Template
NRR-105

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

February 25, 2000

MEMORANDUM TO: Kamal A. Manoly, Chief
Civil & Engineering Mechanics Section
Mechanical & Civil Engineering Branch
Division of Engineering

FROM: Cheng-Ih Wu
Civil & Engineering Mechanics Section
Mechanical & Civil Engineering Branch
Division of Engineering

SUBJECT: TRIP REPORT - ASME CODE MEETINGS

I attended the ASME Section III Working Group on Piping Design (WGPD) committee meeting on Monday, December 13, 1999, in New Orleans, Louisiana. On Tuesday, December 14, 1999, I attended the ASME Section III Working Group on Component Supports meeting. On Wednesday, December 15, 1999, I attended the ASME Section III Subgroup Design meeting (for Keith Wichman). The following summarizes the items that are considered to be of interest to the NRC.

I. WORKING GROUP ON PIPING DESIGN

1. There are three Code Cases up for renewal: N-122, N-318, and N-155. The first two, which concern welded attachments, were on hold pending resolution of the seismic rules. Since they will not be resolved soon, the WG voted to reaffirm these Code Cases. I voted to reaffirm since these two code cases were approved by the staff and are included in Regulatory Guide (RG) 1.184. N-155 is on fiberglass reinforced pipe. It was reaffirmed with comments such that the Code Case is not being used much and there is little interest in it. This is consistent with the NRC staff position that the Code Case is acceptable for inclusion in RG 1.184 subject to additional requirements specified in RG 1.72, "Spray Pond Piping Made from Fiberglass-Reinforced Thermosetting. Interest: Imbro, Manoly, Wichman

2. WGPD-415, "Incorporation of Lug and Trunnion Code cases into a Non-Mandatory Appendix" - The Code Cases include N-122, N-318, N-391, and N-392. This item has been on hold pending resolution of the seismic rules. Minichiello said we should incorporate the Code Cases now, as the seismic rules may take years to decide. Glickstien said we should not make technical changes in the proposed non-mandatory appendix, just incorporate the Cases as is. Cole to submit the proposal to Hill for letter ballot. The proposal should put stress limits in if they are different from the current Code. Interest: Imbro, Manoly, Wichman, Hartzman

6044

DF03

3. WGPD-416, More Rigorous Analysis. This is an inquiry item proposing use of more rigorous analysis methods (similar to those in NB-3200) for Class 2/3 components. Haupt reported that he was having difficulty coming up with a proposal on how to allow more rigorous analysis methods in Class 2/3. There is a question whether the more rigorous methods need to preserve the same factor of safety, and whether the fabrication and examination rules would also need to be more rigorous. If NB-3200 is used, it involves stress terms that are not defined in Class 2. Landers said you should be able to use the Class 2/3 equations but instead of using the SIFs, do a detailed analysis to determine the stress from the moments. Landers will write up a proposal and send it to Haupt to format. Interest : Manoly, Fair, Wichman, Hartzman

4. WGPD-290, SIF Determination by Test. This item proposed an addition to Appendix II to provide criteria for determining SIFs by test (Attachment 1). Antaki has incorporated comments that were collected previously and in the September 1999 meeting. Slagis wrote that when testing in the inelastic range, the moment arm must match that used in Markl's tests. The consensus was that this was not necessary as long as the moment arm is long enough to not have shear effects. Also, Sills suggested adding the words, "the pressure should be sufficient to determine leakage, such as." Antaki mentioned that the figure needs to be extended horizontally. It was moved to adopt the Appendix with editorial changes, the extended figure, and Sills' words about the test pressure. Also the note in II-2240 was moved under (b). The motion was unanimously approved. Interest : Manoly, Fair, Wichman, Hartzman

5. WGPD-305, "SAM Rules," address the SAM effects included in Equation 9. This item had been on hold pending outcome of the seismic rules. There is a concern that if no OBE analysis is done and there are non-reversing loads, SAM won't get checked. This would happen when OBE is less than 1/3 of SSE since the current NRC guidance allows the Design Specification writer to eliminate OBE if it is less than 1/3 of SSE. WG decided to take the item forward, as the concern about no OBE analysis being done is a regulatory issue, which should not dictate Code rules. This item will not be combined with item WGPD-425 as had been previously agreed in the September 1999 meeting. Consequently, the item WGPD-425, "Inquiry on Non-Reversing Loads," which had been put on hold pending outcome of the seismic rules, was also unanimously agreed to bring it forward. Interest: Manoly, Fair, Wichman, Hartzman

6. Professor Vernon Matzen of NC State University presented the status of his work on B_2 indices (Attachment 2). He found that the B_2 for elbows using different shape stress-strain curves was relatively independent of the shape of the curve. However, for a thin wall pipe, the index is affected by the yield stress used, due to ovalization. He also found that the margin between collapse moment and Code for the component is equal to the margin for straight pipe. He plans to do out-of-plane moment testing, and look at different materials, pressure, and other components. Interest: Chen, Fair, Manoly, Wichman, Hartzman, Chokshi

7. Ralph Hill gave a presentation on the use of Mesa Vista which is a Web-based project management software. This software is designed for use by ASME staff and members of Subcommittee Nuclear Power, Subgroup Design and Working Group Piping. A user

manual was handed out (Attachment 3). Hirschberg will post the membership addresses and phone numbers on Mesa Vista. Interest : Manoly, Wichman, Hartzman

II. Working Group Supports

1. Pete Deubler indicated that Mark Bressler and Ron Haupt will both allow their memberships in the committee to expire and that approval of B31.1 allowable revision is expected. This will probably not be published in the 2000 Edition. A factor of safety of 3.5 will be used for supports since Section II, Part D is based on the 3.5 safety factor. Nguyen noted that according to the Federal Register, the NRC has adopted the addition of the 96 Edition, with exceptions concerning the use of new seismic rules and socket weld sizes. Interest: Imbro, Manoly, Wichman

2. NF-265, "Relocation of Appendix K." This item proposed to relocate Appendix K from the non-mandatory appendices to NF. Jean Claude Hannart volunteered to do this task. Hennart has worked up some editorial changes for this item, but it has overlap with NF-272. Uma Bandyopadhay was assigned to provide information to Hannart for this task. Uma presented proposed changes to NF-4221, NF-4222 and Appendix K (Attachment 4). It was voted to combine NF-4221, 4222 and NF4223 into one paragraph and marked up as shown in the attachment. Interest: Manoly, Fair, Wichman, Hartzman

3. NF-274, "Lamellar Tearing Provisions in NF-3000." This item is a part of NF-245 which proposed deleting Figure NF-4441-2, modifying Figure NF-4441-1, and adding the concern of lamellar tearing. Jean-Claude Hennart provided a markup (Attachment 5) of proposed "Consideration of Lamellar Tearing," to be inserted in NF-3256.2, NF-3256.4 and NF-3324.5. This markup provision enhances the weld joint and was approved by the committee. Interest: Manoly, Fair, Wichman, Hartzman

III. Subgroup Design

1. The September 1999 meeting minutes was passed unanimously. Chairmen for WGPD, WGNF, WG Vessel, Enviromental Effect, and SWGSR gave reports on their memberships. WGPD will add one member, WGNF will drop two members and add one; Pump will lose one. WG on Valves has trouble recruiting new members. WG Vessel will have new NRC member. Interest: Imbro, Manoly, Wichman, Hartzman

2. Dr. David Jone briefly described the environmental effect on Fatigue Strength in response to the Subgroup Design's request for input, as it relates to one of NRC areas of concerns (Attachment 6). Further background information can be found in NUREG/CR-6582, "assessment of Pressurized Water Reactor Primary System Leak." Attachment 7 is Subgroup Fatigue Strength response to Slagis's previous comments. Interest: Imbro, Manoly, Fair, Wichman, Hartzman

3. Hiroe Kobayashi presented the results of a revised ABACUS model to simulate Test #37 (Run 5) using shell element (Attachment 8). The new analysis provided a better match the Test 37 Run 5 displacement. Kaoayashi indicated that the model was expensive to run and therefore they did not use it to extrapolate Run 5 to off resonance conditions. The Japanese also concluded that the previous analysis using elbow element provides

adequate results for off resonance conditions. Interest: Imbro, Chen, Manoly, Fair, Wichman, Hartzman

5. Ralph Hill gave a presentation on Mesa Visa. This is same as item I.7 above.

Attachment: As stated

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NRR-105

II –2000 EXPERIMENTAL DETERMINATION OF STRESS INTENSIFICATION FACTORS

This Appendix presents an experimental method to determine stress intensification factors (SIF) of piping components for use in the design of piping systems in accordance with subsections NC/ND-3600.

II-2100 Definitions

Stress Intensification Factor: A fatigue strength reduction factor which is the ratio of the elastically predicted bending moment producing fatigue failure in a given number of cycles in a butt weld on a straight pipe of nominal dimensions, to that producing failure in the same number of cycles in the component under consideration.

II-2200 Test Procedure

II-2210 Test Equipment

A schematic of a test arrangement is given in Fig. II-2210-1.

(a) The machine framework must be sufficiently stiff to prevent anchor rotations.
(b) The pipe component shall be mounted close to the fixed end of the test assembly, but no closer than two pipe diameters.
(c) The free end shall be hinged in a slide capable of applying a fully reversible displacement.
(d) The test equipment shall be calibrated to read displacements with an accuracy of 1% of the imposed displacement amplitude.

II-2220 Test Specimen

The test specimen shall be ASTM SA 106 Grade B pipe and equivalent plates and forgings, otherwise the rules of II-2410 apply.
The fabrication, welding and examinations of the tested components shall be the same as will be followed in fabrication of the component ~~production~~. Weld contours should be

representative of those intended to be used in fabrication.

II-2230 Applied Moment

(a) The test specimen shall be placed in the test configuration and displacements shall be applied in steps to obtain a load-displacement plot analogous to that shown in Fig. II-2230-1. At least five points must be recorded in the linear region of the plot.
(b) The loading sequence shall be stopped ~~interrupted~~ when the recorded load-displacement is no longer

linear.

(c) The specimen must then be unloaded, following the same ~~displacement and~~ recording sequence as during loading.

(d) The linear region of the load-displacement curve and its straight line extension will be used in determining the force F_e in II-2300.

II-2240 Cycles to Leakage

(a) The test specimen shall be placed in the test configuration and pressurized with water at 15 psig to 100 psig.

(b) The specimen shall be subjected to fully reversed cyclic displacements until a visible through-wall leak develops in the component or its weld to the pipe.

(c) The fully reversible displacements shall be applied at a frequency not to exceed 120 cycles per minute.

(d) The number of cycles N at which the leak occurred shall be recorded. The cyclic displacements shall be selected such that failure occurs in a minimum of N = 500 cycles, and preferably 1000 cycles, of reversed displacements.

Note: Other equivalent methods of through-wall crack detection are permissible.

II-2300 STRESS INTENSIFICATION FACTOR

II-2310 Calculated ~~Leakage~~ Stress

(a) The distance L between the point of applied displacement and the leak point is measured.
(b) The imposed displacement is entered on the load-displacement curve established in II-2230, and the corresponding force is noted as F_e.
(e) The applied moment at leakage M_e is to be calculated as

$$M_e = F_e L$$

where

M_e = applied elastic moment amplitude at leakage, in-lb
F_e = force corresponding to the applied displacement, read on the straight line of Fig. II-2230-1, lb
L = distance between the point of applied displacement and the leak point, in the direction perpendicular to the imposed displacement, in

(f) The ~~leakage stress is calculated as~~ elastically calculated stress amplitude corresponding to the elastic moment at leakage is

$$S = \frac{M_e}{Z}$$

where

S = leakage stress, psi
Z = section modulus as defined in II-2320, in^3

II-2320 Section Modulus

The value of the section modulus (Z) used in calculating the leakage stress in II-2310 shall be that intended to be used in design. ~~It is typically Z of the matching pipe~~ The section modulus of the matching pipe is typically used in design. If the leakage stress is computed using Z other than that of the matching pipe, the manner in which Z is computed must be explicitly specified in the definition of the stress

intensification factor, and ~~the design stress must be calculated based on the Z at the same location.~~ The value of Z at the same location shall be used in design.

II-2330 Stress Intensification Factor

The stress intensification factor is established as

$$i = \frac{C}{S(N^b)}$$

where

i = stress intensification factor
C = material constant; 245,000 psi for a carbon steel test specimen
S = leakage stress, psi
N = number of stress reversals to failure
b = material exponent; 0.2 for a carbon steel test specimen

II-2340 Number of Test Specimens

(a) The value of the stress intensification factor *i* shall be the average value from several, preferably a minimum of four, cyclic displacement tests.
(b) Where less than four tests are conducted, the calculated stress intensification factor *i* shall be increased by a factor C_i given in Table II-2340-1.

Table II-2340-1
Stress Intensification Increase Factor

Number of Test Specimens	Increase Factor C_i
1	1.2
2	1.1
3	1.05
≥ 4	1.0

II-2350 Directional Stress Intensification Factors

(a) For non-axisymmetric components, a directional stress intensification factor shall be established independently for each direction of bending.
(b) Where the design Code requires the use of a single stress intensification factor, the largest value from the directional stress intensification factors shall be used.

II-2360 Variable Amplitude Test

If the applied displacement amplitude is changed during a cyclic test, the number of cycles to leakage shall be determined by

$$N = \sum_i \left[\left(\frac{x_i}{x_j} \right)^{1/b} N_i \right] + N_j$$

where

N = equivalent number of stress reversal cycles to leakage, at amplitude x_j.
N_i , N_j = number of stress reversal cycles at amplitudes x_i , x_j.
x_i , x_j = amplitudes of displacement applied during N_i , N_j cycles, in

II-2400 VARIATIONS IN MATERIALS AND GEOMETRY

II-2410 Material Constant and Material Exponent

When using a ~~teat~~ test specimen made of Code listed materials other than carbon steel, a new material constant *C* and material exponent *b* ~~must~~ shall be established as follows:

(a) A butt welded test specimen of the tested material shall be fabricated and ~~tested~~ same in accordance with II-2200.
(b) The cyclic test of II-2230 shall be repeated for a minimum of eight specimens subject to different applied displacements.
(c) The pairs of values (N,S) shall be plotted on log-log scale.
(d) The material constant C and the material exponent b shall be obtained by tracing a best estimate straight line through the (N,S) points, in the form

$$\frac{C}{S(N^b)} = 1$$

II-2420 Geometric Similarity

(a) The stress intensification factor derived from the tests is applicable to components that are geometrically similar within 20% of ~~exact geometric similarity to~~ of the dimensions of the test specimens.
(b) Dimensional extrapolations other than in (a) shall be identified in the test report, along with their

technical justification.

II-2500 TEST REPORT

A test report shall be prepared and certified to meet the requirements of this Appendix by a Professional Engineer competent in the design and analysis of pressure piping systems. The test report shall be complete and written to facilitate an independent review. The report shall contain:

(a) Description of the tested specimens.
(b) Nominal pipe and fitting size and dimensions and actual cross sectional dimensions of importance in interpreting the test results.
(c) Description and photographs or sketches of the test equipment, including positioning of the test specimens in the machine.
(d) Calibration of the test equipment. This information may be provided by reference.
(e) Certified ~~m~~Material test reports for the tested component, including mill-test value of yield and ultimate strength.
(f) Component and component-to-pipe weld examinations where they are required by the construction Code, with certification of Code compliance of the welds.
(g) Loading and unloading load-displacement points and line, in accordance with II-2230.
(h) Values of material constants C and b, section modulus Z, number of cycles to leakage N, length to leakage point L, force F_e and moment M_e for each test.
(i) Derivation of the stress intensification factor *i* for each test.
(j) Description, and photograph(s) or sketch(es) of the leakage location.
(k) Justification for geometrical similarity, if any, in accordance with II-2420.

