From: Case, Michael
To: Lorette, Phillip
Subject: FW: NRC-DR-04-08-147 - PBIAS Project - MLSR for Feb 2011
Date: Tuesday, March 15, 2011 10:25:00 AM
Attachments: Attachment 1 - ASME Reorganization WG-PP-Materials.pdf
Attachment 2 - Emc2 Presentation - Thermal Gradient Stresses - TG-Design 2-11.pdf
Attachment 3 - Emc2 Presentation - EPRI PE Pipe Data Analysis DRAFT.pdf
Attachment 4 - Charter - Joint BPV III SG-ETD and Section XI Task Group.pdf
Feb11 MLSR-BPA - PBIAS -FINAL.pdf
Feb 11 MLSR BPA -PBIAS -Cover Letter.pdf

Please print if it's not the same as that last one.

From: RESDEMLSR Resource [mailto:RESDEMLSR.Resource@nrc.gov]
Sent: Tuesday, March 15, 2011 12:13 AM
To: Case, Michael; Hurd, Sapna; Richards, Stuart
Subject: FW: NRC-DR-04-08-147 - PBIAS Project - MLSR for Feb 2011

From: Prabhat Krishnaswamy[SMTP:KSWAMY@EMC-SQ.COM]
Sent: Monday, March 14, 2011 5:42:07 PM
To: Focht, Eric
Cc: Bud Brust; Yunior Hioe; Sureshkumar Kalyanam; Gery Wilkowski; Do Jun Shim; Gary Hattery; KeithWich; Elizabeth Kurth; Tao Zhang; Mo Uddin; Bob Kurth; Gunter-Henderson, Morie; Basavaraju, Chakrapani; Rudland, David; Naujock, Don; RESDEMLSR Resource; Prabhat Krishnaswamy
Subject: NRC-DR-04-08-147 - PBIAS Project - MLSR for Feb 2011
Auto forwarded by a Rule

<<Attachment 1 - ASME Reorganization WG-PP-Materials.pdf>> <<Attachment 2 - Emc2 Presentation - Thermal Gradient Stresses - TG-Design 2-11.pdf>> <<Attachment 3 - Emc2 Presentation - EPRI PE Pipe Data Analysis DRAFT.pdf>> <<Attachment 4 - Charter - Joint BPV III SG-ETD and Section XI Task Group.pdf>> <<Feb11 MLSR-BPA - PBIAS -FINAL.pdf>> <<Feb 11 MLSR BPA -PBIAS -Cover Letter.pdf>>

Dear Eric,

The Monthly Letter Status Report (MLSR) for February January 2011 on the above Blanket Purchase Agreement (BPA) PBIAS contract is attached. There are six files – a Cover Letter, the MLSR and four attachments. Please confirm receipt.

As required, this Email is also being copied to - RESDEMLSR.resource.nrc.gov.

Please call me if you have questions.

Prabhat

AS/79

Dr. Prabhat Krishnaswamy
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Columbus, OH 43221-1735
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Fax: 614-459-6800
E-mail: kswamy@emc-sq.com

NRC MEETING

ASME BPV III & BPV XI

August 6, 2010

ASME BPV III ORGANIZATION

BPV III Standards Committee

- Executive Committee on Strategy & Management
- Executive Committee on Administration
  - Stakeholders Groups
  - Honorary Members
- Subcommittee on Design
- Subcommittee on Materials, Fabrication & Examination
- Subcommittee on General Requirements
- Subgroup on Pressure Relief
- Joint ACI-ASME Committee

ASME BPV III ORGANIZATION

Division of Work and Responsibility

Division Committees

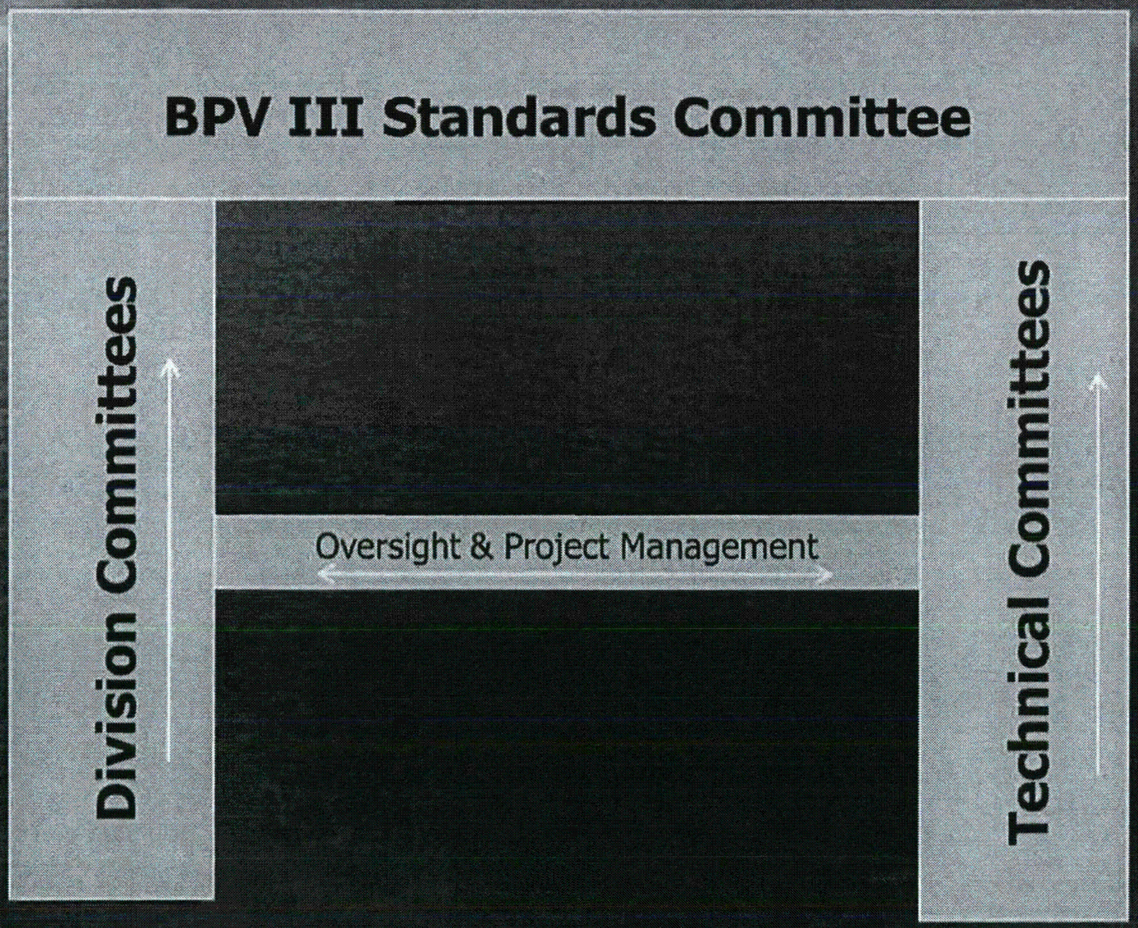
- Division 1
- Division 2
- Division 3
- Division 4
- Division 5

Technical Committees

- SC Design
- SC M, F, & E
- SC GR
- SG Pressure Relief
- Joint Committee ACI-ASME

ASME BPV III ORGANIZATION

BPV III Standards Committee



BPV III EXECUTIVE COMMITTEE ADMINISTRATION

Membership

- Chair BPV III
- Vice Chair BPV III
- Secretary BPV III
- Chair Strategy and Management
- Chair Subcommittee Design
- Chair Joint ACI-ASME Committee
- Chair Subcommittee Materials, Fabrication & Examination
- Chair Subcommittee General Requirements

BPV III EXECUTIVE COMMITTEE

STAKEHOLDERS GROUPS

- SUBGROUP
  HDPE Materials
- SUBGROUP
  Magnetic Confinement Fusion Energy Devices
- SUBGROUP
  High Temperature Gas Cooled Reactors
- SUBGROUP
  High Temperature Liquid Metal Reactors

EXECUTIVE COMMITTEE STRATEGY & MANAGEMENT

Membership (27)

- Code User Executive Representatives (12 invited)
- Generic Subcommittee Chairs (4)
- Chairs Book Committees (5)
  - SC Division 2 (Joint Committee)
  - SG Division 1
  - SG Division 3
  - SG Division 4
  - SG Division 5
- Chairs Technical Projects (6)
  - SG Editing & Review
  - SG Resource Management
  - SG on Industry Experience for New Plants
  - SG HDPE Pipe
  - SG Probabilistic & Risk Informed Methods
  - SWG Advanced LWR Issues

ASME BPV III
Strategy & Management

Subgroup
High Temperature Reactors (Div 5)

Working Group
Liquid Metal Reactors

Working Group
HTGR

ASME BPV III
Strategy & Management

Subgroup
High Density Polyethylene Pipe

Working Group
HDPE Pipe – Research & Development

ASME BPV III ORGANIZATION

SUBCOMMITTEE DESIGN III

- Subgroup Component Design
- Subgroup Elevated Temperature Technology
  - Working Group Design Analysis
  - Working Group Creep/Fatigue
  - Special Working Group R&D

SUBCOMMITTEE DESIGN III ORGANIZATION

SUBGROUP COMPONENT DESIGN

- Working Group Vessel Design
- Working Group Piping Design
- Working Group Pump Design
- Working Group Valve Design
- Working Group Supports
- Working Group Div 3 Design
- Working Group Div 4 Design
- Working Group Core Supports
- Working Group Probabilistic Design
- Special Working Group Environmental Effects


ASME BPV III ORGANIZATION
SUBCOMMITTEE DESIGN III (cont'd)
Subgroup Graphite & Composite Design
Subgroup New Design Applications III
Subgroup Generic Design Analyses (I,III,VIII)
Subgroup Fatigue Strength (I,III,VIII)
Subgroup Elevated Temp Construction (I,III,VIII)
13

ASME BPV III ORGANIZATION

JOINT ACI-ASME COMMITTEE

- Working Group Design
- Working Group Materials, Fabrication & Examination
- Special Working Group Modernization

ASME BPV III ORGANIZATION

SUBCOMMITTEE MATERIALS, FABRICATION & EXAMINATION

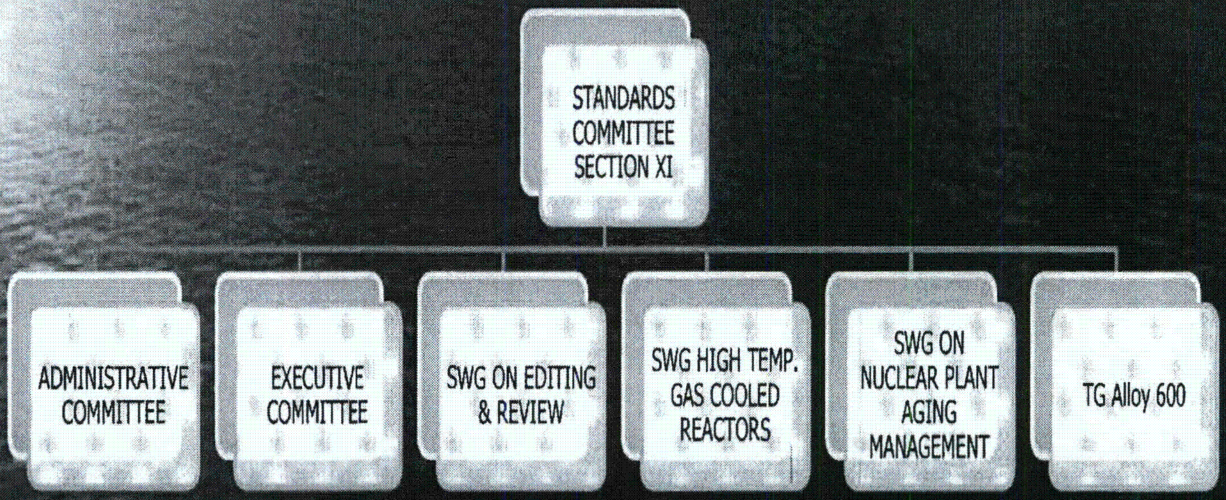
- Subgroup Materials
  - Working Group Elevated Temperature Materials (creep/fatigue)
  - Working Group HDPE Materials
- Subgroup Graphite & Composite Materials
- Subgroup Fabrication & Examination

