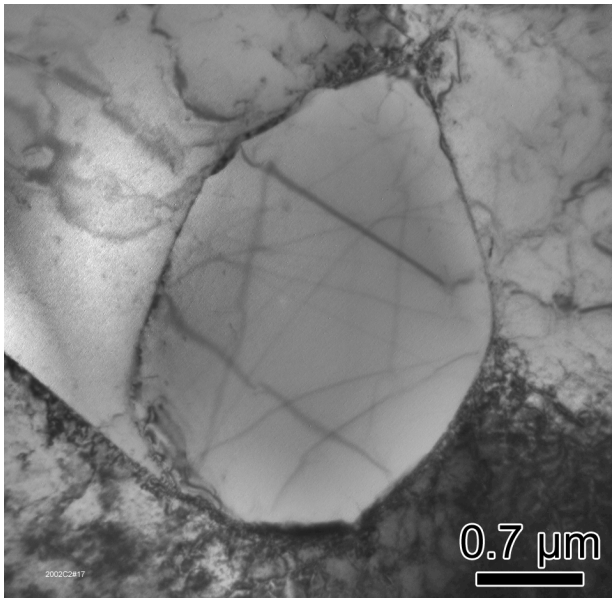
Pacific Northwest Division (Battelle)

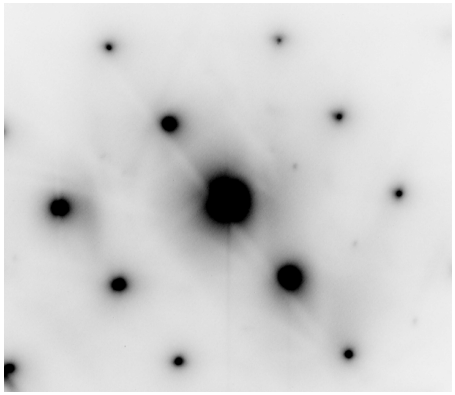
- TEM/EDS Analyses
  - 3 to 5 µm particles identified
  - Delta ferrite pattern
    - Observation

EDS Analyses: wt.%

	Si	Cr	Mn	Fe	Ni
matrix:	0.6	20.2	2	bal.	9.2
ferrite:	0.5	28.4	1.6	bal.	4.8

- Palisades active housing





011 Plane