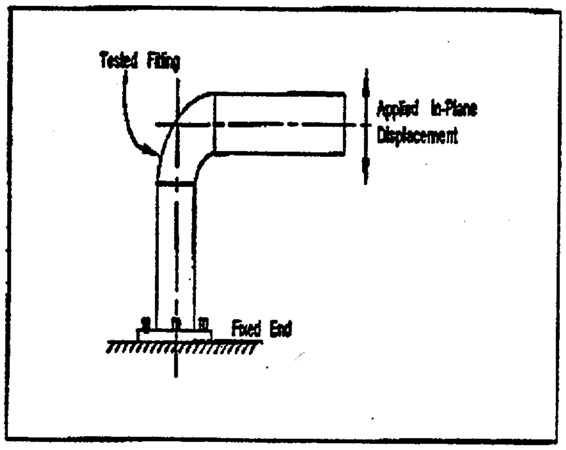

Figure II-2230-1 Schematic of Test Assembly.

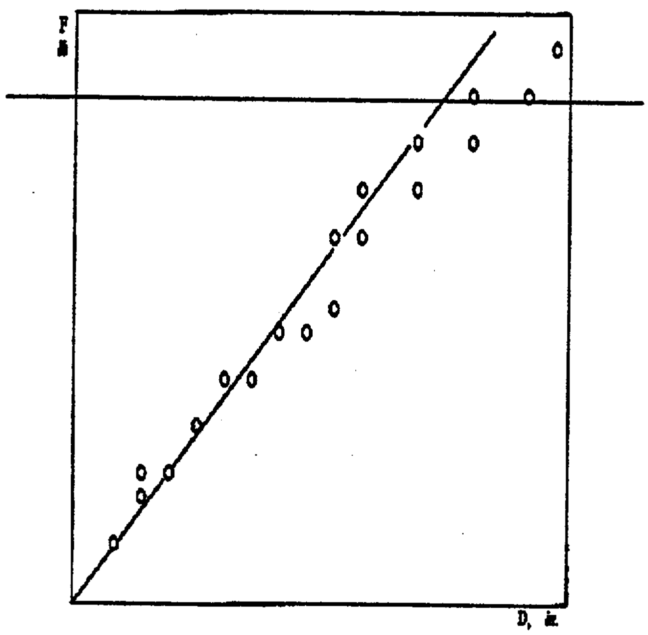

Figure II-2230-1 Displacement (D) and Force (F) Recorded During Loading and Unloading of Test Specimen, with Linear Extrapolation.

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B_2 Stress Index - Update

Vernon Matzen and Ying Tan

C-NPP-SEP

December 1999

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ASME Boiler & Pressure Vessel Code

Equation (9):

$$B_1 \frac{PD_o}{2t} + B_2 \frac{M_i D_o}{2I} \le 1.5S_m \qquad \frac{M_i D_o}{2I} \leftrightarrow \frac{M_i}{Z_e}$$

where

$B = \frac{\sigma}{S}$ — σ: stress magnitude due to a limit load; S: nominal stress due to a limit load

NB-3683.7: for elbows

$$B_2 = \frac{1.30}{h^{2/3}} \text{ but not } < 1.0$$

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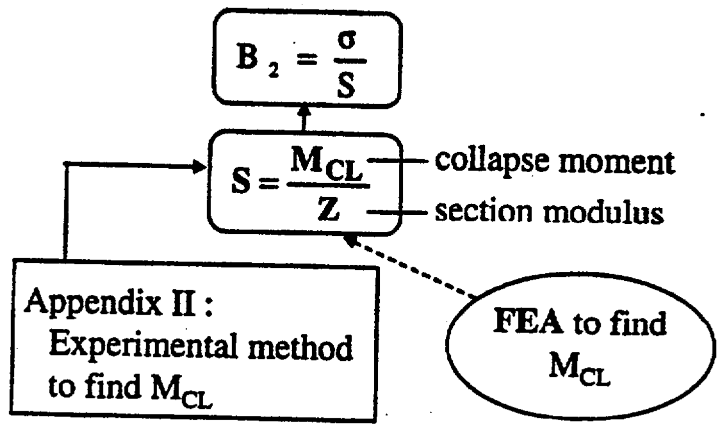
Procedure for Obtaining B_2 for any component



Note: Procedure must give B_2=1 for a straight pipe

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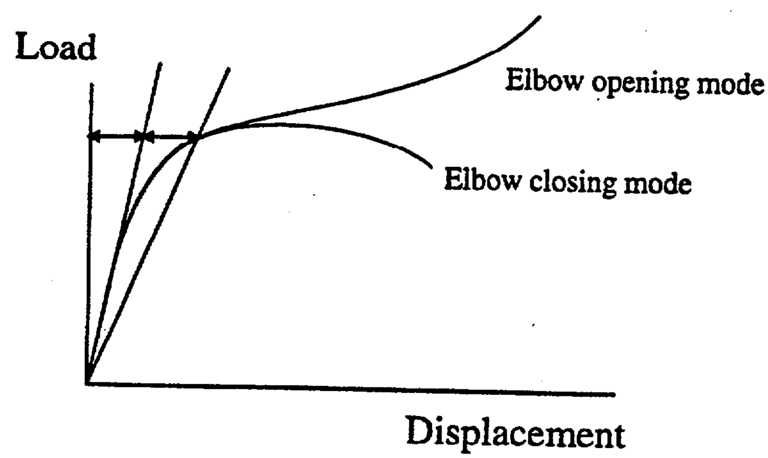
Code-defined collapse: Elbow Example



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$$B_2 = \frac{S_y}{M_{CL}/Z} = \frac{S_y Z}{M_{CL}}$$

$$B_{2,comp,Normalized} = \frac{B_{2,comp}}{B_{2,straightPipe}} = \frac{\left(\frac{S_y Z}{M_{CL}}\right)_{comp}}{\left(\frac{S_y Z}{M_{CL}}\right)_{S.P}}$$

$$B_{2,comp,Normalized} = \frac{M_{CL,S.P.}}{M_{CL,comp}}$$

B_2 Definition

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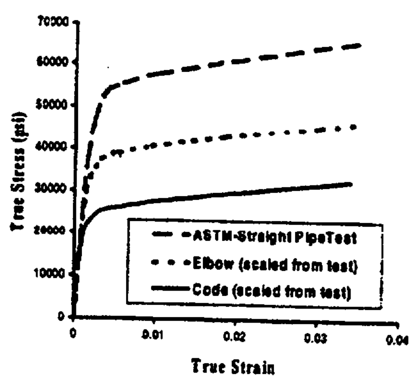
Engineering σ scaling factor

SS304L @RT	S_y (ksi)	S_u (ksi)	α	
			S_y	S_u
ASTM test	53.2	89.4	/	
Elbow	37.42	82.96	0.70	0.93
Code	25.0	70.0	0.47	0.78

True Stress - True Strain



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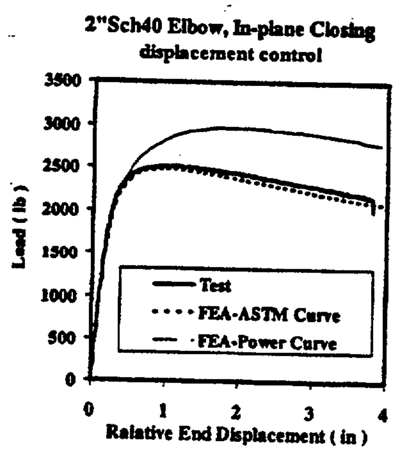

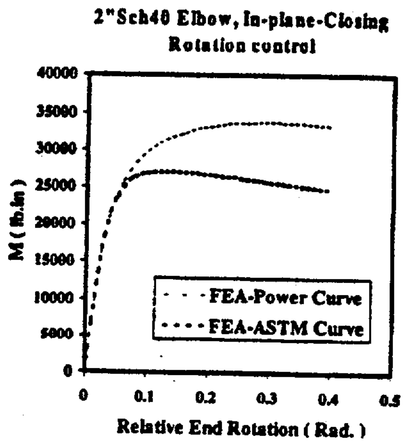

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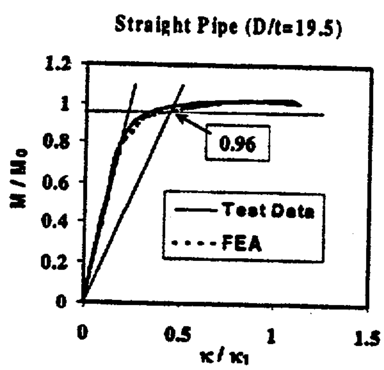
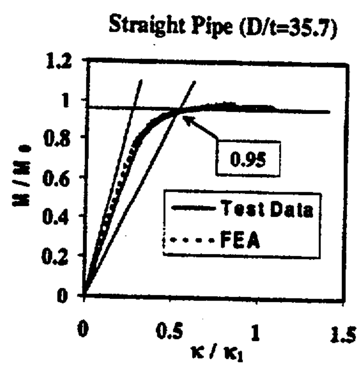
Test Data vs. FEA for Straight Pipe





where, κ — curvature, κ_1 — t/D_o^2, M — moment, M_o — $S_y Z_p$

Test Data Reference:	Test specimens:
Gwo-Tarng Ju, Dissertation of UT at Austin, August, 1991	Geometric characters: D_o=1.25 in, L/ D_o =24.0 Material: aluminum shell Test device: pure bending

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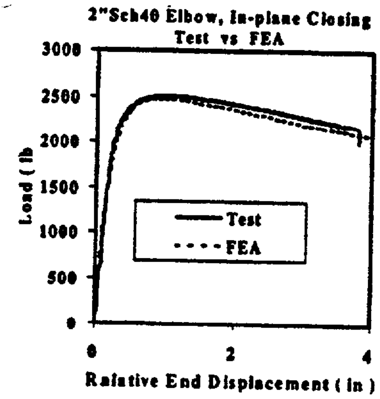
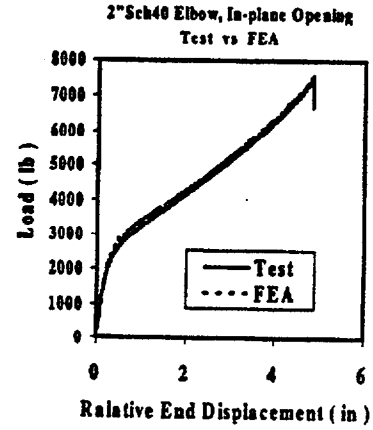
Test Data vs. FEA for Elbows





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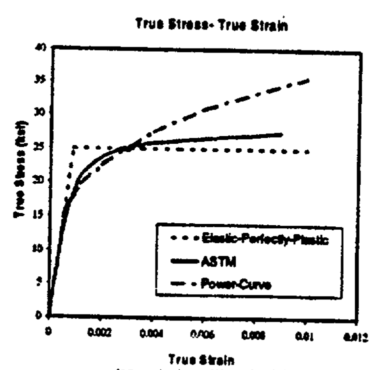
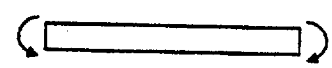
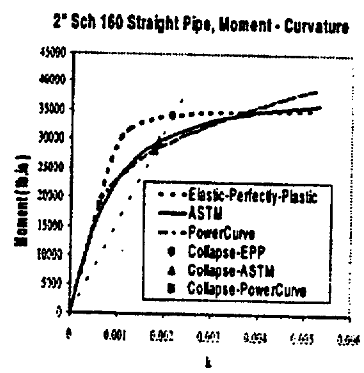
Example:







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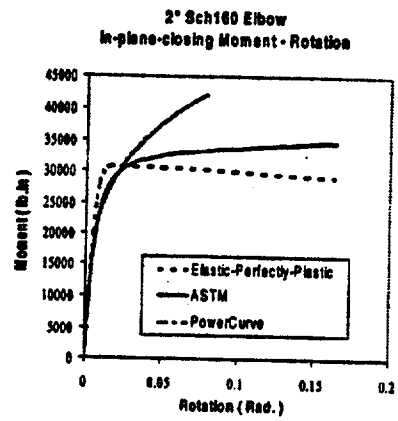

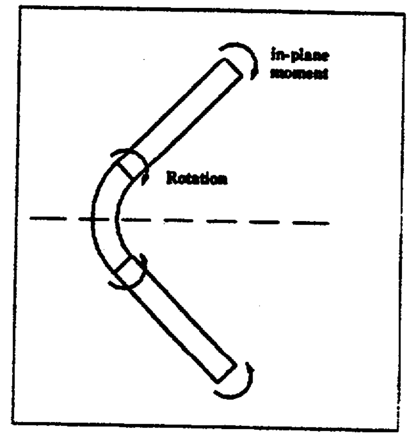

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B_2 values using different shapes of σ–ε curves

Schedule	σ-ε (Code S_y, S_u E)	$M_{\alpha,SP}$ (lb.in)	$M_{\alpha,elbow,in\text{-}plane\text{-}closing}$ (lb.in)	$B_{2,elbow}$
2"Sch160	Code Equation			1.30
	ASTM Curve	29,680	26,525	1.12
	Power Curve	28,076	25,226	1.11
	EPP	34,000	30,427	1.12
8"Sch5	Code Equation			7.50
	ASTM Curve	166,674	31,719	5.25
	Power Curve	157,126	30,926	5.08
	EPP	190,848	34,276	5.57

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B_2 values using different values of S_y

Schedule	σ-ε (ASTM Curve)	$M_{CL,SP}$ (lb.in)	$M_{CL,elbow,in\text{-}plane\text{-}closing}$ (lb.in)	$B_{2,elbow}$
2"Sch160	Code S_y, S_u	29,680	26,525	1.119
	Test S_y, S_u	70,427	62,122	1.133
8"Sch5	Code S_y, S_u	166,674	31,719	5.255
	Test S_y, S_u	389,635	58,535	6.656

Code and Experimental Values of S_y and S_u		
	S_y (ksi)	S_u (ksi)
Code	25.0	70.0
Experiment	53.2	89.4

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$$\text{Margin}_{comp} = \frac{M_{CL,comp}}{M_{code,comp}}$$

$$= \frac{M_{CL,comp}}{\left(S_y Z/B_2\right)_{comp}}$$

$$= \frac{M_{CL,comp}}{S_y Z} B_{2,comp,\ Normalized}$$

$$= \frac{M_{CL,comp}}{S_y Z} \cdot \frac{M_{CL,S.P.}}{M_{CL,comp}}$$

Our Definition

$$= \frac{M_{CL,S.P.}}{S_y Z}$$

$$= \text{Margin}_{straight\ Pipe}$$

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Future Work - Monotonic

1. Out-of-plane test, analysis and reconciliation
2. Use of other materials, sizes and schedules
3. Effect of internal pressure
4. Effect of flange location
5. Effect of elevated temperature
6. Definition and calculation of B_1
7. Consideration of other components such as tees and branches.

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Future Work - Cyclic

- Cyclic tests at both low and high level.
- Reconciliation of test results with FEA results.
- Preliminary investigation of collapse definitions.