ASME BPV III ORGANIZATION

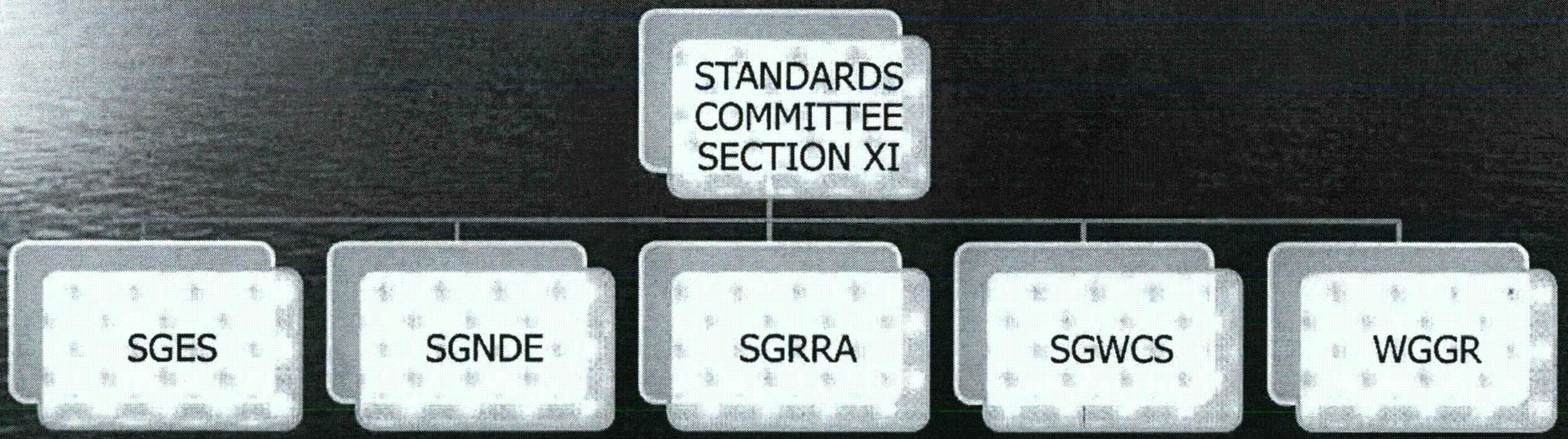
SUBCOMMITTEE GENERAL REQUIREMENTS

- Subgroup Duties & Responsibilities
- Working Group Graphite & Composite Materials
- Working Group Duties & Responsibilities Div 4, 5
- Working Group General Requirements Div 3
- Working Group Quality Assurance, Certification & Stamping
- Special Working Group HDPE Materials
- Working Group Duties & Responsibilities

ASME SECTION XI ORGANIZATION

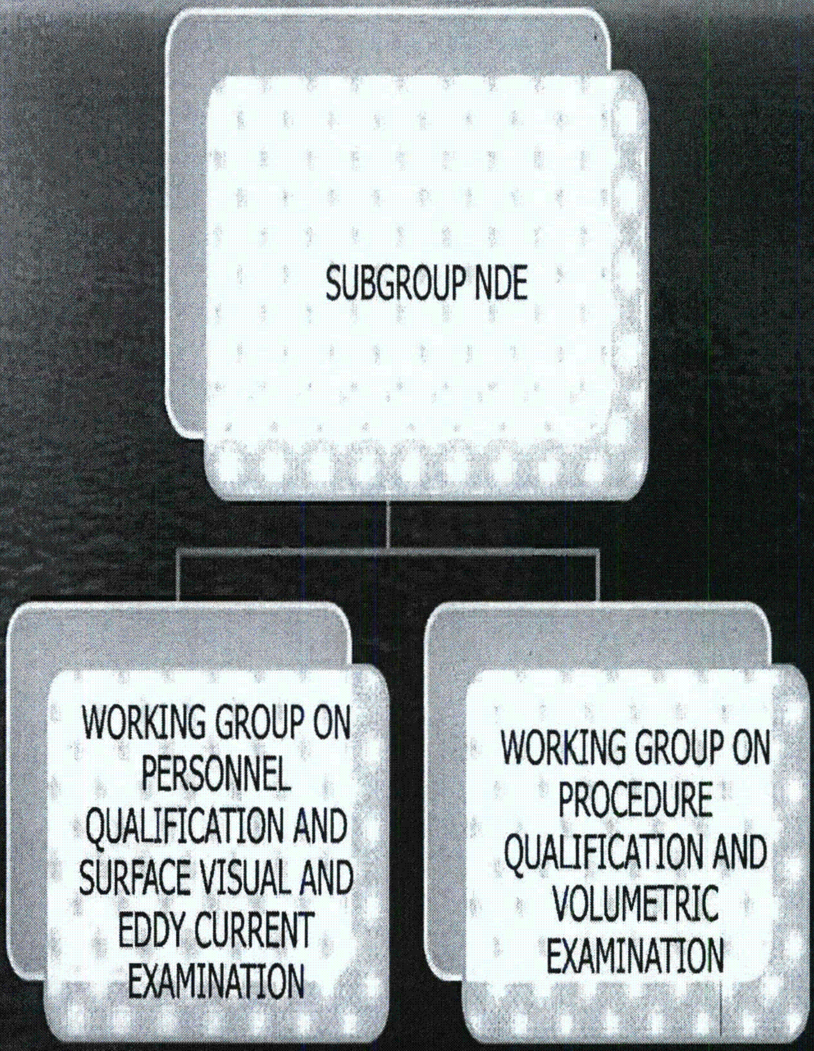


ASME SECTION XI ORGANIZATION



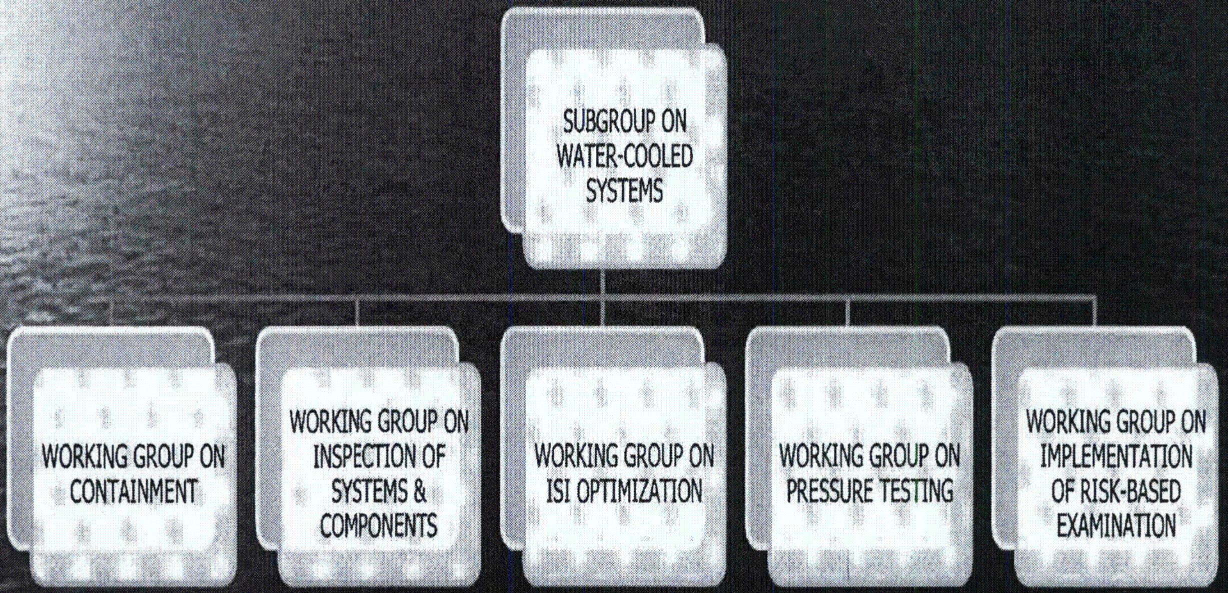

ASME SECTION XI ORGANIZATION
SUBGROUP EVALUATION STANDARDS
WORKING GROUP ON FLAW EVALUATION
WORKING GROUP ON PIPE FLAW EVALUATION
WORKING GROUP ON OPERATING PLANT CRITERIA
19

ASME SECTION XI ORGANIZATION



ASME SECTION XI ORGANIZATION

ASME SECTION XI ORGANIZATION



Effect of Thermal Gradients on Stresses in PE Piping

by

Drs. Prabhat Krishnaswamy, Suresh Kalyanam, and Do Jun Shim

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kswamy@emc-sq.com

February 1, 2011

Seattle, WA

ASME Boiler and Pressure Vessel Code Meetings

Section III –Working Group - Polyethylene Pipe Design

Presentation Outline

- *Issue originally raised by NRC Staff*
- *Thermal Gradients – Steel vs. PE Piping for Class 3 safety-related, service water applications*
- *Thermal Stresses in thick-walled PE Piping – Example Case*
- *Summary comments*

Emc²

Issue Raised by NRC Staff

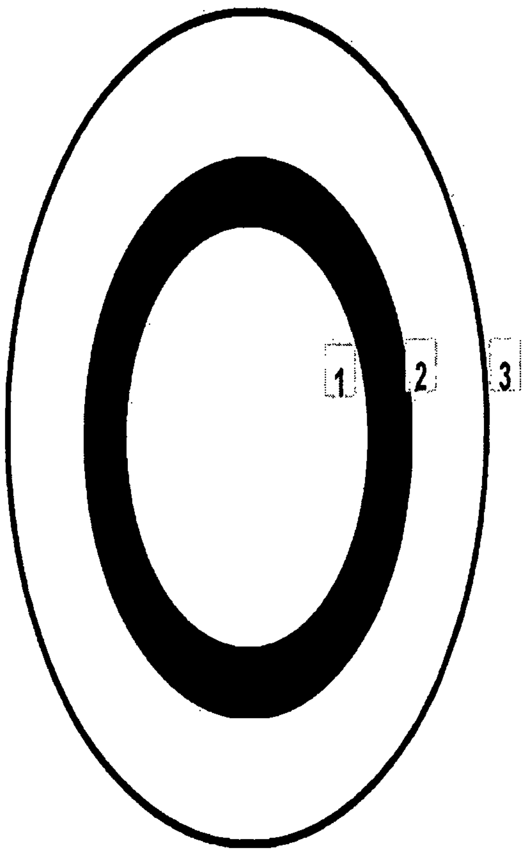
- ASME PVP Paper No. 2009-77747 titled "*Special Design Considerations for Buried HDPE Piping in Nuclear Safety Related Application*" presented by NRC-NRR staff - several key technical issues identified relating to PE pipe design for Class 3, safety-related, service water piping in nuclear power plants applications

- Stresses due to thermal gradient identified as an important design consideration for PE piping due to (i) higher wall-thickness values, (ii) lower thermal conductivity, and (iii) higher thermal expansion coefficient values

- Recommendations include (i) thick-wall equations for stress calculation be used, and (ii) over and above thermal restraint stresses thermal gradient stresses through the wall be considered for PE pipe design

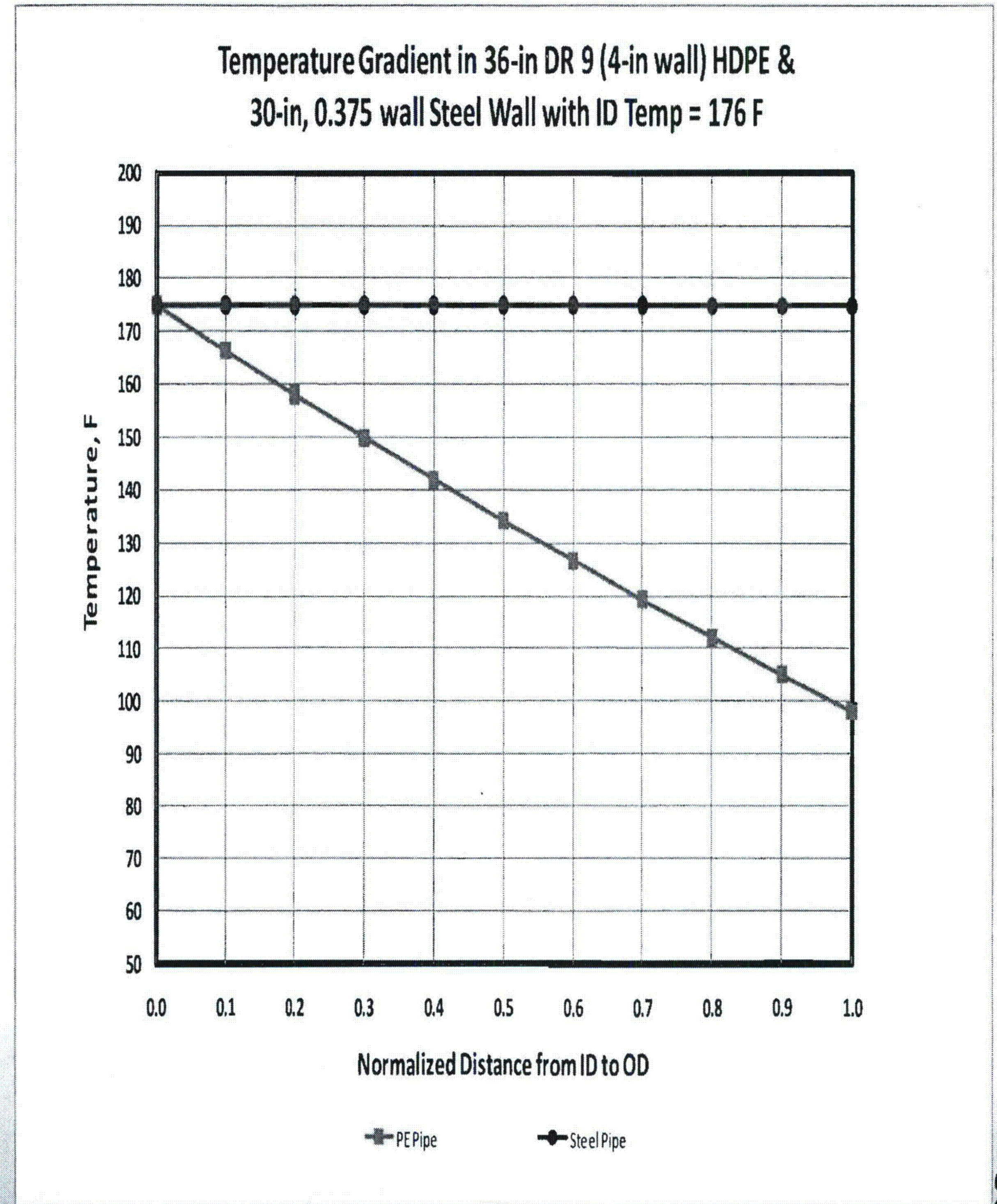
Thermal Gradient - Steel vs PE Piping for Service Water

Example Case of 30" Steel Pipe vs. 36" PE Pipe



Parameter	Steel Pipe	PE PIPE	Units
Inside radius of PE/Steel Pipe	14.625	14	in
Outside radius of PE/Steel Pipe	15	18	in
Outside radius of Soil for Analysis	36	36	in
Thermal Conductivity,	26	0.25	BTU/hr-ft-F
Thermal Conductivity of Soil (av)	0.8	0.8	BTU/hr-ft-F
Temp on ID of Pipe -1	175	175	F
Temp on OD of Soil -3	32	32	F
Temp at OD of Pipe -2	**174.87**	**98.2**	**F**

Thermal Gradient Comparison – PE versus Steel Pipe



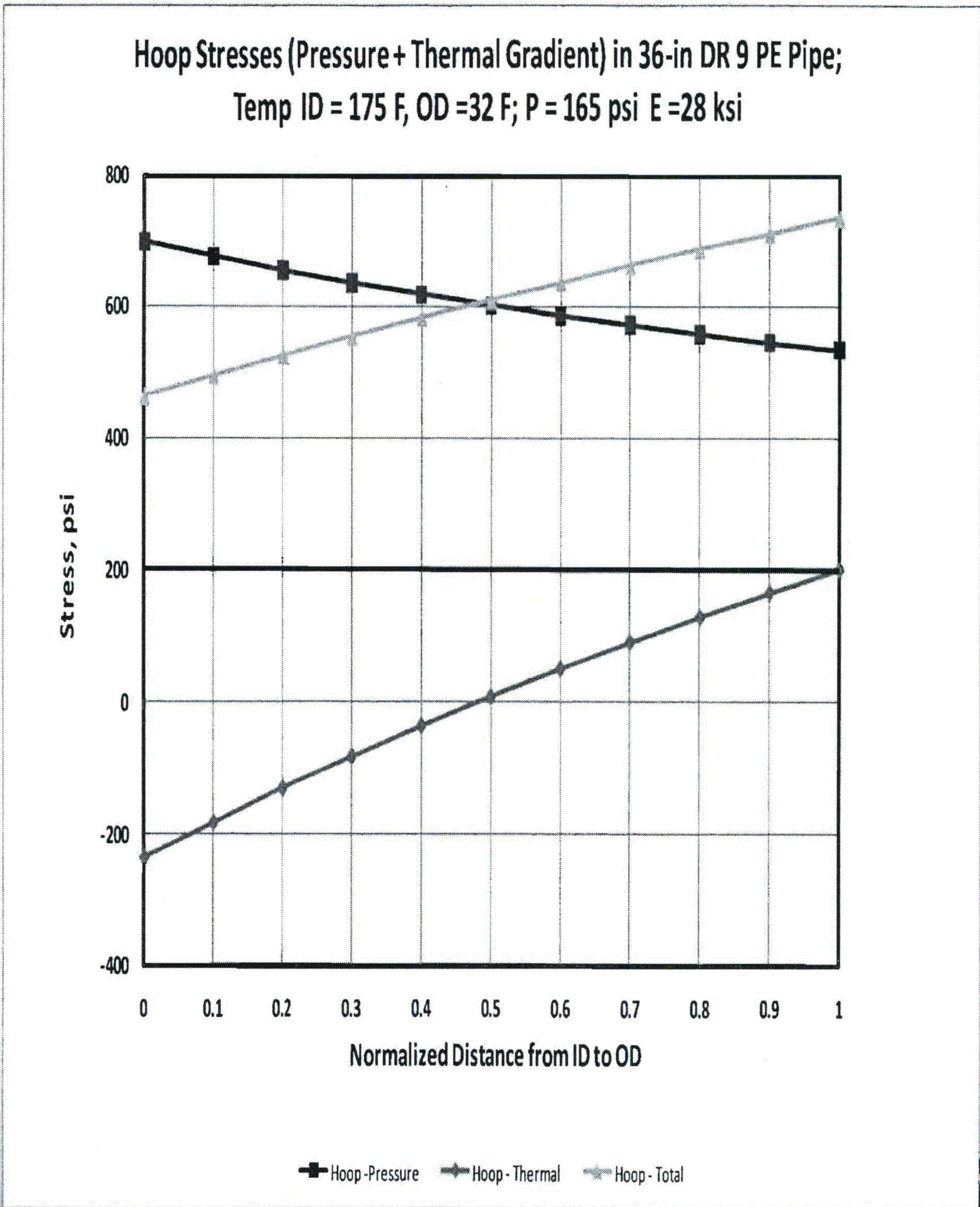
Example Case for Analysis (per NRC Paper)

Input Parameters

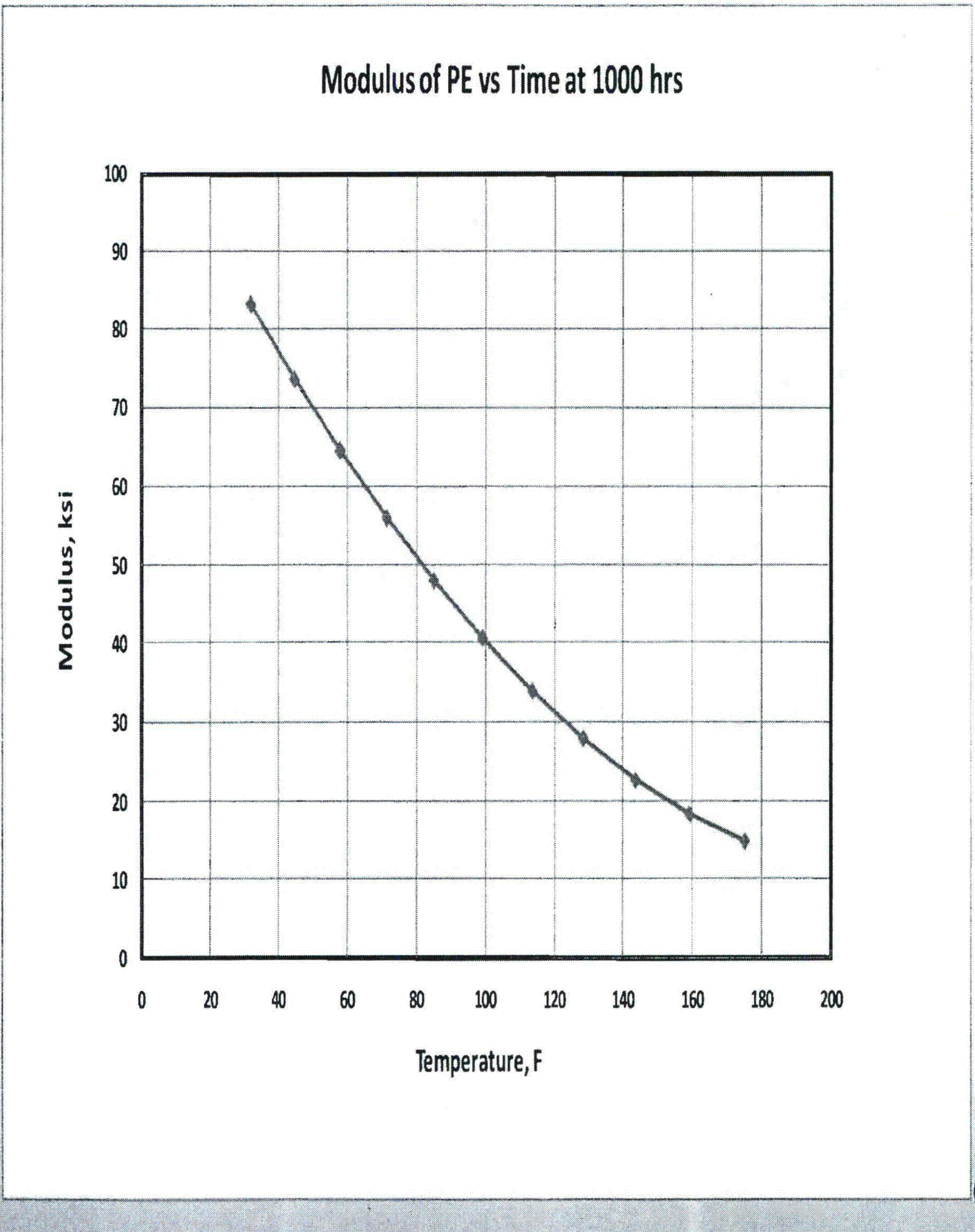
- OD = 36 inches
- DR =9
- Internal pressure = 165 psi
- Temperature at OD = 32 F
- Temperature at ID = 175 F