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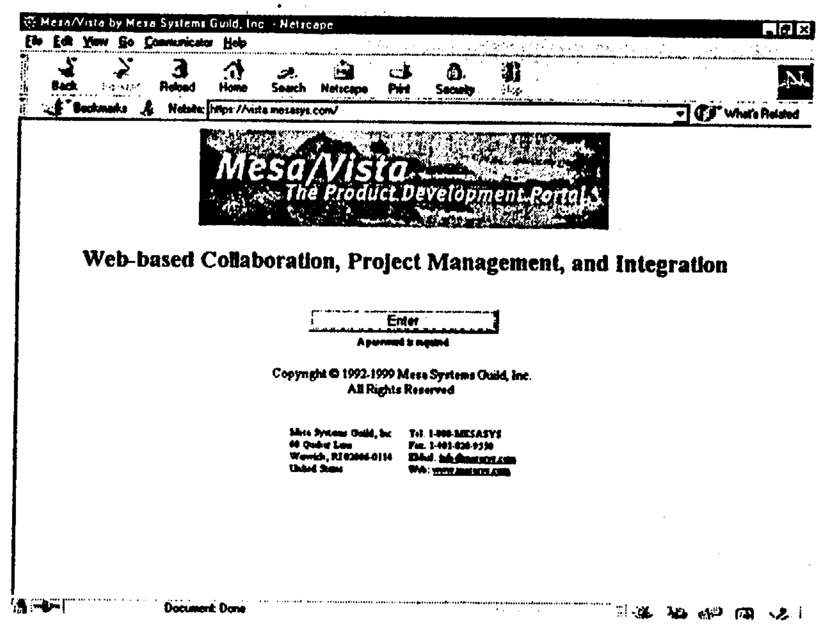
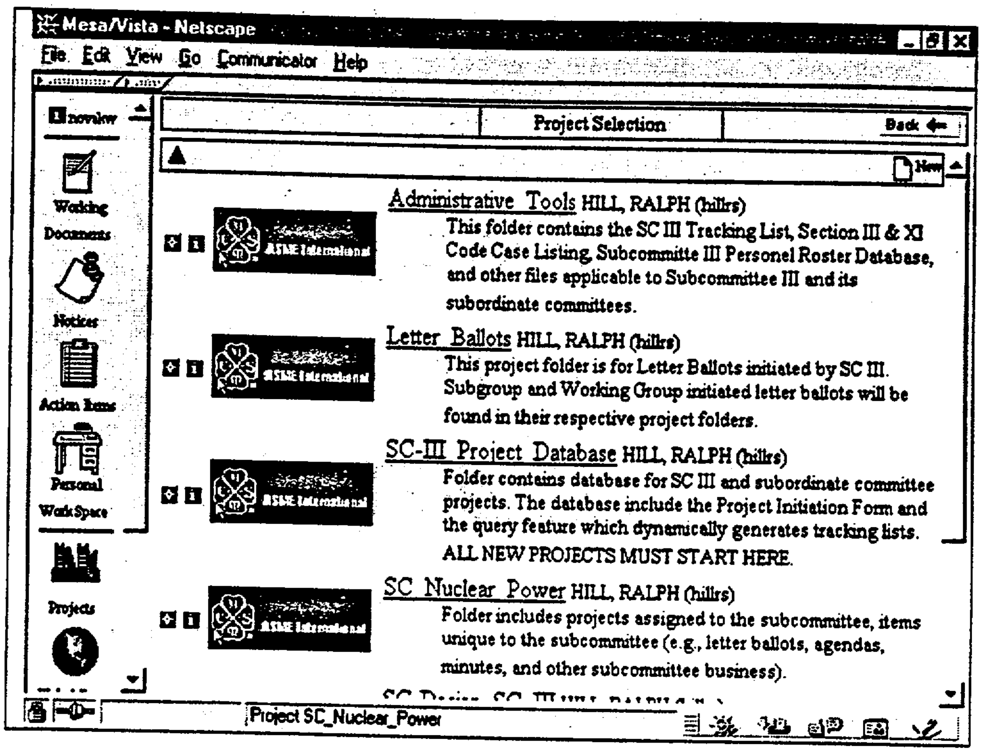
ASME CODES AND STANDARDS REDESIGN PILOT PROJECT

USERS MANUAL

This manual is designed for use by ASME Staff and members of Subcommittee Nuclear Power, Subgroup Design, and Working Group Piping.



For additional information, contact:
Ralph Hill, INEEL at
hillrs@inel.gov or 301-916-2545



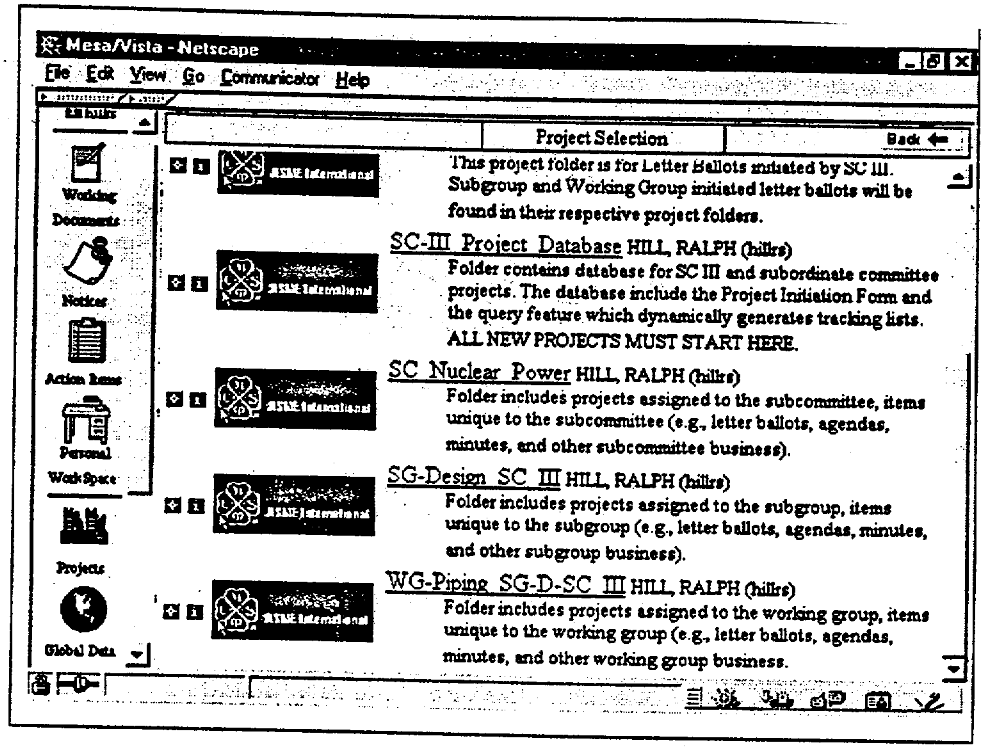
PAGE LAYOUT

The functions in Mesa/Vista are arranged on a number of pages. Figures 1 and 2 show the **Project Selection** page for the ASME pilot project. Each page is composed of three areas:

•The **Work Space Menu** is permanently displayed in a column down the left side of the browser's window. It contains buttons to perform the most often used functions: *Working Documents, Notices, Action Items, Personal Workspace, Projects, Global Data, Search, Administration, Help, and About Mesa/Vista.*

•The top area is a **Page Header Navigation Bar** that is fixed at the top of every page. If *SG-Design SC III* is selected from the Project Selection page of Fig. 2, the **Folders** page for the project is displayed, Figs. 3 and 4. The page header navigation bar at the top of Fig. 3 is split into three sections. The left section displays the project name. Detailed project information and the project hierarchy can be displayed by clicking the information icon "i" and the project hierarchy icon "*", respectively. The middle section is the title of the page currently displayed. The right section is the button bar for navigating backwards.

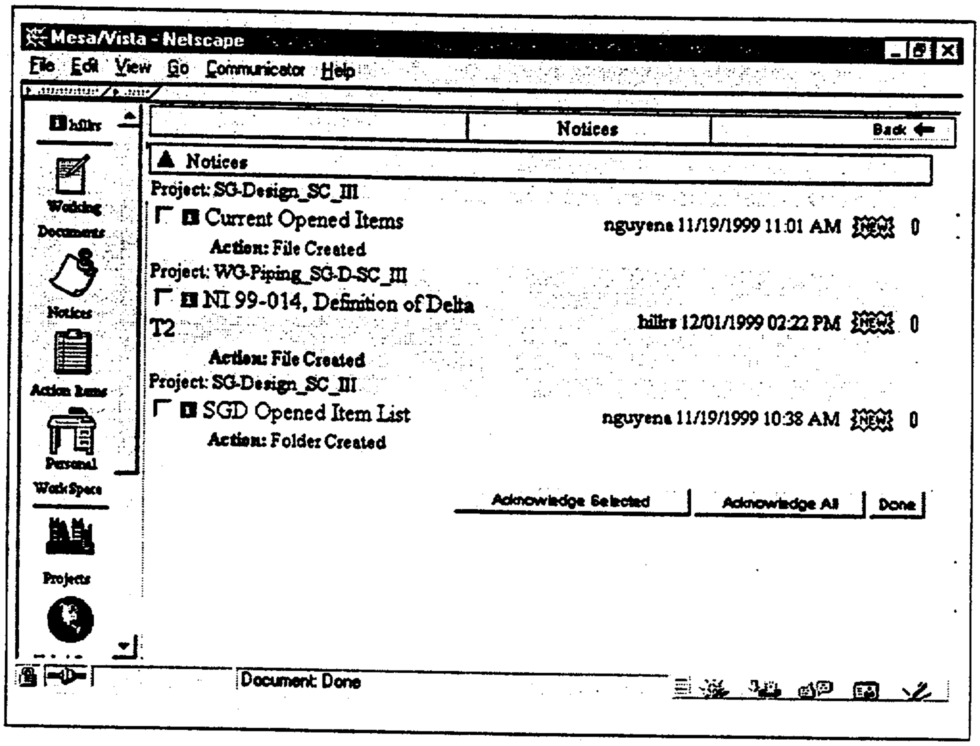
•The lower area is the **Body** and displays the contents of the function requested.



PROJECTS

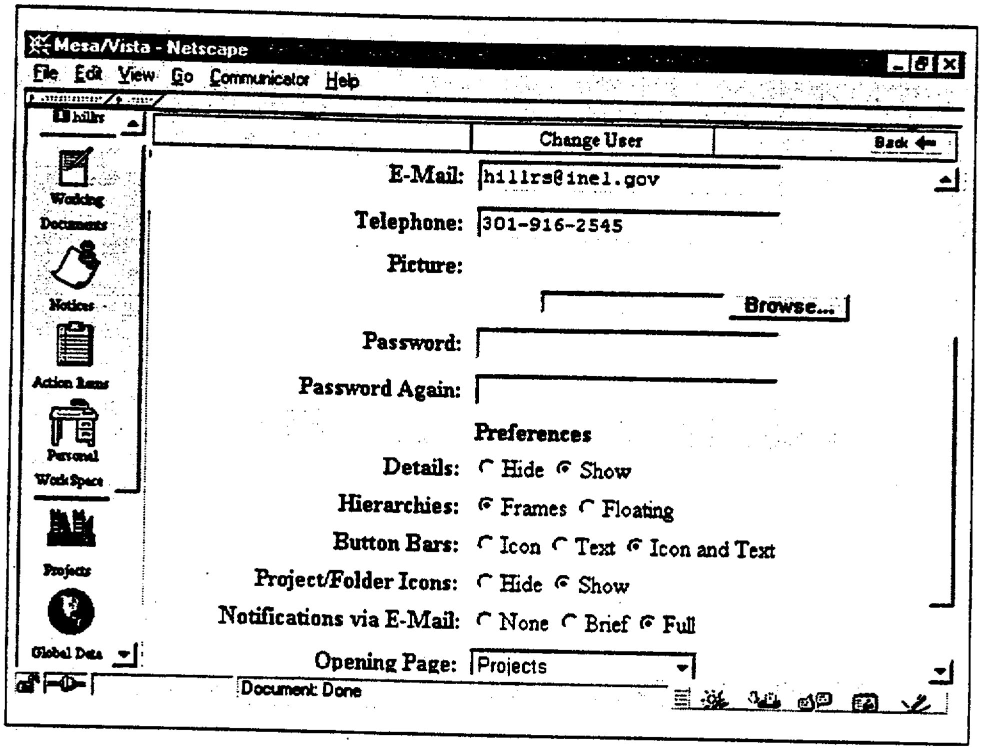
The **Project Selection** page, Figs. 1 and 2, displays a list of the projects of which a user is a member. The projects are displayed in alphabetical order by name, with the ASME or other graphic to the left and the project description to the right.

To see detailed descriptions of all the projects, the user clicks on the down triangle icon "▼" at the left of the table heading. The detail display shows the same information as the brief display, plus the detailed description and project leader. Figures 1 and 2 provide a detailed display of all projects that are part of the ASME pilot project. To switch back to the brief display, the user clicks on the up triangle "▲" at the left of the table heading.



NOTIFICATION

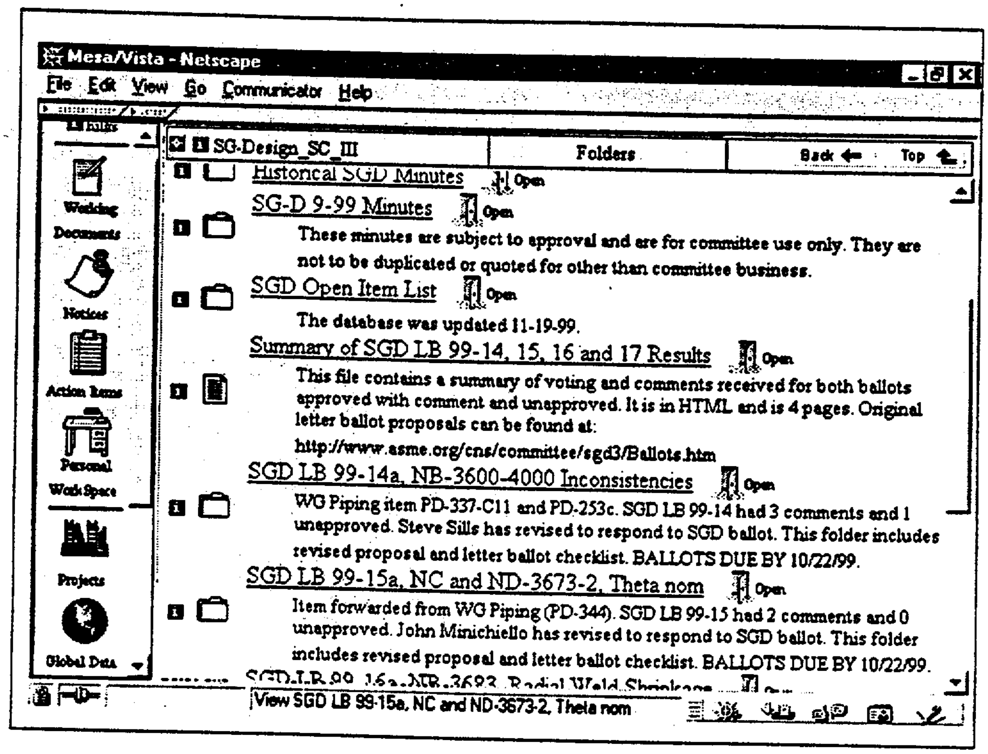
Notification is a method used to alert users that an item they are interested in has been added, changed or deleted. A user is registered to receive notification of changes with any data source, folder or project. Registering with a folder or project causes the user to be notified by e-mail if anything contained in the folder or project is updated.