Calculate hoop stress through the thickness in the radial direction with Modulus as a constant and as a function of temperature

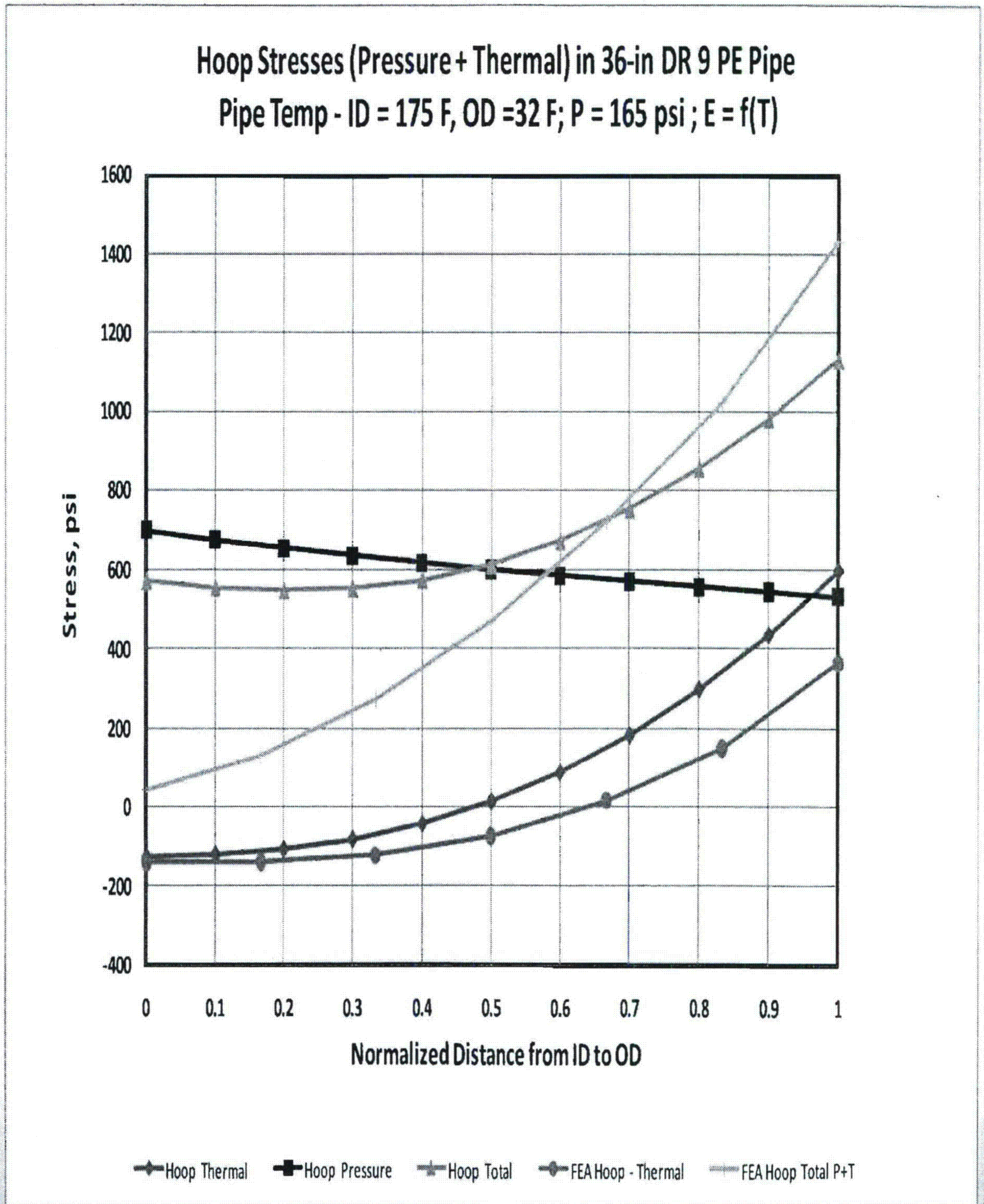
Total Hoop Stress (thermal + pressure) – Closed Form