MAINTAIN USER DATA

Users can change their password and other contact information by clicking on the "i" icon by their User ID at top of the Work Space Menu on the left hand side of the screen.

The User can also specify the Opening Page that appears after User ID and Password are entered.

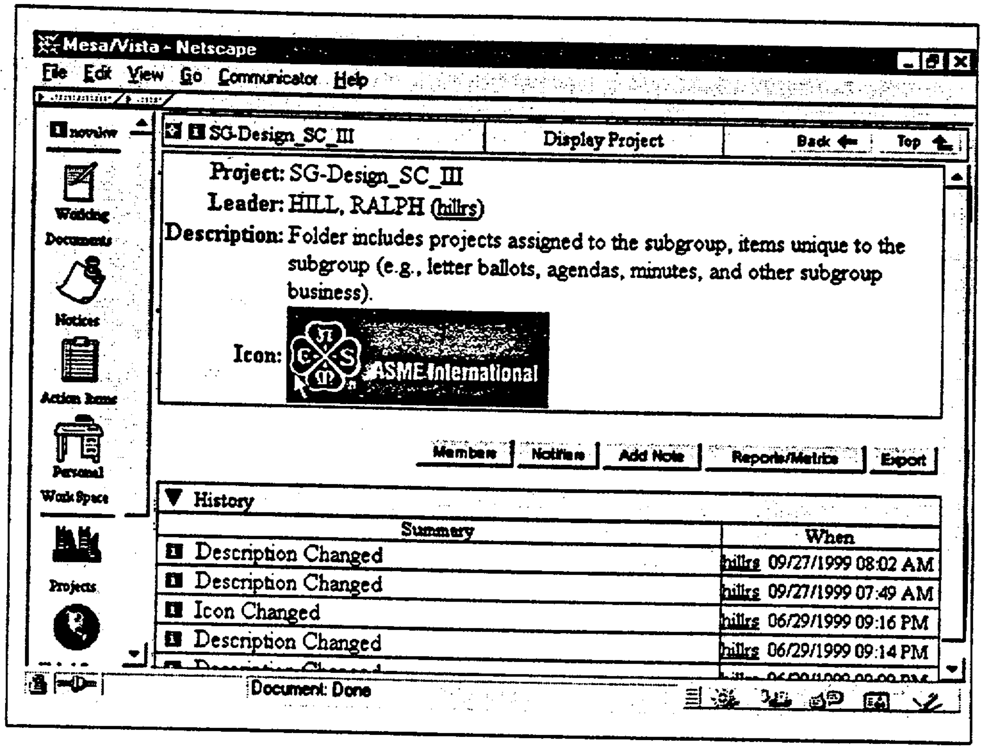


FOLDERS PAGE

By clicking on either a project name or the graphic, the **Folders** page for that project is displayed. Figure 5 is a partial view of the Folders page for the *SG-Design SC III* project.

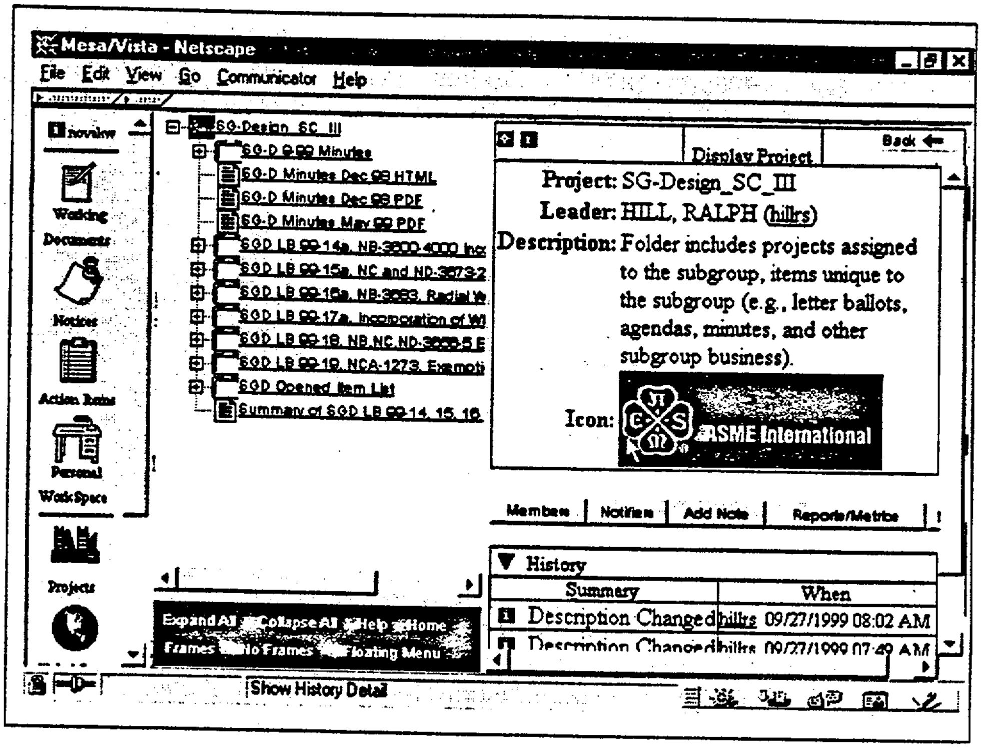
To the left of the project name on the Folders page are two icons. Clicking the information icon "i" displays the **Display Project** page. Figure 6 displays detailed information about the *SG-Design SC III* project and provides access to the project configuration.

The project hierarchy icon * displays the **Project Hierarchy** page. It is displayed in another frame and shows the entire project at a glance. Figure 7 displays the hierarchy for all folders and files contained in the *SG-Design SC III* project. The Project Hierarchy page is used as a shortcut -- to navigate directly to a specific data source page. Both icons can also be found next to the project name in the header.



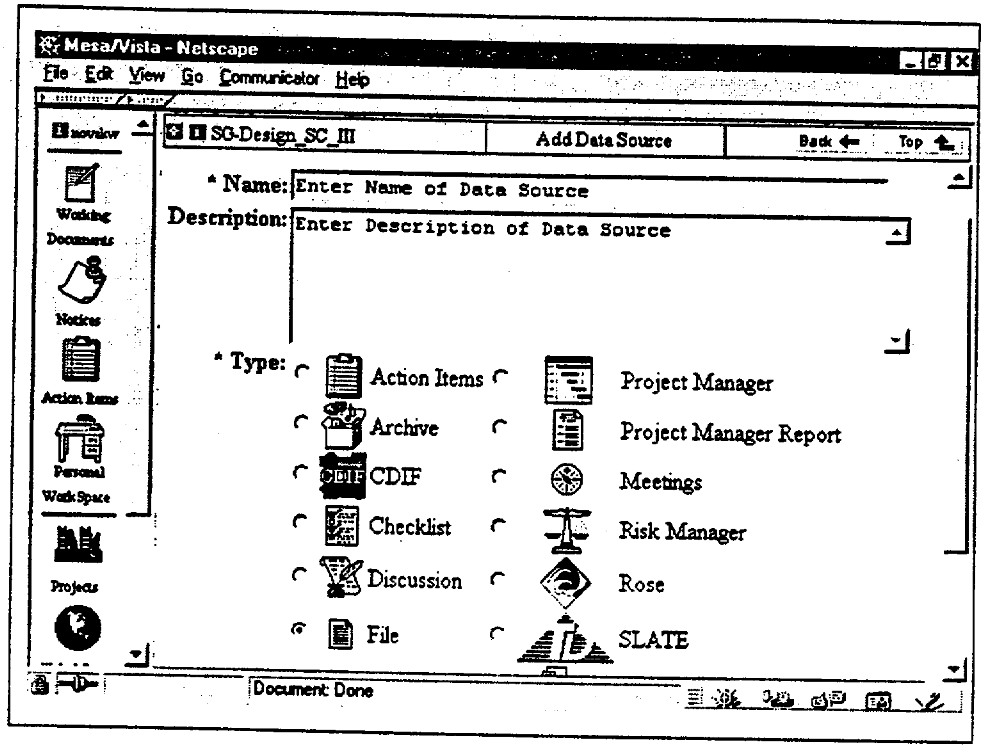
DISPLAYING PROJECT INFORMATION

The Display Project page, Fig. 6, shows the project name, the project leader and the icon associated with the project. It also displays a set of buttons for changing the membership of the project, producing reports and metrics, exporting the project to a backup file and other configuration options. Below the buttons, the history of changes made to the project is displayed. The second row of buttons is controlled by the user's authorization. A user must have *Change* authorization to see these buttons. The Project Leader and users with *Administration* authorization automatically have *Change* authorization, and can see these buttons.



PROJECT HIERARCHY

The project hierarchy icon * displays the **Project Hierarchy** page. It is displayed in another frame and shows the entire project at a glance. Figure 7 displays the hierarchy for all folders and files contained in the *SG-Design SC III* project. The Project Hierarchy page is used as a shortcut -- to navigate directly to a specific data source page. Both icons can also be found next to the project name in the header.

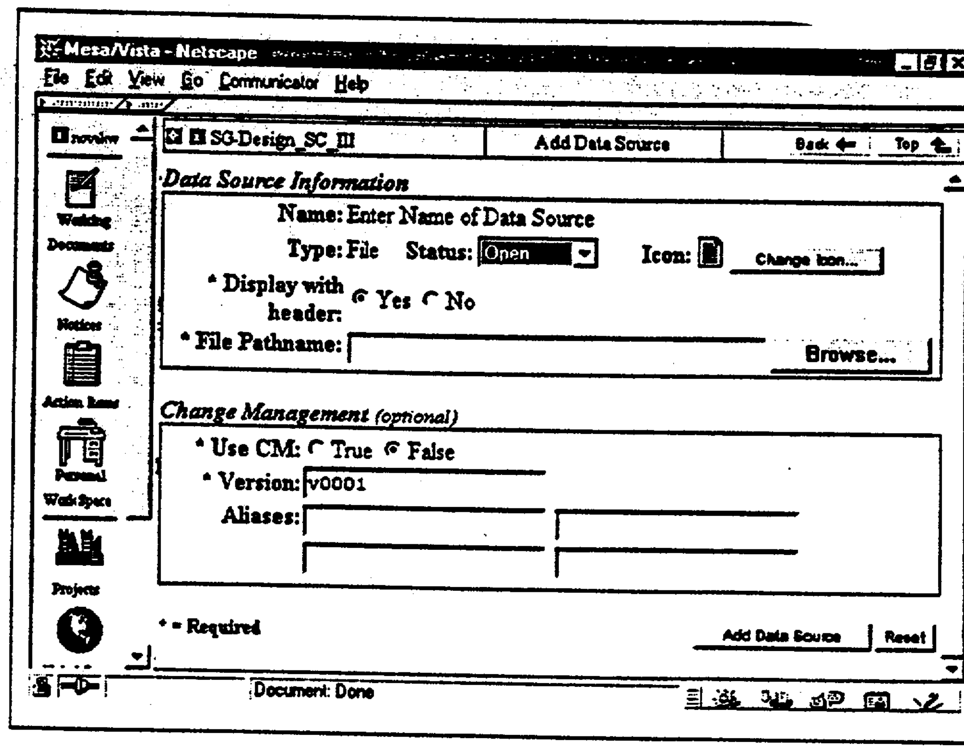


DATA SOURCES

A data source is the generic term used to mean any file, folder, diagram, chart, note, etc., that is stored and maintained in the folder hierarchy. Data sources can be either specific to a project (local) or span multiple projects (global). Local data sources could be system requirements, project plan. design specification, etc. Global data sources might be company operating procedures, handbooks. etc.

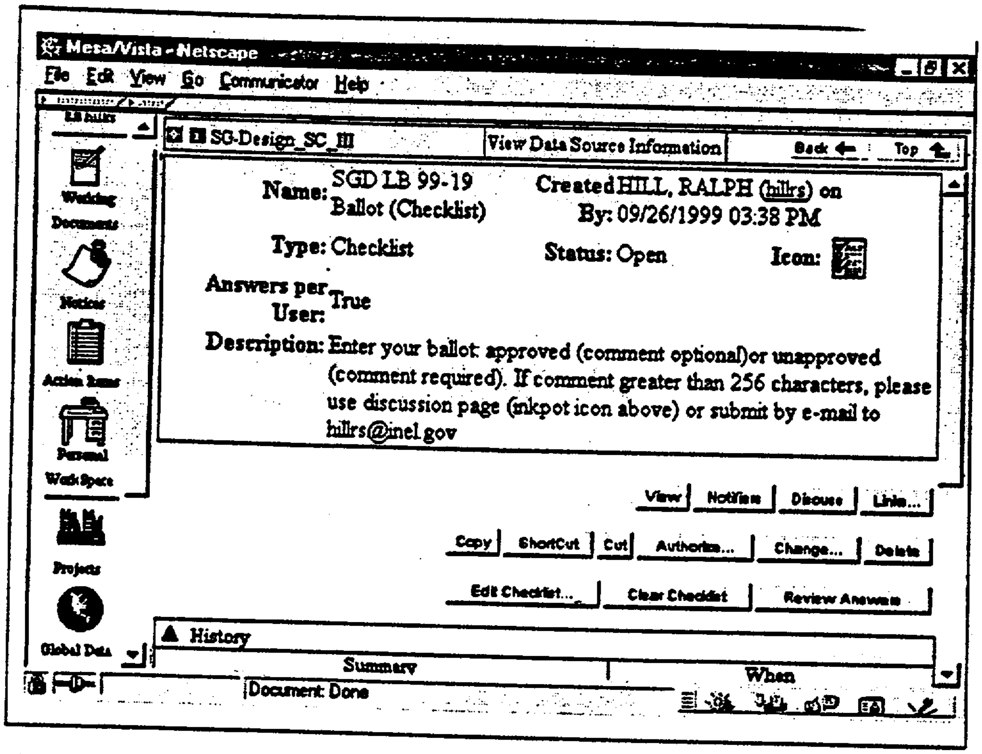
Typical data sources used by the ASME pilot project include meeting minutes and agendas, tracking lists. proposed changes to the Code. letter ballot "checklists", and the Section III Project Initiation Form. Use of the Mesa/Vista environment for letter balloting and for initiation and tracking committee action items are the key functions in support of the ASME redesign project.

Data sources can be added into any folder by clicking the *New* button. The button is only visible if a user has *Add* or *Administrator* authorization. Clicking the *New* button brings up the **Add Data Source to Folder** page, Fig. 8. Adding a data source is a 2 step - 2 page process. In the first step the type of data source is selected and given a name.