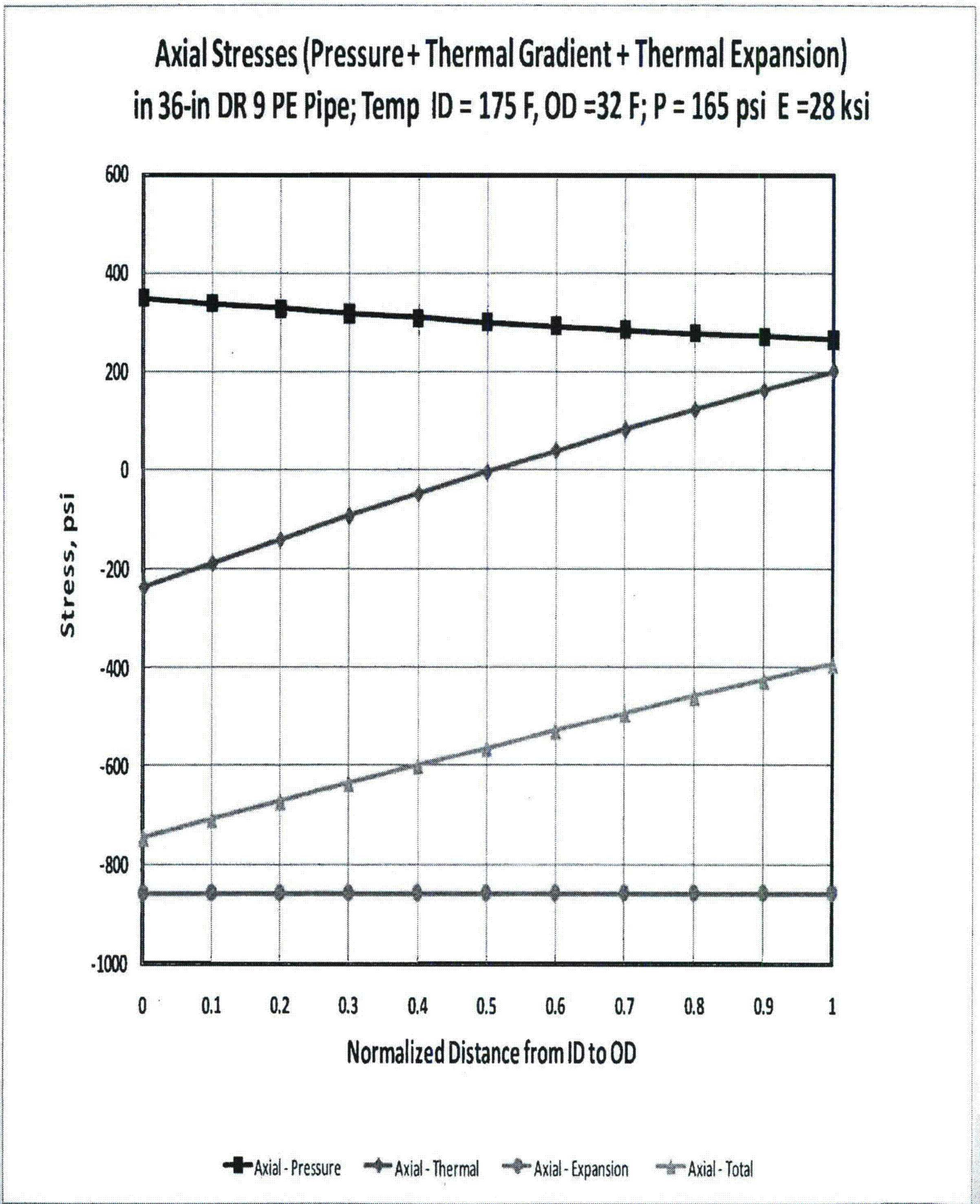
Modulus as a function of Temperature



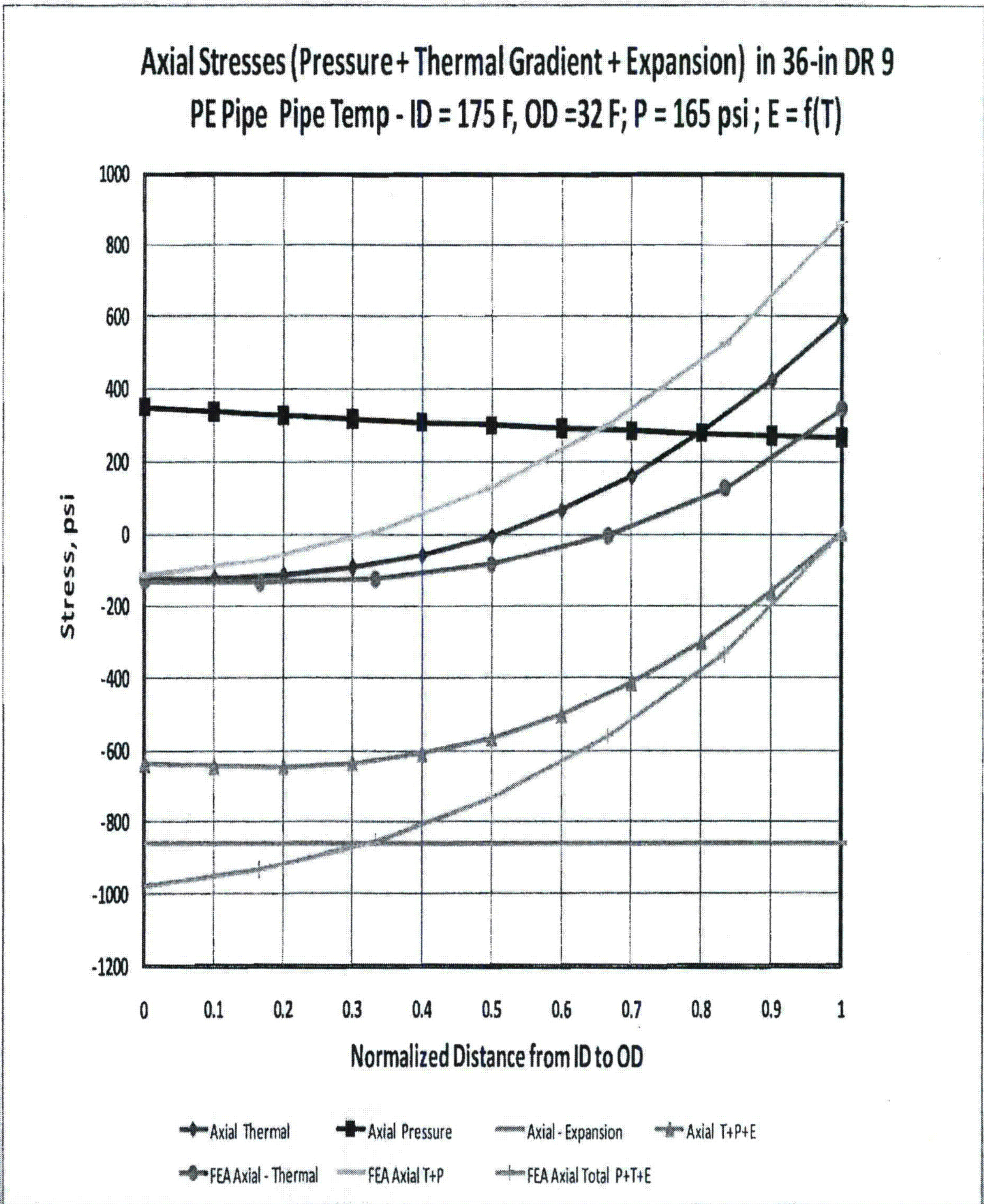
Total Hoop Stress (thermal + pressure); E =f(T)



Axial Stress (thermal + pressure +expansion)



Axial Stress (thermal + pressure +expansion) E =f(T)



Summary Comments

- Thermal gradients are more significant in thick walled PE Piping than for steel piping
- Through-wall thermal stresses due to gradients can be a significant percent of the allowable stresses for PE
- Thermal gradient stresses need to be addressed in PE piping design – perhaps by incorporating them into secondary stresses??

Preliminary Analysis of EPRI PE 4710 Razor Notched Pipe Data

by

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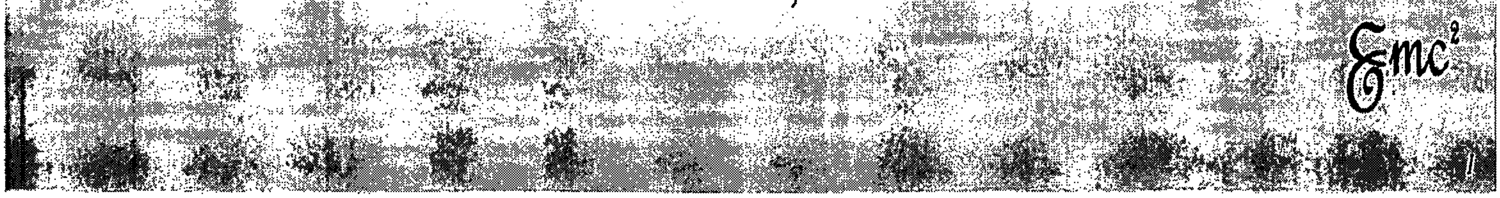
February 1, 2011

ASME Boiler and Pressure Vessel Code Meetings

Section III – Special Working Group on Polyethylene Pipe

Seattle, WA



Bidirectional Shift Model & EPRI Data

Bidirectional Shift Model

Shift Model Input Temperature, T, Sig (T), and Failure Time t-f(T)

a-T	=exp[-a-1*(T-T-R)]
b-T	=exp[b-1*(T-T-R)]
Sig (T-R)	Sig (T) * b-T
t-f (T-R)	t-f(T) / a-T
a-1	0.109
b-1	0.0116

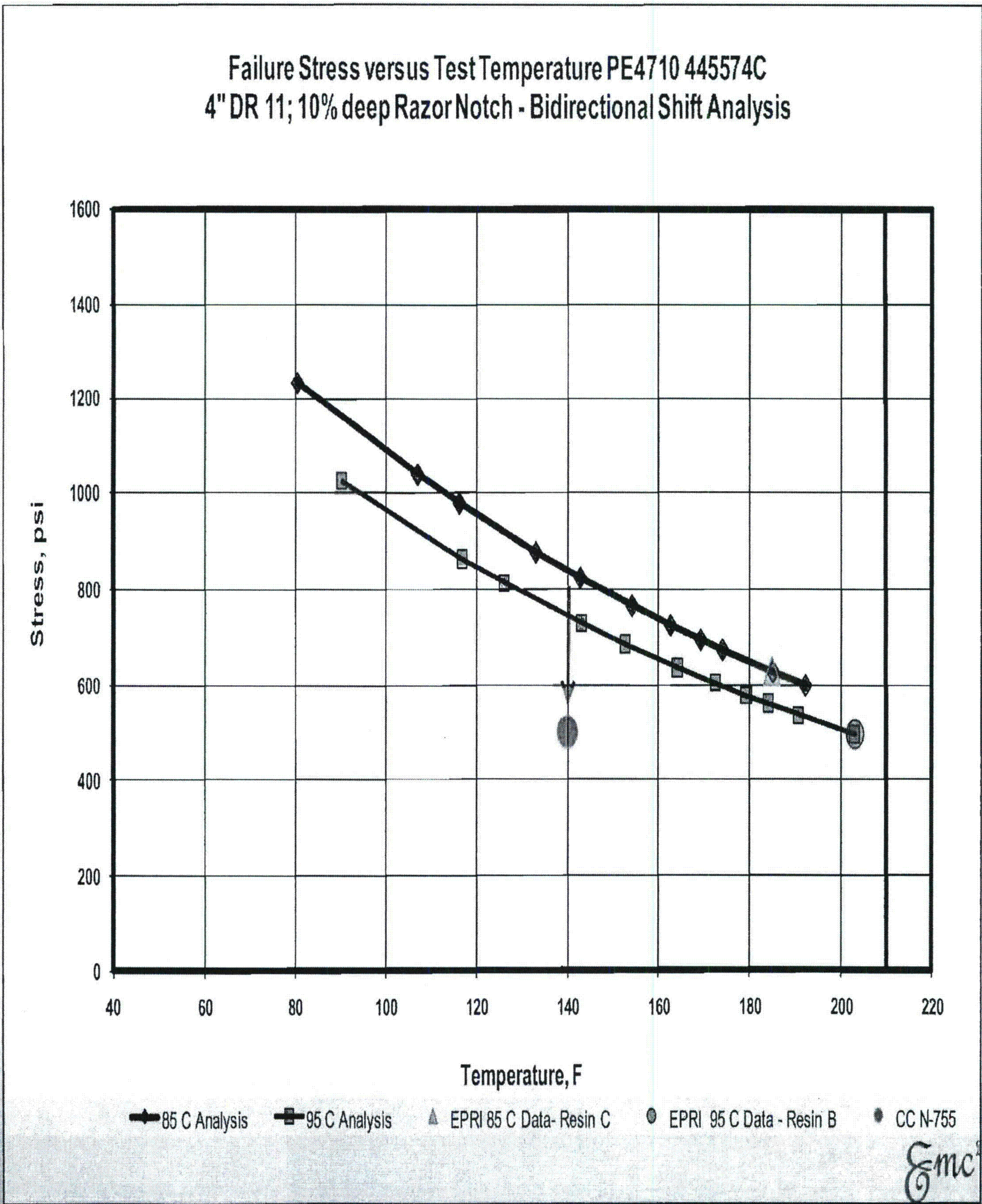
Shift Model Output at Temperature, T-R, predict combinations of Sig (T-R), and Failure Time t-f(T-R)

EPRI Data

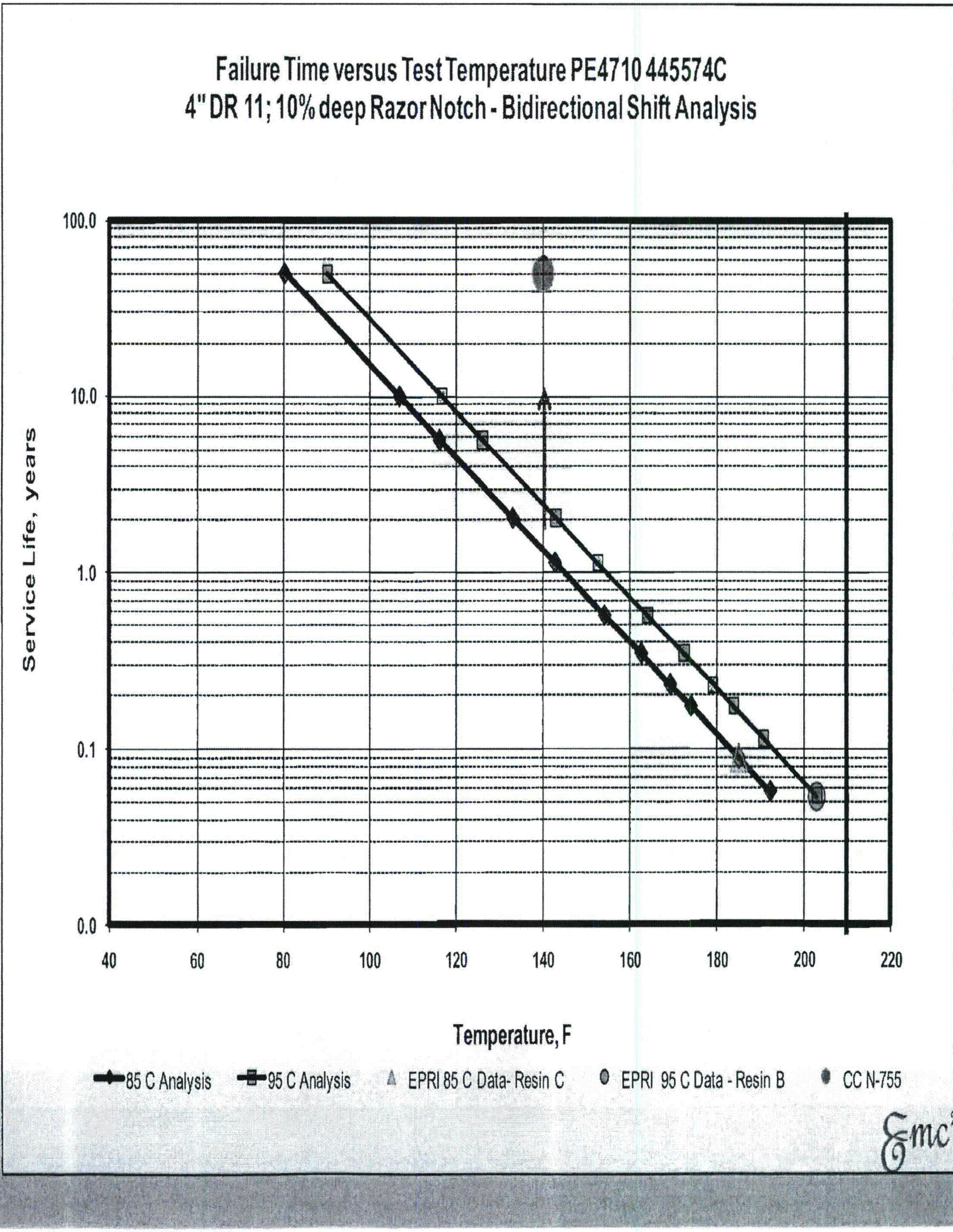
Resin C 445574C - 4" SDR 11 Pipe with Razor Notch; 10% deep - 85 C		
Failure Time, hrs		776
Sig (T)	psi	629
T	F	185