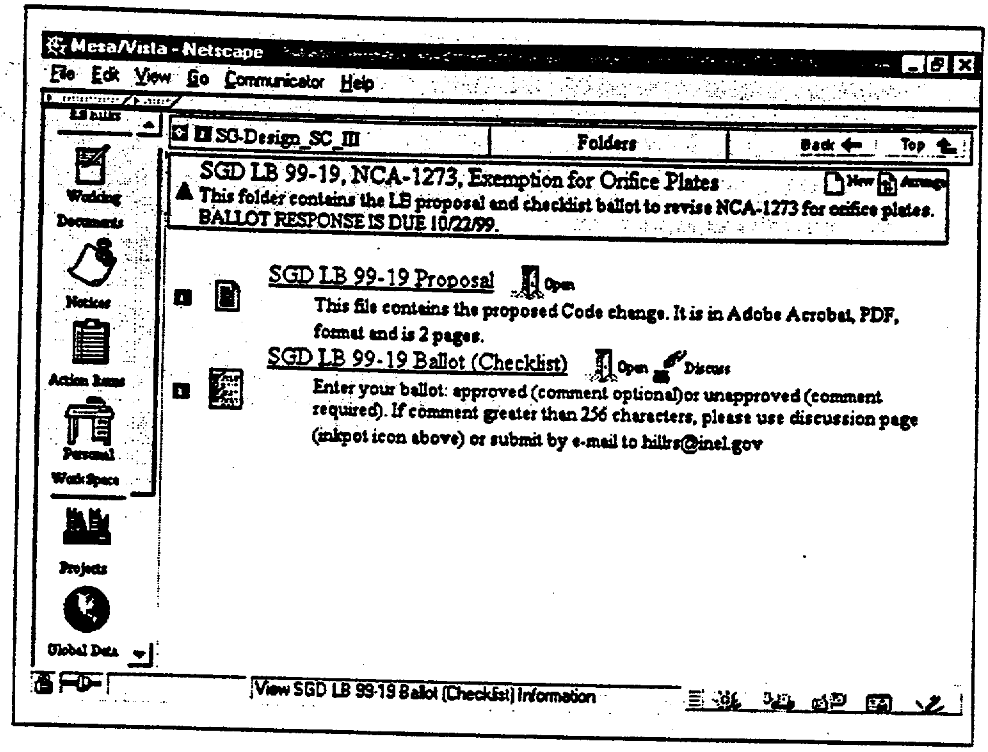
ADD DATA SOURCE (cont.)

After completing the first page, clicking the *Set Details* button brings up the second page, Fig. 9, of Add Data Source. During the second step, the user sets the icon associated with the data source, the data source status, and fields specific to the type of data source selected. For example, the *File* type requires selecting a document from the user's client machine. A user may also elect to place a file under *Change Management* (see below). With the required fields filled in, clicking on the *Add Data Source* button adds the data source to the folder.



VIEW DATA SOURCE

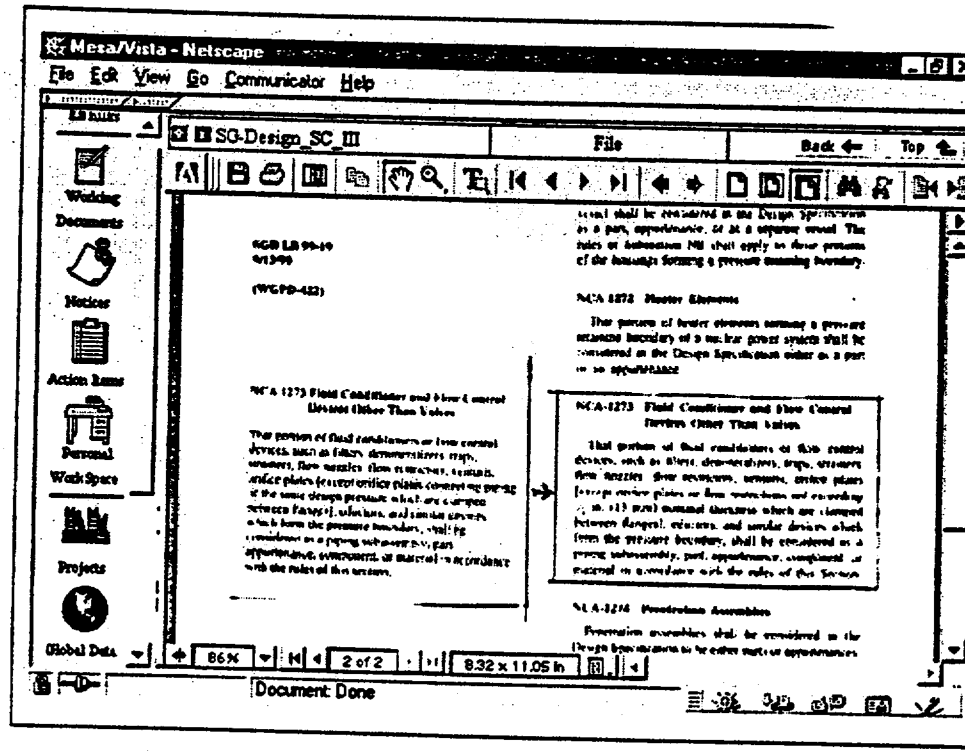
The details of a data source are displayed by clicking on the information icon "i" next to the data source. The **View Data Source Information** page displays information on who created the data source, its type, scope, status, etc. Options are also provided for manipulating this data. The options displayed depend upon the type of data source and the user's authorization. Figure 10 is the View Data Source Information page for *SGD LB 99-19 (Checklist)*. Options related to committee letter ballots are discussed in the section on *Checklists*.



LETTER BALLOT CHECKLISTS

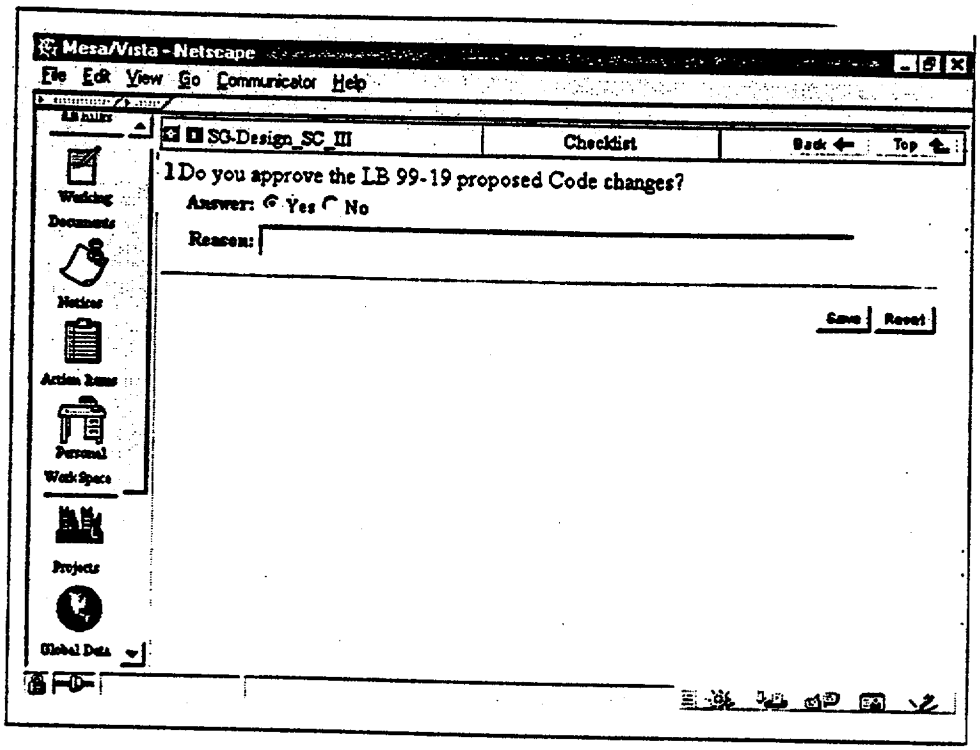
The ASME pilot project uses the checklist data source feature (see Fig. 8) of to implement a web-based letter ballot process. Proposed Code changes and a letter ballot "checklist" are combined into a Folder page. Fig. 11 is the Folder page for *SGD LB 99-19 (Checklist)*. This folder was accessed from the *SG-Design SC III* project Folder page shown in Fig. 5.

Figs. 12 and 13 display the proposed change and the letter ballot.



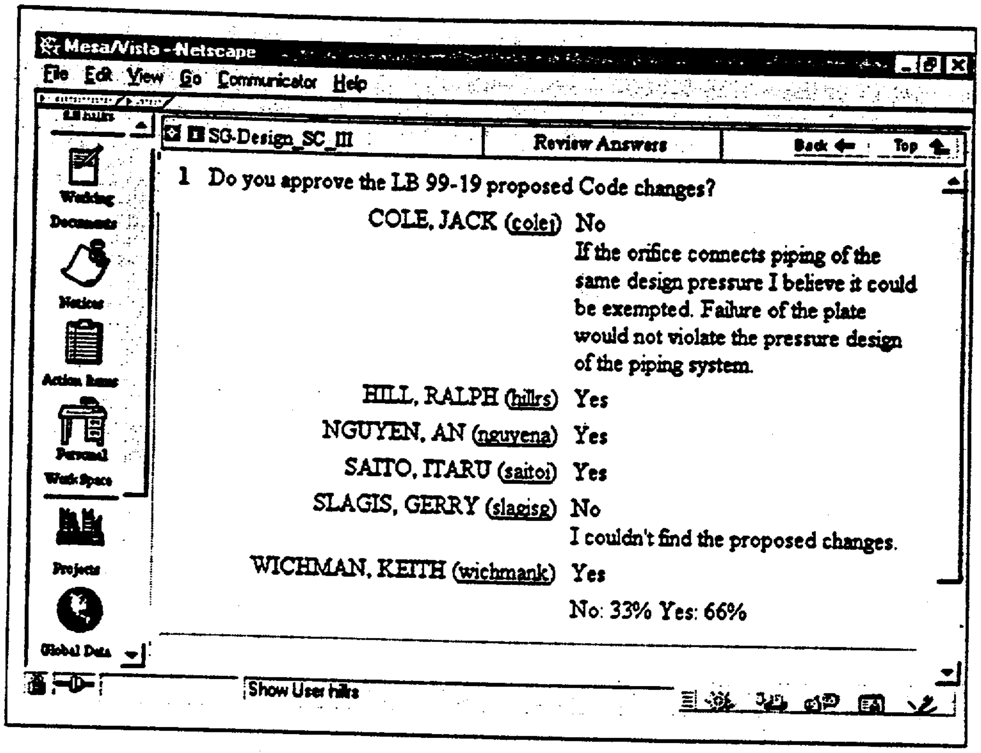
LETTER BALLOT CHECKLISTS (cont.)

Figs. 12 display s the proposed change.



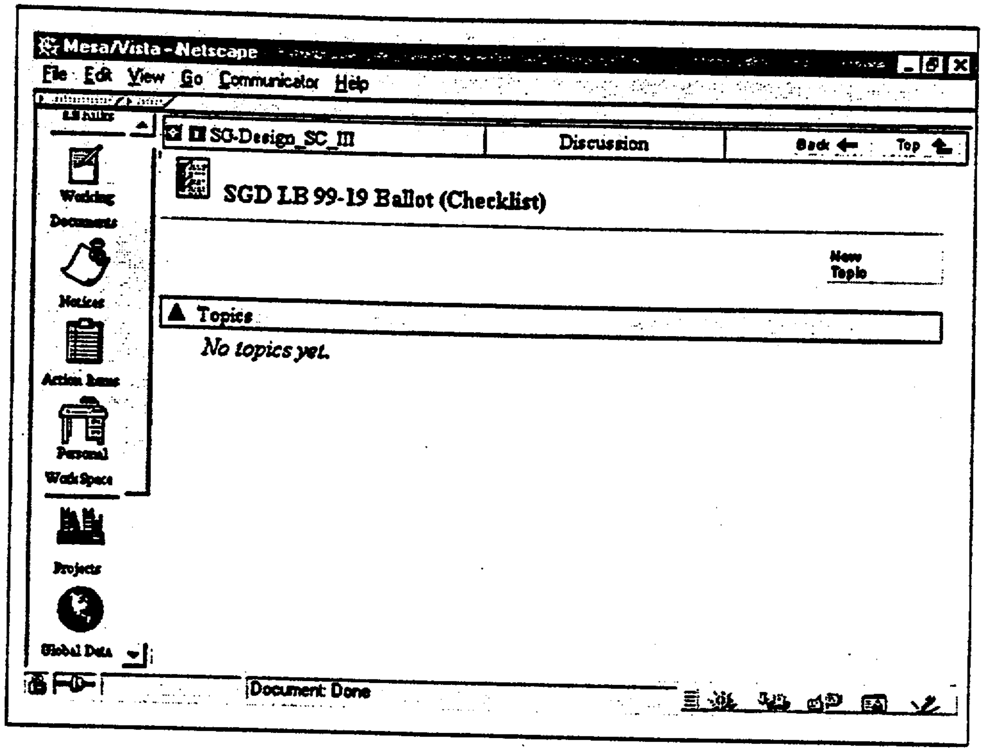
LETTER BALLOT CHECKLISTS (cont.)

Fig. 13 displays the letter ballot. Comments for unapproved ballots or ballots approved with comments can be made in two ways. Comments less than 256 characters can be made in the **Reason** section of the ballot. For longer comments, the Mesa/Vista **Discuss** feature is used (see Fig. 15).



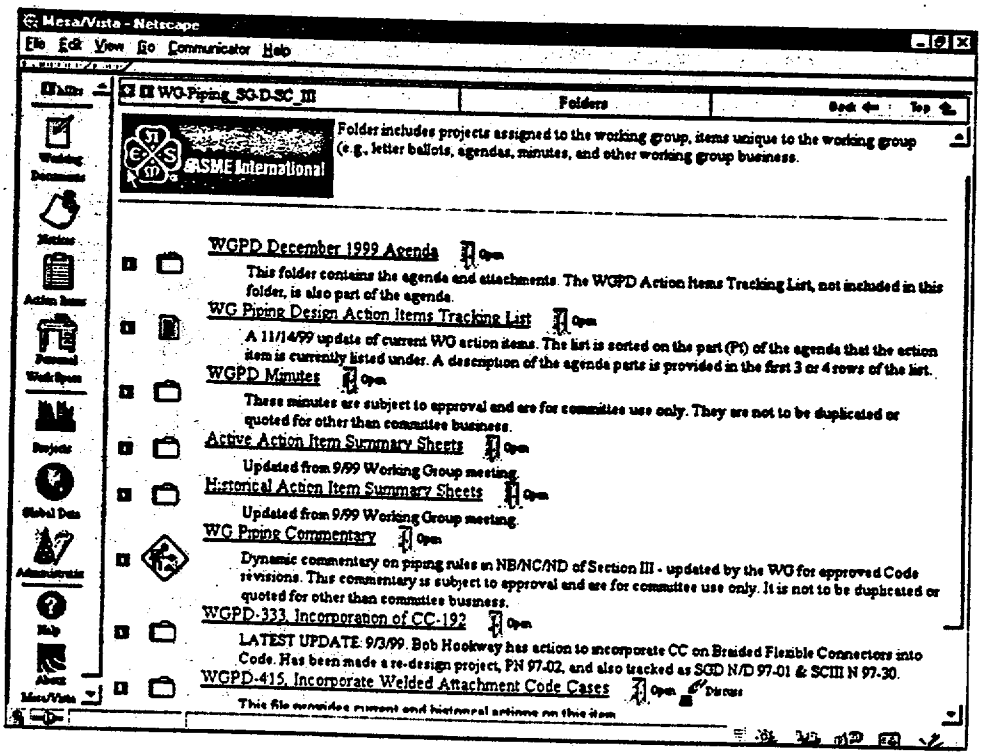
LETTER BALLOT CHECKLISTS (cont.)

Cumulative letter ballots results are also accessed from the View Data Source Information page for the ballot. Figure 10 displays this page for *SGD LB 99-19 (Checklist)*. Clicking on *Review Answers* button displays results for the ballot as shown in Fig. 14.