Resin B 445574C - 4" SDR 11 Pipe with Razor Notch; 10% deep - 95 C = 195 F		
Failure Time, hrs		475
Sig (T)	psi	496
T	F	203

Emc²



Failure Stress versus Test Temperature PE4710 445574C
4" DR 11; 10% deep Razor Notch - Bidirectional Shift Analysis
Stress, psi
1600
1400
1200
1000
800
600
400
200
0
40
60
80
100
120
140
160
180
200
220
Temperature, F
85 C Analysis
95 C Analysis
EPRI 85 C Data- Resin C
EPRI 95 C Data - Resin B
CC N-755


Failure Time versus Test Temperature PE4710 445574C
4" DR 11; 10% deep Razor Notch - Bidirectional Shift Analysis
100.0
10.0
1.0
0.1
0.0
Service Life, years
40
60
80
100
120
140
160
180
200
220
Temperature, F
85 C Analysis
95 C Analysis
EPRI 85 C Data- Resin C
EPRI 95 C Data - Resin B
CC N-755

Charter

TASK GROUP ON HIGH TEMPERATURE FLAW EVALUATION

F. W. Brust, Engineering Mechanics Corporation

Joint BPV III SG-ETD and Section XI Task Group

Background

ASME Standards Technology, Ltd, in conjunction with the US Department of Energy, funded a GEN IV/NGNP Materials Project entitled, "Task 8: Creep and Creep-Fatigue Crack Growth at Structural Discontinuities and Welds", with the final report submitted in January, 2010. This report proposed draft rules for assessing flaw growth and failure for nuclear components which operate in the creep regime. After careful consideration it was determined by B&PV Code Subgroup on Elevated Temperature Design (SG-ETD: BPV III) that the rules are not appropriate for the inclusion in the high temperature design code, NH, since the rules are necessarily too complex. It is felt that the rules belong within the charter of Section XI. At the last Subgroup meeting, the charter was approved by ETD.

Proposed Charter

The Task Group on high temperature flaw evaluation shall develop rules for high temperature flaw assessment for nuclear reactors components and materials which operate at high temperatures where creep may occur. The rules shall consider pressure vessels, piping, pressure retaining portions of rotating equipment including; pumps, blowers, turbines, and compressors, valves, heat exchangers and for core support structures, metallic components. The rules shall contain requirements to assess flaws including; material consideration, weldments, fabrication contributions, high temperature testing, NDE examination, inspection, and the preparation of reports. The Task Group shall identify research and development efforts and needs required to support the technical development of these code rules.

TECHNICAL PROGRESS REPORT

and

FINANCIAL STATUS REPORT

for

GSA SCHEDULE CONTRACT NUMBER – GS-10F-0145T
NRC CONTRACT NUMBER - DR-04-08-147

Task 001 – Technical Support for ASME Activities
Task 002 - PE Pipe Service Life Confirmation
Task 003 – Fracture Mechanics Analyses
Task 004 – Characterization of HDPE Viscoelastic Properties

PRESSURE BOUNDARY INTEGRITY ANALYSES SUPPORT

CONTRACT PERIOD of PERFORMANCE
January 13, 2009 – August 19, 2011

REPORT PERIOD of PERFORMANCE
February 1 to 28, 2011

TWENTY FIFTH MONTHLY REPORT

Principal Investigators
Drs. Prabhat Krishnaswamy & Frederick Brust

March 14, 2011

ENGINEERING MECHANICS CORPORATION OF COLUMBUS
3518 RIVERSIDE DRIVE - SUITE 202
COLUMBUS, OHIO 43221-1735

TECHNICAL PROGRESS REPORT
ON
PRESSURE BOUNDARY INTEGRITY ANALYSES SUPPORT

SUMMARY

This is the 25th monthly report on the project that terminates on August 19, 2011. Tasks that are currently authorized within the entire program are listed below:

Task 1 - Support ASME Code Case Development
- Task 1A – Support ASME Code Case Development – Polyethylene Piping
- Task 1B – Support ASME Code Case Development - Nickel Based Alloys
- Task 1C – Support ASME Code Case Development - Inlay Analysis Work

Task 2 – SCG Testing of Polyethylene Piping for Service Life Confirmation

Task 3 – Fracture Mechanics Analyses
- Task 3A – Probabilistic Fracture Mechanics Analysis
- Task 3B – Probabilistic Fracture Mechanics Analysis & Technical Assistance
- Task 3C – Technical Assistance on the Development of xLPR Code

Task 4 – Characterization of HDPE Viscoelastic Properties

A summary of the financial status of the project by Task is provided below:'

Task	Expenditure for Current Month	Total Expenditure	Percent of Obligated Funds	Percent of Total Appropriation
Task 001	$8,934	$300,695	93.97%	92.46%
Task 002	$2,859	$120,781	92.95%	92.95%
Task 003	$7,704	$325,000	100.00%	100.00%
Task 004	$6,838	$102,323	87.46%	87.21%

As stated in the cover letter and conveyed noted during our last meeting in Rockville, MD on March 3, 2011, Task 3 has been FULLY expended, since no additional obligated funds were received during the last reporting period. This task has therefore been put on hold effective immediately.

As noted above, Tasks 1 and 3 have three distinctly different activities and are therefore reported separately in the MLSRs as detailed below.

Task 1A - Support ASME Code Case Development – PE Piping

Efforts Completed During this Reporting Period

Dr. Krishnaswamy attended the ASME BPV Meetings on PE Piping held in Seattle, WA from January 31- February 2, 2011. There has been some major reorganization and elevation of all

ASME groups that work on code issues relating to PE piping, as detailed in Attachment 1. The new groups responsible for PE Piping within the ASME Code include the following:

1. Section III - Subgroup – High Density Polyethylene (HDPE) Pipe (Tim Adams, Chair, Dudley Burwell, Secretary)
    a. Working Group – HDPE Pipe Research & Development (Adel Haddad, Chair)

2. Section III Subgroup – Component Design
    a. Special Working Group on HDPE - Design of Components (Tim Adams, Chair)

3. Section III Subgroup – Materials, Fabrication & Examinations
    a. Working Group – HDPE Pipe Materials (Matt Golliet, Chair)

4. Section III Subgroup – Duties and Responsibilities
    a. Special Working Group – HDPE

5. Section IX – Welding
    a. Task Group on HDPE Pipe Joining (Jim Craig, Chair)

6. Section XI - Flaw Evaluation
    a. Task Group – HDPE Pipe Flaw Evaluation (Harvey Svetlik, Chair)

Dr. Krishnaswamy was invited to be a member of the two technical groups - SWG-Design and WG-Materials – Items 2 and 3 above. NRC Staff will be represented at the SG-HDPE Pipe, though Dr. Krishnaswamy will continue to attend and provide input to all groups listed above except Items No. 4 and 5.

The major items of interest at these meetings are as follows:

- Dr. Krishnaswamy made a presentation at the WG-Design on the Thermal Gradient Issues, see Attachment 2. There was considerable discussion regarding the inclusion of thermal gradient in the design basis of Class 3 piping. Tom Musto of Sargent & Lundy (designers of the Callaway PE piping) requested Dr. Krishnaswamy for his presentation and as a result of follow-up discussions will independently present the industry basis for comparing thermal stresses versus yield stress for PE materials at the relevant temperatures.

- EPRI presented the analyses of their PE notched-pipe, full-scale hydrostatic test data and concluded that the use of either the RPM or bi-directional shift models predicts >> 50 year life of PE pipe with flaws at 140 F (see pp 92 of 105 of the SG- HDPE Pipe Meeting Minutes from February 1, 2011). The details of these analyses were not available, and have been requested from EPRI along with their complete report. These analyses will be reviewed and studied in detail prior to discussion with NRC & EPRI staff after the proposed MOU between the two organizations has been executed. For comparison purposes, Emc2's analysis of EPRI's data is provided in a DRAFT presentation in Attachment 3.

- Prof Choi from Korea made a presentation on residual stresses in PE piping and joints as a result of manufacturing and joining and their effect on slow crack growth failure. The minutes of the SG-Design has this presentation and will be reviewed and studied in detail. Dr. Krishnaswamy did request from the SG Chair, time to respond to Prof Choi's presentation at the next ASME meeting in May, 2011.

- The ballot response to Revision 1 of CC N-755 was discussed at length to address the various comments and negative votes received. Most of the technical items, NRC's concerns and negatives from CC N-755 Rev 0 have NOT as yet been resolved. Apparently since the CC N-755 Rev 0 has been passed by ASME, the unresolved items from the previous ballots do not need to be addressed in Rev 1 on procedural grounds. This position by ASME is being reviewed and discussed

- CC N-755 Rev 1 will be updated based on the comments and feedback at the meeting and will be submitted for balloting (unless all items are deemed resolved).

The complete minutes of SG-HDPE Pipe is NOT attached to this report for brevity. NRC Staff as members of the SG-HDPE Pipe receive these minutes independently and a copy of the minutes can be sent, if needed, under separate cover due to its file size (~9 Mb).

Problems or Delays for Task 1A
There were no problems or delays.

Plans for the Next Reporting Period for Task 1A
Dr. Krishnaswamy will review the technical issues raised (and discussed above) during the ASME BPV meetings in Seattle, WA from January 31-February 1, 2011.

Task 1B – Support for ASME Code Case Development - Nickel Based Alloys

Efforts Completed During this Reporting Period
This effort was on hold during this reporting period.

Problems or Delays for Task 1B
There were no problems or delays to report.

Plans for the Next Reporting Period for Task 1B
No additional work has been planned for this task in the next reporting period.

Task 1C – Analysis of Inlay Repairs

Efforts Completed During this Reporting Period
This task has been completed.

Problems or Delays for Task 1C
There were no problems.

Plans for the Next Reporting Period for Task 1C
This task has been completed.

__Task 2 - SCG Testing of PE Piping for Service Life Confirmation__

Efforts Completed During this Reporting Period

__SCG Testing on PENT Specimens:__

The installation and calibration of the creep test frames in the new laboratory building continued last month for additional SCG testing. Also based on the results obtained to date and the EPRI data presented, some specific SCG testing on PENT type specimens from Dow's bimodal resin will be undertaken. The specific conditions for the SCG tests (nominal stress, flaw depth and temperature) have yet to be determined.

Also, SCG displacement vs. time data from both the 1"x1" specimens and the PENT specimens are being re-analyzed so as to make comparison with the FE modeling work being carried out in Task 4 below.

Problems or Delays for Task 2
There were no problems or delays in this Task.

Plans for the Next Reporting Period for Task 2
Additional SCG experimental work on PENT specimens from DOW's bimodal resin work will be undertaken during the next period along with continuation of both EPRI's and Emc2's data already available.

__Task 3A – Probabilistic Fracture Mechanics Analysis__

Efforts Completed During this Reporting Period
This effort is undertaken to satisfy NRR user need regarding probabilistic fracture assessment of CRDM tube cracking. Ultimately, confirmatory analyses of industry work are needed. During January base case deterministic analyses were performed that demonstrated consistent sets of deterministic results. This month's efforts focused on the additional code development for non-standard distributions that had not been previously included in the PCRDM code, the incorporation of an inspection model that allows future comparisons to be made, and an examination of improved methods for modeling crack inspections. The work performed during February is described in the following.

P-CRDM Code Updates
The original version of the P-CRDM code has several limitations. Chief among them were
:

- Limited distribution types for defining random variables
- Single method of probabilistic analysis (Monte Carlo)
- Stochastic variables are defined and hard coded

- Stress and stress intensity factor models are fixed

In order to perform meaningful comparisons to the analysis in MRP 105 it was necessary to change the coding to eliminate these limitations in the P-CRDM code.

Previous efforts addressed the final three points while this month two additional distribution types were programmed for the PCRDM code: (1) two-parameter Weibull distribution and (2) log-triangular distribution. With the previous distribution types that were already available all of the input distributions can now be matched.

PCRDM did not consider crack detection inpsections when it was programmed. This makes comparisons difficult since very few analyses were performed until failure. Rather credit is taken for crack detection and the analyses halted when the crack is found. This has the siginificant advantage of modeling the vessesl as it would be operated, i.e. known cracks will not be allowed to exist in the nozzles. However, there is a significant disadvantage in that slight differences in the PoD curves can lead to dramatically different results as well as requiring many more (two to three orders of magnitude) simulations to be performed to study low probability events. Therefore we implemented a Probability of *Non*-Detection (PoND) model. This allows us to continue the analysis until failure and then weight the reulst by this PoND. And in fact we can change the detection method *post processing* to assess the impact of different methods of detection or different inspection schedules.

We give an example of this detection method in Figure 1. In this figure we plot the PoND versus time for sveral different crack depth calculations. As expected the more frequently that crack inspections are performed the lower the PoND.

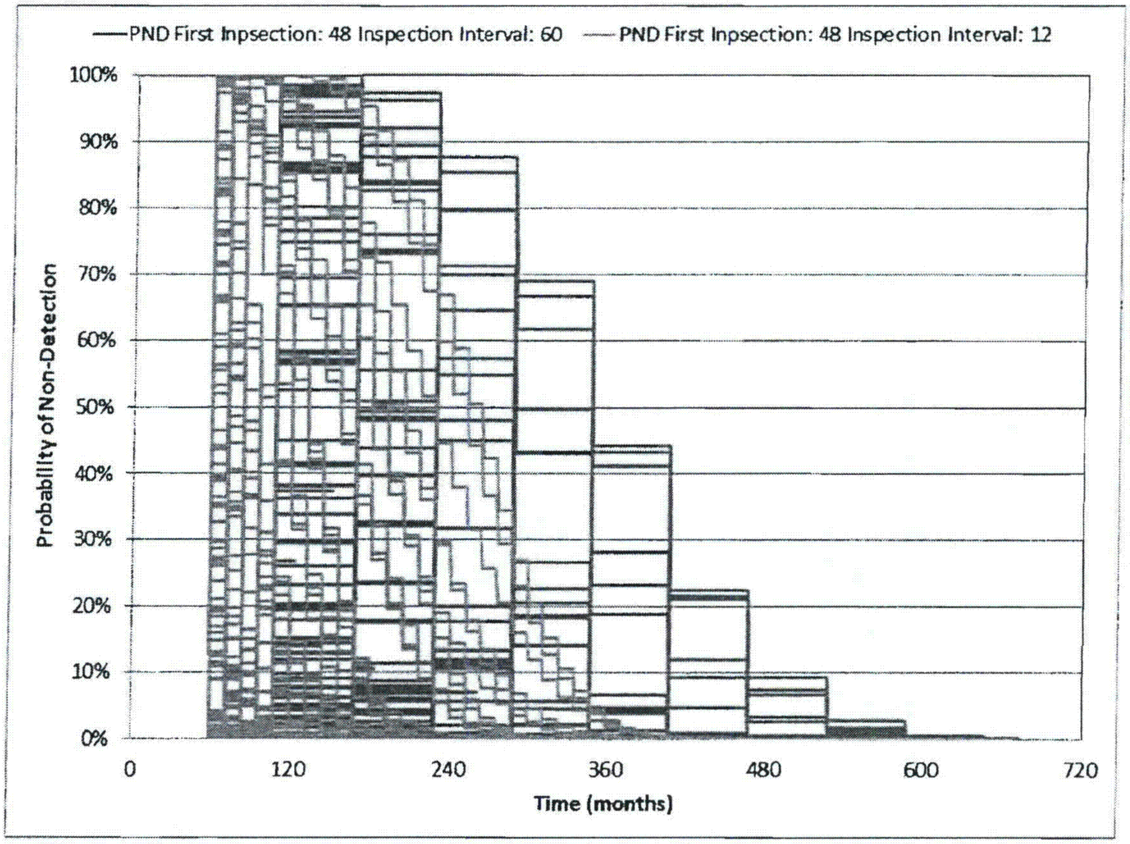


Figure 1 Example Calculations of theProbability of Non-Detection for Two Inspection Schedules

We show how these curves are used by a single crack growth simulation in Figure 2. Here we see that if we wished to compare 120 month and12 month inspection intervals that just priori to the 172 month there is a PoND of approximately 2 in 1,000 when the 12 month inspection schedule is used. Therefore to do any comparisons requires many runs if we stop the crack growth analysis when a crack is detected. Thus by allowing the crack to continue to grow and weighting the simulation results by this PoND curve we can be much more efficient in our calculations.

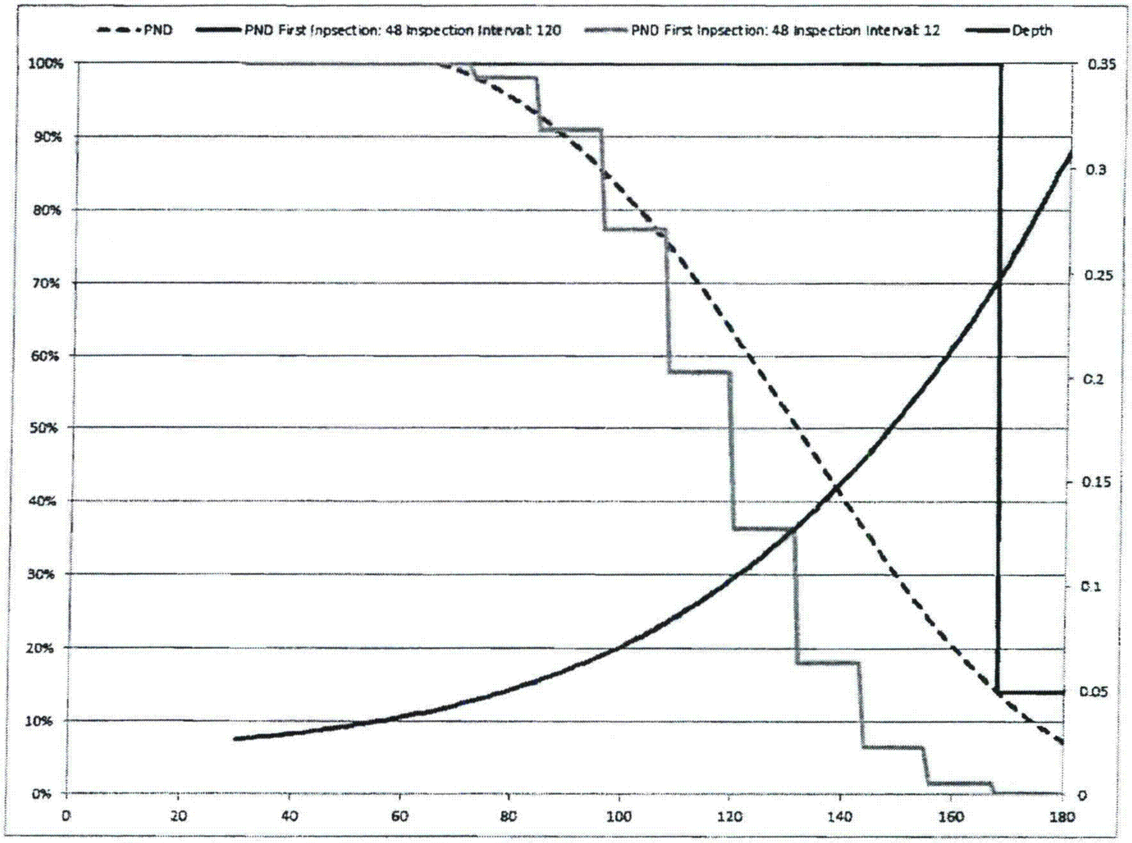


Figure 2 Sample Calculation of the PoND for a Single Crack Simulation

The remaining hours this month were spent investigating statistical methods for comparing the MRCPERD and PCRDM results with inspections. Such comparisons are being planned.

Problems or Delays for Task 3A
There were no problems or delays during the reporting period in this Task.

Plans for the Next Reporting Period for Task 3A
Next month's work will involve the testing of the assumptions and their impact on the predicted time for nozzle rupture and the confirmatory analyses. Also comparisons of the inspection modeling differences will continue.

<u>Task 3B - Probabilistic Fracture Mechanics Analysis Technical Assistance</u>

Efforts Completed During this Reporting Period
This effort is used for general probabilistic fracture mechanics purposes. Work was performed studying the industry work and defining the analyses that need to be performed for confirmatory purposes using our P-CRDM code.

Problems or Delays for Task 3B
There were no problems or delays during the reporting period in this Task.

Plans for the Next Reporting Period for Task 3B
Future work will involve the testing of the assumptions and their impact on the predicted time for nozzle rupture and confirmatory analyses.

Task 3C - Technical Assistance on the Development of xLPR Code

Efforts Completed During this Reporting Period
Drs. Brust, Shim, Wilkowski, R. Kurth, Zhang, and Ms. E. Kurth have been working on activities associated with the xLPR code. This participation in past months was as part of the Models and the Inputs group. However, with the recent addition of Dr. Kurth to the Emc^2 staff, we now participate in the xLPR Computational group. Here we report based on activities since our xLPR staff participants work jointly on each task, especially with the addition of Dr. Kurth to the team.

ASME BPV Code Participation
Drs. Brust, Shim, Krishnaswamy, and Mr. Keith Wichman attended the ASME Boiler and Pressure Vessel meeting in Seattle in February. Dr. Krishnaswamy reported his activities elsewhere in this report (as part of Task 4) and Appendix A provides the participation by Mr. Wichman. Dr. Shim attended a number of Section XI meetings including Working Group on Flaw Evaluation and Subgroup on Evaluation Standards. Dr. Shim is following up with the update on K solutions for flaws in cylinders for Appendix A.