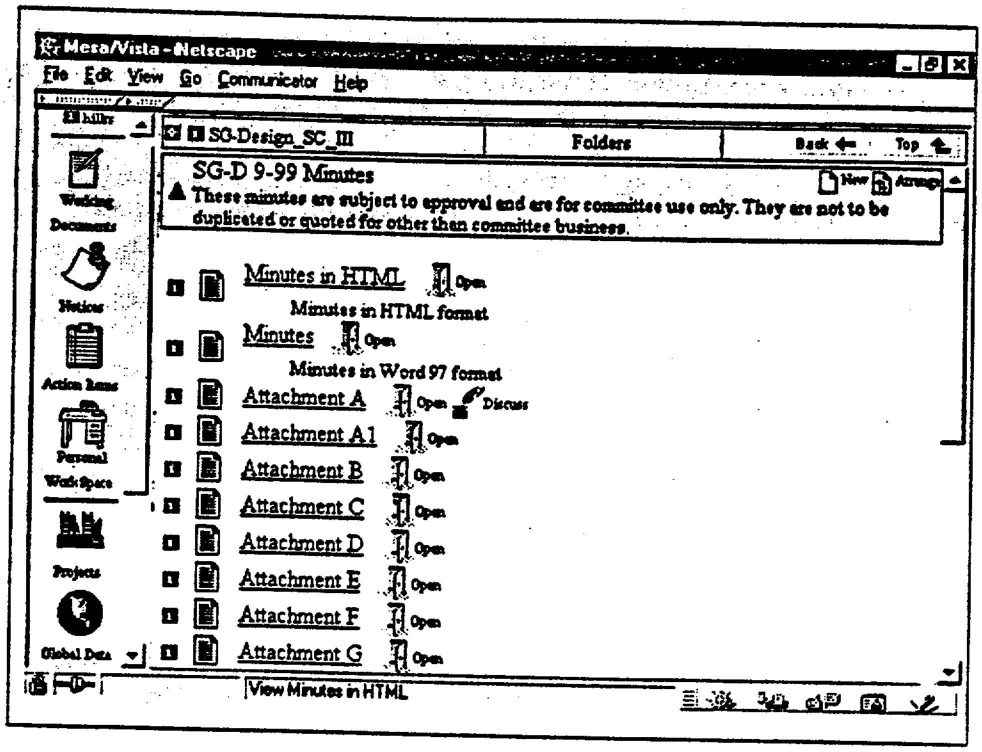


DISCUSS FEATURE

For longer comments on letter ballot checklists or on any project, folder or file, the discuss feature is used. This figure displays the **Discussion** page Discuss accessed from the View Data Source Information page for the SGD LB 99-19 (Fig. 10).



WG Piping Folders page as of 12/10/99.



SG Design 9-99 Minutes folder as of 12/10/99.

Committee Correspondence

-Keep ASME Codes and Standards Department Informed-

COMMITTEE: Working Group on Supports

SUBJECT: Review of NF-4220
(Item NF-272)

DATE: 11-23-99

ADDRESS WRITER CARE OF:
UMA BANDYOPADHYAY, P.E.
CARPENTER & PATERSON INC
SADDLE BROOK, NJ 07663
Telephone: (973) 772-1800
Fax No.: (973) 772-8333

RECEIVED
NOV 29 1999

TO: Mr. PETE DEUBLER, P.E.
Chairman, working group on supports
Fronek Company Inc.
15 Engle Street
Englewood, NJ 07631

CC: Mr. R.M. Dulin Jr.
Mr. J.C. Hennart

Dear Pete,

I have finished the review of NF-4220 & Appendix "K". I am recommending the following changes:

NF-4221 ---------Revise (See attached marked-up sheets.)
NF-4222 ---------Revise (See attached marked-up sheets.)

Appendix "K"----Revise (See attached marked-up sheets.).

Please call me, if you have any questions.

Sincerely yours,

UMA BANDYOPADHYAY

NF-4213.2 Procedure Qualification Test. The procedure qualification test shall be performed in the manner stipulated in (a) through (f) below.

(a) The tests shall be performed on three different heats of material both before and after straining to establish the effects of the forming and subsequent heat treatment operations.

(b) Specimens shall be taken in accordance with the requirements of NF-2000 and shall be taken from the tension side of the strained material.

(c) The percent strain shall be established by the following formulas:

For cylinders:

$$\%\ \text{strain} = 50t/R_f[1 - (R_f/R_o)]$$

For spherical or dished surfaces:

$$\%\ \text{strain} = 75t/R_f[1 - (R_f/R_o)]$$

For pipe:

$$\%\ \text{strain} = 100r/R$$

(a) the maximum change of lateral expansion and energy of the temperature under consideration, or

(b) the maximum change of temperature at the lateral expansion and energy levels under consideration; or

(2) when lateral expansion is the acceptance criterion (NF-2300), either the maximum change in temperature or the maximum change in lateral expansion.

NF-4213.3 Acceptance Criteria for Formed Material. To be acceptable, the formed material used in the support shall have impact properties before forming sufficient to compensate for the maximum loss of impact properties due to the qualified forming procedure used.

NF-4213.4 Requalification. A new procedure qualification test is required when any of the following changes are made:

(a) the actual postweld heat treatment time at temperature is greater than previously qualified considering NF-2211; if the material is not postweld heat treated, the procedure must be qualified without postweld heat treatment;

(b) the maximum calculated strain of the material exceeds the previously qualified strain by more than 0.5%;

(c) where preheat over 250°F is used in the forming or bending operation but not followed by a subsequent postweld heat treatment.

NF-4214 Minimum Thickness of Fabricated Material

If any fabrication operation reduces the thickness below the minimum required to satisfy the rules of NF-3000, the material may be repaired in accordance with NF-4130.

NF-4220 ~~FORMING~~ TOLERANCES

NF-4221 Tolerances for Plate- and Shell-Type Supports

~~*(a)* The outer surface of a Plate- and Shell-Type Support shall not deviate from the specified shape by more than the greater of 1¼% of the overall design dimension or those tolerances permitted by NF-4222 or NF-4223. Such deviations shall not include abrupt changes.~~

~~*(b)* For Plate- and Shell-Type Supports which are skirts, the difference between the maximum and minimum outside diameters shall not exceed 1% of the nominal outside diameter.~~

Tolerances for plate and Shell-type supports may be as recommended in Appendix K (Section III, Division 1, appendicies), unless otherwise specified in the Design Specifications.

NF-4222 Tolerances for Linear-Type Supports

Tolerances for Linear-Type Supports fabricated from built up members may be as recommended in Nonmandatory Appendix K (Section III, Division 1, Appendices), unless otherwise specified in the Design Specifications.

NF-4223 Tolerances for Standard Supports

Tolerances for Standard Supports may be as recommended in Appendix K (Section III, Division 1, Appendices), unless otherwise specified in the Design Specifications.

NF-4230 FITTING AND ALIGNING

NF-4231 Fitting and Aligning Methods

Parts that are to be joined may be fitted, aligned, and retained in position during the joining operation by the use of bars, jacks, clamps, drift pins, tack welds, or temporary attachments. Mechanical devices shall be carefully used to avoid damage to surfaces of the parts and to avoid enlargement of bolt holes.

NF-4231.1 Tack Welds. Tack welds used to secure alignment shall either be removed completely, when they have served their purpose, or their stopping and starting ends shall be properly prepared by grinding or other suitable means so that they may be satisfactorily incorporated into the final weld. Tack welds shall be made by qualified welders using qualified welding procedures. When tack welds are to become part of the finished weld, they shall be visually examined and defective tack welds removed.

NF-4231.2 Column Bases

(a) Column bases shall be set level and to correct elevation with full bearing on the masonry.

(b) Column bases shall be finished in accordance with the requirements of (b)(1) through (3) below.

(1) Rolled steel bearing plates 2 in. or less in thickness may be used without milling, provided a satisfactory contact bearing is obtained. Rolled steel bearing plates over 2 in. but not over 4 in. (102 mm) in thickness may be straightened by pressing or, if presses are not available, by milling for all bearing surfaces except those noted in (b)(3) below to obtain satisfactory contact bearing. Rolled steel bearing plates over 4 in. (102 mm) in thickness shall be milled for all bearing surfaces except as noted in (b)(3) below.

TABLE NF-4232-1
MAXIMUM ALLOWABLE OFFSET IN FINAL BUTT WELDED JOINTS

Section Thickness, in.	Maximum Allowable Offset
Up to 3/4, incl.	1/4 t
Over 3/4 to 1 1/2, incl.	3/16 in.
Over 1 1/2 to 2, incl.	1/8 t
Over 2	Lesser of 1/8 t or 3/4 in.

(2) Column bases other than rolled steel bearing plates shall be planed for all bearing surfaces, except as noted in (b)(3) below.

(3) The bottom surfaces of bearing plates and column bases which are grouted to ensure full bearing contact on foundation need not be planed.

NF-4232 Maximum Offset of Aligned Sections

Alignment of butt joints shall be such that the maximum offset of the finished weld will not be greater than the applicable amount listed in Table NF-4232-1, where t is the nominal thickness of the thinner section of the joint.

NF-4232.1 Fairing of Offsets. Any offset within the allowable tolerance of Table NF-4232-1 shall be blended uniformly over the width of the finished weld or, if necessary, by adding additional weld metal beyond what would otherwise be the edge of the weld.

NF-4240 REQUIREMENTS FOR WELDED JOINTS

Butt welds may be made with or without backing or consumable insert rings. When the use of permanent backing rings is undesirable [NF-3226.1(a) or NF-3256.1(a)]:

(a) the backing ring shall be removed and the inside of the joint ground smooth; or

(b) the joint shall be welded without backing rings; or

(c) consumable insert rings shall be used.

NF-4245 Complete Joint Penetration Welds

Complete joint penetration is considered to be achieved when the acceptance criteria for the examinations specified by this Subsection have been met. No other examination is required to assess that complete penetration has been achieved.

ARTICLE K-1000
TOLERANCES

98 **K-1100 INTRODUCTION**

It is recognized that design of supports is based on the use of nominal dimensions. This is not different from the design of piping or equipment which also is based on nominal dimensions. Good design practice dictates that the designer consider the degree of deviation from nominal design which can be tolerated when supports are manufactured as well as when they are installed. It is the intent of this Appendix to provide guidance to the designer as to the need for establishing such tolerances. The tolerances shown in Table K-1330-1 are for guidance and need not be measured.

98 **K-1200 OBJECTIVE**

(a) Tolerances referred to in this Appendix apply only to such values that may affect Code compliance of a support and are not already addressed in the body of the Code. Any other dimensions and tolerances associated with a support are not addressed.

(b) Since specific tolerance values are a function of the interrelationship between design, manufacturing and installation, it is impossible to provide specific values in this Appendix with the exception of Table K-1330-1. In addition, it is recognized that there can be cost/benefit considerations associated with the establishment of tolerances.

K-1300 GENERAL REQUIREMENTS

98 **K-1310 Material**

Material supplied to an SA. SB. SFA Specification. or Table NF-3132-1 Dimensional Standards. need not have material dimensional tolerances specified by the support designer. Material provided to those specifications and standards have their own tolerances and the use of nominal dimension design is adequate. However, tolerance(s) on any manufacturing operation(s) affecting the support load capacity needs to be considered.

K-1320 Fabricating Tolerances

The recommended maximum fabricating tolerances are listed in (a) through (j) bellow. Such tolerances shall be cited in the Design Specification, Design report, Design Drawing, Load Capacity Data Sheet or Design Report Summary. It is the responsibility of the N-type Certificate holder or QSC Supplier of Standard Supports to assure that tolerances associated with the support part have been considered.

(a) Tolerances for raw material such as strip, sheet, bar, plate, pipe, tubing, structural and bar size shapes, bolting, hot wound springs and cold wound springs shall be in accordance with recognized standards or specifications.

(b) Tolerances for castings, forgings and extrusions shall be to the individual manufacturer's standard.

(c) Cut to length – linear

(1) Hanger rods ± ½ in.

(2) Structural shapes, pipe and tubing for critical assembly make up dimensions ± 1/8 in. Squareness of cut 1 degree, not to exceed 1/8 in. offset.

(3) Plates and bars for critical dimensions ± 1/8 in Squareness of cut 1 degree, not to exceed 1/8 in. offset.

(4) Tolerances for non-critical dimensions shall be to the individual manufacturers's standard.

(d) Clamps for pipe and tubing, formed and Fabricated, are shown in Table K-1320-1

(e) Threads

(1) Screw threads – Shall be in Conformance with ANSI/ASME B1.1-1989 or National Bureau of Standards Handbook H-28, UNC 2A/2B for the coarse thread series and 8UN 2A/2B for the eight thread series.

(2) Pipe threads – Standards straight pipe threads for supports shall be ANSI/ASME B1.20.1 – 1983 NPSM and NPSL, Standard Straight Pipe Threads.

(3) Tapered pipe threads – Shall be in conformance with ANSI/ASME B1.20.1-1983 NPT.

(f) Welds

(1) Weld size: All welds-plus only, no minus.

(2) Weld length
For welds < 3 in long: + no max, -1/8 in.

For welds > 3 in long: + no max, -1/4 in.

(g) Angularity

All forming operations ± 4 degrees.

(h) Punched Holes

(1) Location – center to edge, or center to center ± 1/8 in.

(2) Diameter – plus 0.2 times metal thickness or minus 1/32 in. (1mm).

(i) Drilled Holes

As specified on manufacturer's drawings.

(j) Machined Parts
As specified on manufacturer's drawings.

K-1330 INSTALLATION TOLERANCES

(a) Installation tolerances of supports need to be established. There are two categories of installation tolerances associated with a support. The first is a local installation tolerance affecting only the load capacity of the support itself. The second being a global installation tolerance which may affect the conclusions of the component or piping qualification.

(b) The support Design Specification, Design Report, Design Report Summary, or Load Capacity Data Sheet shall specify local installation tolerances. Table K-1330-1 provides acceptable local installation tolerances for piping supports. When piping support installation meets these tolerances any change in the established piping support load capacity calculations are adequate. Global installation tolerances should be addressed in the piping or component Design Specification or Design report.

(c) It is the responsibility of the Construction Specification or Design report Summary preparer to incorporate any component and piping support installation tolerances into the Construction Specification.

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15 sec

APPENDIX-K

TABLE K-1320-1

CLAMP TOLERANCES

CLAMP, I.D.	Diameter	Pipe Centerline to Load Bolt Hole
up to 2 in	± 1/16 in.	± 1/8 in.
over 2 in. to 4 in.	± 1/8 in.	± 1/8 in.
over 4 in. to 8 in.	± 3/16 in.	± 1/4 in.
over 8 in. to 18 in.	± 1/4 in.	± 3/8 in.
over 18 in. to 30 in.	± 3/8 in.	± 1/2 in.
over 30 in.	± 1/2 in.	± 1/2 in.

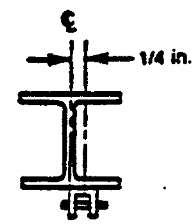
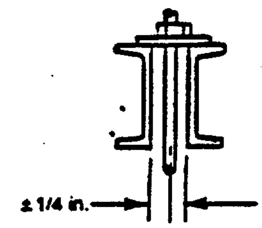
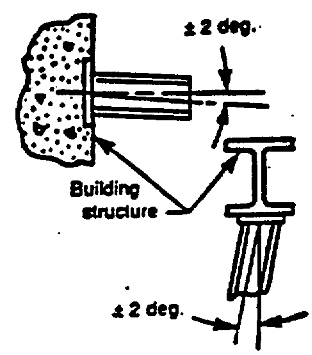
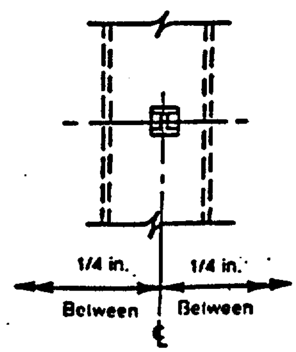
Notes:

(a) Clamp I.D. equals pipe or tubing O.D. plus suitable clearence as established by the clamp manufaturer

(b) Clamp I.D. measured at one half of the clamp width.

NF-265
12/14/99
7/11

TABLE K-1330-1
LOCAL INSTALLATION TOLERANCES FOR PIPING SUPPORTS

Item	Total Tolerance	Configuration
I. Tolerance for General Measurement/Installation		
A) Deviations in the location of the centerline of any attachment to the flange centerline of building steel member(s) or piping support steel member(s); if the support drawing specifies an offset, the attachment may be relocated to any distance towards the centerline of the member to facilitate installation.	±1/4 in.	
B) Deviation of back-to-back distance for channels with rod type component support.	±1/4 in.	
C) Deviation in the centerline angular orientation of piping support steel members in the horizontal or vertical planes.	±2°	
D) Deviation in the centerline location of attachments between flanges of building steel members.	±1/4 in.	

Attachment 4
Page 7 of 11

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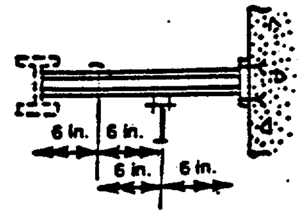
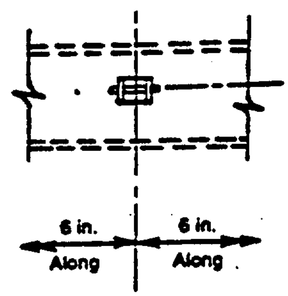
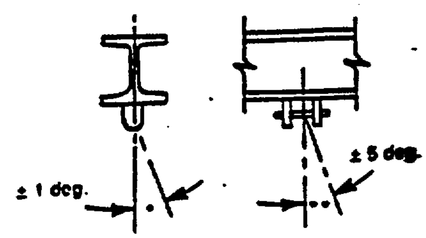
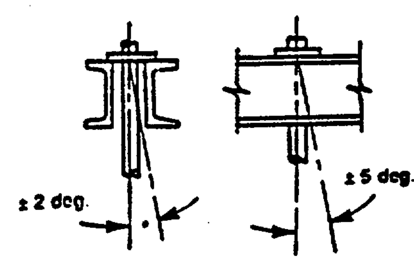
TABLE K-1330-1
LOCAL INSTALLATION TOLERANCES FOR PIPING SUPPORTS (CONT'D)

Item	Total Tolerance	Configuration
II. Tolerances for Attachment Installation		
A) Deviations in the location of attachments to piping support steel member with two ends attached to the building structure (ends may be pinned or fixed).	±6 in.	
B) Deviations in the centerline location of attachments along building steel member length.	±6 in.	
C) Deviation in conical angularity of snubber or strut attachments to piping support steel member or building steel member *± 1° need not be justified ± 5° is more reasonable and should be considered in the designer's calculations to allow ± 5° in practice. ** Subject to limitations defined by hardware manufacturer.	±5°	
D) Deviation in angularity of rod type component attachments to back-to-back channels. * ± 2° need not be justified ± 5° is more reasonable and should be considered in the designer's calculations to allow ± 5° in practice.	±5°	

Attachment 4
Page 8 of 11

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12/14/99
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98 TABLE K-1330-1
LOCAL INSTALLATION TOLERANCES FOR PIPING SUPPORTS (CONT'D)

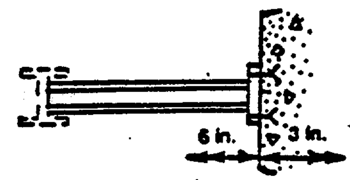
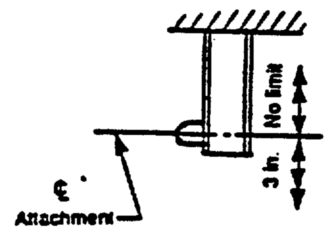
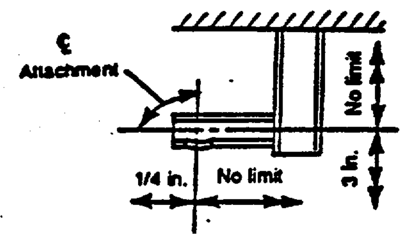
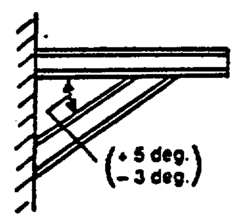
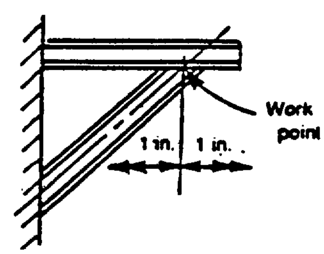
Item	Total Tolerance	Configuration
III. Tolerance for Piping Support Steel Member Installation		
A) Deviation in the length of steel member with two ends attached to the building structure (ends may be pinned or fixed).	+3 in. −6 in.	
B) Deviation of component attachment centerline for a single steel cantilever member attached to the building structure. Note: A cantilever with a kneebrace connection has the same installation tolerances as a single cantilever. See items (D) and (E) for kneebrace tolerances.	+3 in.	
C) Deviation of connection centerline for double (or more) cantilevers. See figure. Note: Any cantilever member (single, both members of a double, etc.) can be shortened any distance required to complete installation.	+1/4 in.	
D) Deviation in kneebrace angle with respect to cantilever.	+5°, −3°	
E) Deviation in brace work point with respect to cantilever.	±1 in.	

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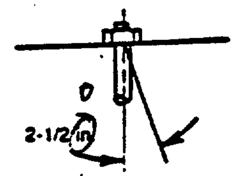
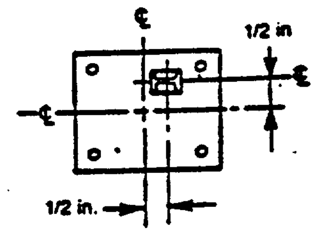
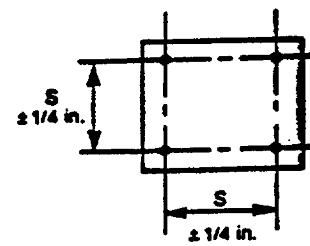
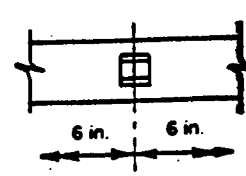
TABLE K-1330-1
LOCAL INSTALLATION TOLERANCES FOR PIPING SUPPORTS (CONT'D)

Item	Total Tolerance	Configuration
IV. Tolerances for Concrete Expansion Anchor (CEA)/Plate Installation		
A) Deviation in conical angularity of CEA	±2 1/2 in	
B) Deviation of centerline of attachment with respect to specified attachment point.	±1/2 in.	
C) Deviation of CEA location with respect to design location.* * Minimum edge distance must be maintained.	±1/4 in.	
V. Tolerances for Embedment Plate Attachment Installation		
Deviation in attachment centerline with respect to embedment plate design location.		
A) Individual embedment plate	±1/4 in. (See Note)	
B) Strip embedment plate 1) perpendicular to longitudinal axis 2) along longitudinal axis	±1/4 in. (See Note) ±6 in.	

Note: The designer shall determine the appropriate distances to be maintained between centerline or edge of attachments and edge of embedment plates.

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TABLE K-1330-1
LOCAL INSTALLATION TOLERANCES FOR PIPING SUPPORTS (CONT'D)

Item	Total Tolerance	Configuration
VI. Tolerances for Standard Support Component Setting		
A) Deviation in variable spring load settings.		±10% of specified loads
B) Deviation in constant spring settings.		±1/4 in. of specified position
C) Deviation in cold setting of snubber.		±1/4 in. of specified setting
VII. Miscellaneous Tolerances		
A) Deviation in gap between pipe and supporting steel member (in nonsupport direction)	Gap (G) Size G < 1/8 in. 1/8 in. < G < 1/2 in. G > 1/2 in.	 ± 0 in. + 1/2 in., −0 + 1/2 in., −1/8 in.
B) Deviation in dimensions of piping support lugs		± applicable measurement tolerance
C) Deviation in weld size Deviation in weld length For welds <3 in. long For welds ≥3 in. long		specified size minimum −1/8 in., no max. −1/4 in., no max.

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COMMITTEE CORRESPONDENCE

ASME SECTION III

COMMITTEE :W.G. on Supports

Address writer care of :
Jean Claude Hennart
Tractebel Energy Engineering
Avenue Ariane, 7
B-1200 BRUSSELS
Belgium
Tél. 32 2 773 9625
Fax 32 2 773 8220
e.mail : jean-claude.hennart@tractebel.be

Subject : WGNF- 274

Date : DEC 23, 1999

To : Dulin Jr., Robert M., Engineering Manager
Duke Engineering & Services Inc.
1180 Town Center Dr
MS 617
Las Vegas, NV 89134-6363 - USA

Dear Bob,

I have inclosed herewith the new mark-up for item NF-274 on Lamellar tearing.

Merry Christmas and Happy New Year,

J.C. Hennart

NF-3226.3 Consideration of lamellar tearing

Welded joint configurations causing significant through thickness tensile stress during fabrication and /or service on rolled product forms should be avoided.However if this type of construction is used, the designer should consider one or several of the following factors that may reduce the susceptibility of the joint to experience lamellar tearing :

(a) Reduce volume of weld metal to the extent practical;

(b) Invoke any of the special fabrication requirements of Paragraph NF-4441.

(3) partial penetration, single welded between the end surface of a closed tubular section or a closed formed section, Fig. NF-3226.1-1, sketch (h);

(4) the applicable welds may be square groove, bevel groove, J groove, flare V groove or flare bevel groove.

NF-3226.2 Stress Intensities and Stress Limits for Welded Joints in Plate- and Shell-Type Supports

(a) Design Limits. The stress intensity and allowable stress limits which must be satisfied for welds for the Design Loadings stated in the Design Specification shall be the following.

(1) Full Penetration Groove Welds. The stress intensity limits for full penetration groove welds shall not exceed the applicable stress intensity value for the base metal being joined, as specified in NF-3221.1 and Table NF-3324.5(a)-1. See NF-3111.

(2) Partial Penetration Groove Welds

(a) Compression Normal to Effective Throat or Shear on Effective Throat. The stress intensity and stress limits shall be the same as those for the base metal as required in NF-3221.1.

(b) Tension Normal to the Axis on the Effective Throat. The stress limits shall be as specified in Table NF-3324.5(a)-1.

(3) Fillet Welds. The allowable stress limits for fillet welds shall be as specified in Table NF-3324.5(a)-1.

(b) Service Limits, Level A Through D, and Test. The rules and stress limits which must be satisfied for welds for any Level A through D Service and Test Loadings stated in the Design Specification are those given in NF-3226.2(a) multiplied by the appropriate base material stress limit factor given in Table NF-3622(b)-1 for Piping Supports and Table NF-3522(b)-1 for Component Supports.

(c) The effective sizes of welds shall be as given in NF-3324.5(d) and NF-3324.5(f).

NF-3250 DESIGN BY ANALYSIS FOR CLASS 2 AND MC

Plate- and Shell-Type Supports may be designed by either elastic or limit analysis, limits for which are given in the following subparagraphs. Limits for bolts and welds are given in NF-3255 and NF-3256. For general requirements and definitions, see NF-3100 and NF-3210.

NF-3251 Stress Limits

NF-3251.1 Design Loadings. The stress[2] limits are satisfied for the Design Loadings (NCA-2142.1) stated in the Design Specifications if the requirements of Eqs. (1) and (2) are met.

$$\sigma_1 \le 1.0S \quad (1)$$

$$\sigma_1 + \sigma_2 \le 1.5S \quad (2)$$

where

σ_1 = membrane stress, ksi, which is the average stress across the solid section under consideration. It includes the effects of discontinuities, but not local stress concentrations.

σ_2 = bending stress, ksi, which is the linear varying

[2] *Stress* means the maximum normal stress (principal stress).

(3) Fillet Welds. The allowable stress limit for fillet welds shall be as specified in Table NF-3324.5 (a)-1.

(b) Service Limits. Level A Through D, and Test. The rules and stress limits which must be satisfied for welds for any Level A through D Service and Test Loading stated in the Design Specification are those given in NF-3356.2(a) multiplied by the appropriate base material stress limit factor given in Table NF-3652(b)-1 for Piping Supports and Table NF-3562(b)-1 for Component Supports.

NF-3256.3 Effective Size. The effective sizes of welds shall be as given in NF-3324.5(d), (e), and (f).

NF-3256.4 Consideration of lamellar tearing

Welded joint configurations causing significant through thickness tensile stress during fabrication and /or service on rolled product forms should be avoided.However if this type of construction is used, the designer should consider one or several of the following factors that may reduce the susceptibility of the joint to experience lamellar tearing :

(a) Reduce volume of weld metal to the extent practical;

(b) Invoke any of the special fabrication requirements of Paragraph NF-4441.

NF-3260 DESIGN BY ANALYSIS FOR CLASS 3

NF-3261 Stress Limits

The design of Class 3 supports shall be in accordance with the requirements of NF-3250 using one of the design procedures indicated in Table NF-3131(a)-1 for Class 3 construction.

NF-3265 Design of Bolting

The provisions of NF-3225 apply.

NF-3266 Design of Welded Joints

The types of welded joints shall be as stipulated in NF-3256 for Class 2 and MC supports, except that for groove welded T-joints, groove welded corner joints, and fillet welded T-joints, as listed in NF-3256.1(a)(2) and (3), the welds may be intermittent instead of continuous. Intermittent fillet welds shall meet the requirements of NF-3324.5(d)(7). The allowable stress limits shall be as stipulated in NF-3256.2.

NF-3270 EXPERIMENTAL STRESS ANALYSIS

Supports may be designed by experimental stress analysis in accordance with Appendix II (Section III, Division 1, Appendices).

NF-3280 DESIGN BY LOAD RATING

NF-3281 Procedure for Load Rating

The procedure for load rating shall consist of imposing a total load on one or more duplicate full-size

(7) Effective Shearing Area of Plug and Slot Welds. The effective shearing area of plug and slot welds shall be considered as the nominal cross-sectional area of the hole or slot in the plane of the faying surface.

(f) Full Penetration and Partial Penetration Joints. The effective area shall be the effective weld length multiplied by the effective throat thickness.

(1) The effective weld length for any groove weld, square or skewed, shall be the length of weld throughout which the correct proportioned cross section exists. In a curved weld it shall be its true length measured along its curvature.

(2) The effective throat thickness of a full penetration groove weld which shall conform to the requirements of NF-4000 shall be the thickness of the thinner part joined. No increase is permitted for weld reinforcement.

(3) The effective throat of partial penetration groove welds is dependent upon the type of groove.

(a) For square, U, and J groove welds, the effective throat is equal to the depth of preparations.

(b) For V and bevel groove welds with an included angle at the root equal to or greater than 60 deg., the effective throat shall be the minimum distance from the root to the face of the weld.

(c) For V and bevel groove welds with an included angle at the root less than 60 deg. but equal to or greater than 45 deg., the effective throat shall be the minimum distance from the root to the face of the weld less ⅛ in. (3.2 mm).