Dr. Brust attended the BPV III Elevated Temperature Design (ETD) working group meeting on Tuesday. This group is attempting to modernize the high temperature design process to bring the process up to date with new technology. Brust has been asked to lead a joint task group on High Temperature Flaw Evaluation which will be a joint task group between ETD and Section XI. The charter for this task group is attached as Attachment C and it was fully approved by both ETD and Section XI. The first meeting will occur at the May BPV meeting.

Brust attended the ASME Section XI – Subgroup on Evaluation Standards on Wednesday morning. He also attended the Section XI Task Group meeting on Crack Growth Reference Curves (of which he is a member) on Wednesday afternoon. There were a number of issues covered in these meetings including discussion of weld residual stress solutions for PWR reactor's which may experience PWSCC. In the 1980's BWR reactors experienced IGSCC. Mitigation of this was performed by using weld overlay repairs or MSIP (and other methods) over affected welds. The types of welds of concern were stainless steel welds and the cracking occurred in the heat affected zone (HAZ) of the stainless base metal. There is a movement from industry to attempt to characterize bimetal welds in PWR plants that may experience PWSCC in a similar manner. The industry now recognizes that the US NRC is developing a policy on WRS fields in DM welds. This policy was presented and discussed with these groups after discussions between Dr. Rudland and Dr. Brust on Tuesday (Dr. Rudland could not attend Wednesday's meetings). PWSCC in bimetal welds is more involved than IGSCC in BWR plants. For PWSCC, there are three materials involved (ferritic nozzle, Alloy 82/182 weld, and stainless steel safe-end. Moreover, the region of concern is the weld metal rather than the base metal. Therefore, the WRS field for PWSCC analysis should be carefully calculated rather than using a simple estimate as was done with the BWR stainless steel welds. The industry now recognizes that this is an evolving NRC policy under development and discussion of the issue will be deferred until NRC completes this work. In addition, in the task group on Crack growth Reference Curves, Dr. Brust is working on developing WRS solutions for the group (with Guy Deboo and D. Rudland). The policy is not established yet and the group is awaiting the NRC position.

PIFRAC Database

As reported in the last monthly, the code for the Pifrac database must be rewritten to account for the updates that have been made to the PHP code and the internet browsers that parse PHP making the database, as it is currently written, inaccessible. The Pifrac database was moved to the new server and the necessary software was installed so that the needed modifications can be made. The progress of these modifications will be reported in the next reporting period.

xLPR New Weld Residual Stress Plan

This effort was on hold awaiting direction from NRC staff during February.

Report Work

Emc^2 staff obtained the final xLPR Loads report during February after detailed review by NRC staff. This final version is being addressed.

Crack Stability and the LBB.ENG2 Method Implementation in xLPR

The main through-wall crack instability routine within xLPR is based on an equivalence method for J-estimation in pipe and nozzles. The method, called LBB.ENG2 was developed by Emc^2 and Battelle staff. LBB.ENG2 was chosen because it was found to be the most accurate method for predicting crack instability as compared to full scale pipe fracture experiments. It is very convenient for xLPR because it is a closed form solution and is extremely rapid and accurate.

As discussed in the December and January MSLR reports, Emc^2 has noticed some discrepancies between predictions made using the 2008 and 2010 versions of the Newton algorithm based code. Moreover, in examining the issue further, it was noticed that there were some differences between the 2010 version and results predicted in the early, original versions of the code from the late 1980's, and the CD-ROM version of NRCPIPE from 1994. These issues were summarized in December's report for cases with smaller crack sizes and last month for larger cracks. In addition, the 2010 version of the code is being studied to determine the reason for the discrepancies. In general, it appears that the latest implementation of the LBB.ENG2 code within xLPR provides consistently higher predictions compared to both the 2008 xLPR code and prior releases of NRCPIPE that had LBB.ENG2 as an option.

Moreover, in recent probabilistic calculations using xLPR code it is noticed that the method, as implemented using the 2010 procedure, appears to be quite slow for some examples. The reason for these discrepancies' is being examined.

Problems or Delays for Task 3C

There were no problems or delays during the reporting period in this Task.

Plans for the Next Reporting Period for Task 3C
The crack transition behavior work will continue next month as will the new WRS method development. The LBB.ENG2 through-wall crack stability model, as it is currently implemented into xLPR will be further investigated due to some recently observed inconsistencies in results compared with older versions of the code in NRCPIPE. The issues with LBB.ENG2 will continue to be examined to find the source of the discrepancies. Work on possible WRS fields for the TG on Crack Growth Reference Curve group will begin. Finally, further development of the xLPR WRS plan will continue in March with emphasis on coming up with a method which does not rely on polynomial fits of the WRS field.

<u>**Task 4 – Characterization of HDPE Viscoelastic Properties**</u>

Efforts Completed During this Reporting Period
Creep Modulus: As planned, the data on creep modulus reported in the previous MLS (as a function of stress) for PE 4710 materials were discussed at the ASME BPV meetings in early February. Also in mid February, these data were discussed during Dr. Krishnaswamy's visit to CP Chem along with NRC staff. CP Chem has recently generated limited data on bimodal resins at one temperature and two stress levels that clearly indicated that creep modulus is a function of stress – indicating that the PE material is nonlinear viscoelastic, i.e., the material properties are time, temperature and stress dependent.

The ASME has responded to the above concerns with a white paper that essentially claims that the values of apparent modulus presented in CC N-755 Rev 0 and Rev 1 are conservative lower bound values and may therefore be used for all the design calculations and equations presented in the Code Case. This white paper is being studied in detail to assess the industry position on this issue.

FEA of Proposed Pressurized Vessel: The FE model is still on hold until the methodology for analyzing creep behavior is completed.

FEA of SCG Specimens: The FEA modeling of SCG specimens using unnotched specimen creep data continued at a lower level of effort until the above issue of nonlinear material behavior is resolved. Appropriate ways to model the instantaneous response when creep loads are applied are being investigated to incorporate in the FEA models. Preliminary comparison of the SCG specimen displacement versus time curve using creep data show some discrepancies in the instantaneous modulus/response that still need to be resolved.

Problems or Delays for Task 4
There were no problems or delays during the reporting period in this Task.

Plans for the Next Reporting Period for Task 4
The evaluation of nonlinear creep modulus work as well as the FEA of SCG specimens using creep material property data of bimodal PE 4710 resins will continue in the next reporting period.

FINANCIAL STATUS REPORT

on

PRESSURE BOUNDARY INTEGRITY ANALYSES SUPPORT

Financial Status

The financial information for the reporting period is summarized in the Table below including total amounts appropriated and obligated to date. The monthly (reporting period) and cumulative (inception to date) expenditures for each of the tasks are detailed below as well as the percent expended of the obligated funds and the balance remaining in each Task.

Per discussions with NRC staff additional funds are expected to be obligated to all four tasks in this effort to continue progress through February 2011.

Property Status

No property was acquired during this reporting period.

Travel Status

Drs. Krishnaswamy, Brust, Shim and Mr. Wichman travelled to the ASME BPV meetings in Seattle during the reporting period. Mr. Wichman's travel expenses were not covered by this project.

Table - Financial Status Report

February-11	FINANCIAL STATUS REPORT				
REPORTING PERIOD COSTS	Task 1	Task 2	Task 3	Task 4	Total
Costs					
Labor	$7,626.82	$2,858.80	$7,703.98	$6,838.44	$25,028.04
Travel	$1,306.81	$0.00	$0.00	$0.00	$1.306.81
Materials	$0.00	$0.00	$0.00	$0.00	$0.00
Total	**$8,933.63**	**$2,858.80**	**$7,703.98**	**$6,838.44**	**$26,334.85**
INCEPTION TO DATE COSTS	Task 1	Task 2	Task 3	Task 4	Total
Direct Costs					
Labor	$274,342.58	$118,902.06	$317,574.30	$101,313.63	$812,132.56
Travel	$26,352.55	$67.00	$7,425.70	$1,008.90	$34,854.15
Materials	$0.00	$1,811.65	$0.00	$0.00	$1,811.65
Total Costs	**$300,695.13**	**$120,780.71**	**$325,000.00**	**$102,322.53**	**$848,798.36**
Total Appropriation	**$ 325,230.60**	**$ 129,945.76**	**$ 325,000.00**	**$ 117,326.00**	**$897,502.36**
Total Obligated Funds	**$ 320,000.00**	**$ 129,945.76**	**$ 325,000.00**	**$ 117,000.00**	**$891,945.76**
Balance of Obligated Funds Remaining	**$ 19,304.88**	**$ 9,165.05**	**$ -**	**$ 14,677.47**	**$43,147.40**
Percent of Appropriation Expended	**92.46%**	**92.95%**	**100.00%**	**87.21%**	**94.57%**
Percent of Obligated Fund Expended	**93.97%**	**92.95%**	**100.00%**	**87.46%**	**95.16%**

LIST OF ATTACHMENTS

1. ASME Reorganization and Groups Responsible for Plastic Pipe Code Work
2. Emc^2's Presentation at ASME BPV on Thermal Gradient Stress Effects on PE Piping
3. Emc^2's Presentation (DRAFT) on EPRI Data Analysis.
4.

Emc²

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March 14, 2011

Mr. Eric Focht
Project Officer
U.S. Nuclear Regulatory Commission
Research, Mail Stop C-C07M
Washington, DC 20555
Sent via E-mail: eric.focht@nrc.gov

Subject: February 2011 Monthly Status Report – "TECHNICAL ASSISTANCE IN PRESSURE BOUNDARY INTEGRITY ANALYSES AND SUPPORT (PBIAS)" under GSA SCHEDULE CONTRACT NUMBER – GS-10F-1045T; NRC CONTRACT NUMBER – NRC-DR-04-08-147

Dear Mr. Focht:
Attached is our Monthly Letter Status Report (MLSR) for the above contract for the following tasks that have been authorized to date:

1. Task 001 – Technical Support for ASME Activities
2. Task 002 – PE Pipe Service Life Confirmation
3. Task 003 – Fracture Mechanics Analyses
4. Task 004 – Characterization of HDPE Viscoelastic Properties

This is the 25th monthly progress report on the project that started on January 13, 2009, and ends on August 19, 2011. The attached MLSR includes the financial status report (FSR) for the project and the four Task Orders, a summary of which is provided below:

Task	Expenditure for Current Month	Total Expenditure	Percent of Obligated Funds	Percent of Total Appropriation
Task 001	$8,934	$300,695	93.97%	92.46%
Task 002	$2,859	$120,781	92.95%	92.95%
Task 003	$7,704	$325,000	100.00%	100.00%
Task 004	$6,838	$102,323	87.46%	87.21%

As noted during our last meeting in Rockville, MD on March 3, 2011, Task 3 has been fully expended, since no additional obligated funds were received during the last reporting period. This task has therefore been put on hold effective immediately.

Please call me if you have any questions or need further information.

Sincerely,

Kswamy

Dr. Prabhat Krishnaswamy

cc: Ms. Morie Gunter-Henderson; Morie.Gunter-Henderson@nrc.gov; Division of Contracts; RESDEMLSR.Resource@nrc.gov.