(d) For V and bevel groove welds, with an included angle at the root less than 45 deg. but equal to or greater than 30 deg., the effective throat shall be the minimum distance from the root to the face of the weld less ⅛ in. (3.2 mm) and multiplied by 0.75. The required effective throat must be specified on the drawing.

(e) For V and bevel groove welds, angles less than 30 deg. at the root are not allowed.

(f) For flare bevel groove welds, when filled flush to the surface, the effective throat shall be 0.31 times the outside radius of the curved section forming the groove. For formed rectangular tubing, the outside radius may be considered as two times the wall thickness.

(g) For flare V groove welds, when filled flush to the surface, the effective throat shall be 0.5 (except use 0.375 for GMAW when $R \geq \frac{1}{2}$ in. (13 mm) times the outside radius when the outside radius is less than 1 in. For flare bevel groove welds, the effective throat shall be 0.312 times the outside radius.

NF-3324.6 Design Requirements for Bolted Joints. The rules and stress limits for bolting shall be as given in this paragraph. The stress limits which must be satisfied for any Design, Level A through D, and Test Loadings, shall be those given in this paragraph, multiplied by the appropriate stress limit factors given in Table NF-3225.2-1 for the particular Loading specified in the Design Specification (NCA-3250). This product shall not exceed the yield strength of the material at temperature.

(a) Allowable Stresses. Allowable tensile, shearing, and bearing stresses in bolts and threaded parts shall

NF-3324.5

(g) Consideration of lamellar tearing

Welded joint configurations causing significant through thickness tensile stress during fabrication and/or service on rolled product forms should be avoided. However if this type of construction is used, the designer should consider one or several of the following factors that may reduce the susceptibility of the joint to experience lamellar tearing:

(a) Reduce volume of weld metal to the extent practical;

(b) Invoke any of the special fabrication requirements of Paragraph NF-4441.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

ACTION:
SGFS [illegible]

December 1, 1999

Attachment 6
Page 1 of 4

5/00

John H. Ferguson, Chairman
ASME Board on Nuclear Codes and Standards
Northeast Utilities
Millstone Nuclear Power Station
Ropeferry Road
Waterford CT 06385-0128

• SGFS [illegible]
• SGDC [illegible]

Dear Mr. Ferguson:

The purpose for this letter is to request ASME action to address issues related to the effects of the reactor water environment on the reduction of fatigue life of light water reactor (LWR) components. These effects and issues have been under discussion between the Nuclear Regulatory Commission (NRC) staff, ASME and Pressure Vessel Research Council (PVRC) committees, and the technical community for over 12 years. The need to address this issue continues to become more important in light of the aging of plants, changes in other parts of the fatigue analyses addressed by the Code, and the renewal of plant licenses for an additional 20 years of operation. Ample data now exist to support the required changes.

The NRC has sponsored a research program on Environmentally Assisted Cracking in Light Water Reactors (LWRs) at Argonne National Laboratory (ANL) since 1978. One of the tasks of the program has been to understand and quantify the effects of LWR coolant environments on the fatigue life of pressure vessel and piping steels. Results from studies in Japan and those at ANL illustrate potentially significant effects of LWR coolant environments on the fatigue resistance of carbon and low-alloy steels and of austenitic stainless steels. Under certain loading and environmental conditions the reactor water environmental effects alone substantially exceed the reductions in the current design curve to account for the differences between specimen tests and component behavior. Based on these studies, NRC and ANL staff have been recommending to ASME Code committees and to the Board on Nuclear Codes and Standards (BNCS) since the late 1980's that the ASME Code fatigue design curves need to be updated to incorporate the effects of reactor coolant environments. Background for this recommendation is provided in the enclosure.

Although the existing fatigue design curves are non-conservative for certain LWR conditions and environments, the current design procedures, e.g., stress analysis rules, cycle counting, etc., are conservative enough that the overall assessment of fatigue life has been conservative. However, the Code permits new improved approaches for fatigue evaluations, e.g., finite element analyses, fatigue monitoring, improved Ke factors, etc., which can significantly reduce the conservatism in the other elements of the present design methods. To ensure that the overall assessment maintains a degree of conservatism consistent with that chosen for the fatigue limit in air, the current understanding regarding environmental effects should be incorporated into the ASME Code for fatigue evaluations as discussed above.

Because of the need for NRC and industry to conduct fatigue reviews and analyses in conjunction with license renewal activities, and because environmental effects need to be incorporated in these analyses, we request that the ASME Code be revised to include methods for incorporating the environmental effects into the Code procedures and in the analyses. The NRC can support the use of either environmentally adjusted fatigue design curves, or the use of fatigue life correction factors (without the Z factor) as discussed in the enclosure.

I request that the ASME address the issue of incorporating the environmental effects on fatigue in the Code procedures on an expedited basis. In addition, I request that the fatigue design air curve for stainless steels in Section III be corrected to reflect the available data and the intended factor of 2 on strain or 20 on cycles. NRC staff and contractors are ready to work with various ASME Code committees to bring about the required changes including participation in meetings to discuss these issues. Please let me know what actions the ASME Code will be undertaking to address these issues and needs.

Sincerely,

Original signed by John W. Craig

John W. Craig, Director
Division of Engineering Technology
Office of Nuclear Regulatory Research

cc: G.M. Eisenberg (ASME)
O. F. Hedden, Chair Sec XI
C. J. Pieper, Chair Sec III
D. A. Canonico, Chair BPVSC

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The ASME Code fatigue design curves, given in Appendix I of Section III, are based on strain-controlled tests of small polished specimens at room temperature in air. The fatigue design curves were developed from the mean curves for the experimental data by reducing the fatigue life at each point on the mean curve by a factor of 2 on strain or 20 on cycles, whichever was more conservative. This reduction was intended to account for data scatter (heat-to-heat variability), effects of mean stress or loading history, and the differences in surface condition and size between the test specimens and actual components. However, because the mean fatigue curve used to develop the current Code design curve for austenitic stainless steels does not accurately represent the available experimental data (Jaske & O'Donnell, 1978), the current design curve for stainless steels in Section III includes a reduction of only 1.5 and 15 from the mean curve for the stainless steel data, not the 2 and 20 originally intended. As explicitly noted in Subsection NB-3121 of Section III of the Code, the effects of the LWR coolant environment are not addressed in the current Code fatigue design curves. The Subsection states that the owner's design specifications should provide information on any reduction to fatigue design curves necessitated by environmental conditions.

In 1991, the ASME BNCS requested the PVRC to examine the existing worldwide fatigue strain vs. life (S-N) data and develop recommendations for ASME. The PVRC committee on cyclic life and environmental effects has evaluated the issue and, at its June 15, 1999 meeting in Columbus, Ohio (Welding Research Council Program Report, Vol. LIX No. 5/6, May/June 1999), the committee endorsed a method for incorporating the effects of LWR coolant environments into the ASME Code fatigue evaluations. The Executive Director of PVRC has transmitted their recommendations and approach to implement environmental fatigue procedures to the ASME BNCS by letter from Hollinger to Ferguson dated October 31, 1999. The methodology, proposed by EPRI/GE (EPRI TR-105759 and PVP-Vol. 386), is based on the use of fatigue life correction factors (F_{en}) to account for environmental effects on fatigue life.

The PVRC recommendation also defines an "effective" F_{en}, F_{en}/Z, where Z is a factor that constitutes the perceived conservatism in the Code design curves, i.e., the portion of that factor of 20 that is judged not actually necessary to account for data scatter, surface finish, etc. PVRC proposed the factor Z as 3.0 for carbon and low-alloy steels and 1.5 for stainless steels. The NRC does not currently support the "effective" F_{en} approach, although it had previously accepted a similar approach for two license renewal applications. Recent reports from Japan (PVP 1999,Vol. 386, pg. 161) and also findings from the ANL work (to be presented at the ICONE-8 conference in April 2000) indicate that the entire margin of 20 is expended by factors other than the environmental effects. Also, the effective F_{en} approach presumes that all other uncertainties have been anticipated and accounted for.

The NRC sponsored work at ANL has also studied methods for incorporating environmental effects into ASME Code Section III fatigue evaluations (NUREG/CR-6583, NUREG/CR-5704). Two procedures have been proposed: (a) use of environmentally adjusted fatigue design curves or (b) use F_{en} to adjust the current ASME Code fatigue usage values for environmental effects. Although estimates of fatigue lives based on the two methods may differ somewhat because of differences between the ASME mean curves used to develop the current design curves and the best-fit curves to the existing data used to develop the environmentally adjusted curves, the NRC can support either of these methods as they provide an acceptable approach to account for environmental effects.

The Sub-Group Fatigue Strength provides the following response to Mr.Slagis of the Sub-Group Design Analysis.

1. The Class 1 fatigue curves should only be modified if a majority (2/3) of the components in a plant are significantly affected by environmental effects. My impression of the PVRC and EPRI studies is that the majority of the piping systems are not significantly affected.

   Answer: The Sub-Group Fatigue Strength is not proposing a change to the fatigue curves. The existing curves are the proper reference curves for most applications.

2. For components that are significantly affected, a simple penalty factor should be defined by the Code. The penalty factor should be a variable dependent on which influence parameters (chemistry, strain rate, etc.) are present for a particular component.

   Answer: The Sub-Group Fatigue Strength proposes concept of the 'P factor' first proposed by Dr. Higuchi and Dr. Iida. The concept has been further developed by EPRI, PVRC, Argonne, TEMPES, and others. The use of a penalty factor should only be applied to that portion of the transient that the particular environment applies. We do not recommend the use of alternate curves than the reference design curve.

3. The penalty factor should not be based only on environmental effects. The total factor of safety on fatigue is comprised of several factors (environmental, size, scatter, etc.). We should not just increase the total FS by the increase in the environmental factor. A major concern in design is that the size factor my be larger than necessary. [That is, the small specimen based fatigue procedure overpredicts damage for the actual size components.] We need to review the interdependence of all factors that go into the total FS to come up with a penalty factor.

   Answer: The Sub-Group Fatigue Strength has reviewed the basis for the '2 and 20' factors currently included in the Code curves for low alloy carbon steel. The '20' Factor is composed of several contributors. One of those contributors is the environmental effect; This has a value of about 4. The proposed methodology has a threshold value such that the environmental P Factor is not used until the threshold value is exceeded. The result is that the present penalties are used unless the threshold is exceed and then only for that portion of the transient. For stainless steels a similar concept has been proposed by EPRI and others, but there is more development needed. The presentation by Mr. Nakamura is the beginning of data on stainless steels. He validated the P Factor for a specific design condition. This was then presented as a curve.

4. Guidance should be provided on a more detailed analysis procedure for environmental effects (for example, the EPRI proposed procedure) if the designer does not want to use the conservative penalty factor.

   Answer: The Sub-group Fatigue Strength does not propose using an overall penalty factor. The P Factor may be applied to the entire fatigue calculation, but should only applied where the threshold is exceeded. The procedure should developed by PVRC or EPRI, but may not necessarily a Code item.

5. We do a fatigue analysis for thermal expansion cycling in Class 2/3 piping. A Class 2/3 penalty factor needs to be developed.

   Answer: The Sub-group Fatigue Strength agrees with this suggestion. The P Factor approach would also work for Class 2/3. There would have to be some additional work because the P Factor is applied to the Cumulative Usage Factor and NC/ND do not make this computation.

Japanese Joint Research Proprietary

SIMULATION OF TEST #37 (Run5) USING SHELL ELEMENT

(Japanese Joint Research Result)

Dec. 14. 1999
at ASME SWG-SR

Hiroe Kobayashi
Ishikawajima-Harima Heavy Industries Co., Ltd.

SH-1

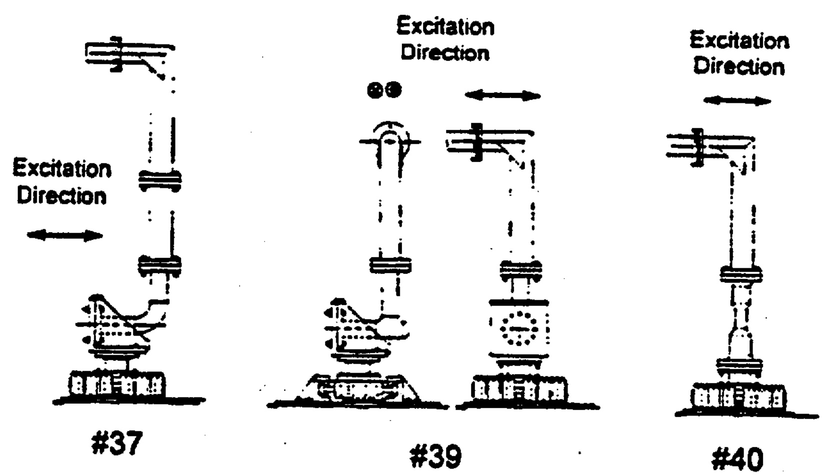
SGD 12/99 ATTACHMENT F

BACK GROUND (1)

1994 : NEW SEISMIC RULES had issued
LEVEL D : primary stress ≤ 4.5Sm
dead weight stress ≤ 0.5Sm
stress range by anchor motion
bending ≤ 6.0Sm, axial ≤ 1.0Sm

PFDRP : Test #37 (ELBOW), #39 (TEE), #40 (RED)
Excessive deformation had been observed.

EXCESSIVE DEFORMATION (PFDRP)



Japanese Joint Research Proprietary

BACK GROUND (2)

FEM analysis on test #37 by Elbow element

1) Verification of simulation method by comparison with experiment (RUN4)

2) Parametric study

a) Dead weight stress

b) Seismic input level

c) Frequency ratio

(Dominant Freq. of Input) / (Natural Freq. of Pipe)

⇩

NEW SEISMIC RULES was verified to prevent EXCESSIVE DEFORMATION by simulation

SH-4

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BACK GROUND (3)

FEM analysis by elbow element
can not simulate
the response(rotation) after 20sec. of run5
(out of current seismic stress limits)

⇩

FEM analysis using the shell element

- Static analysis
- Dynamic analysis

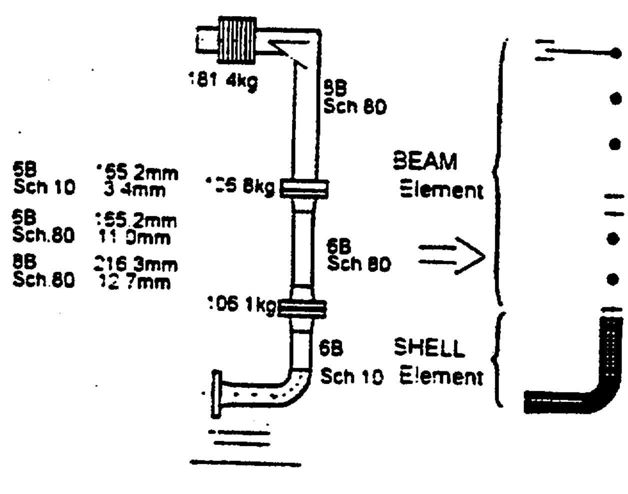
SH-5

STATIC ANALYSIS CONDITION

ANALYSIS CODE : ABAQUS Ver. 5.8
ELEMENTS : 8 NODES SHELL ELEMENTS
THICKNESS : DISTRIBUTION
At end of RUN4 from "QUICK LOOK REPORT"
DIAMETER : OVAL SECTION
At end of RUN4 from "QUICK LOOK REPORT"
LOAD : DISPLACEMENT LOAD
PROCEDURE : STATIC ELASTO-PLASTIC ANALYSIS
with LARGE DEFORMATION OPTION

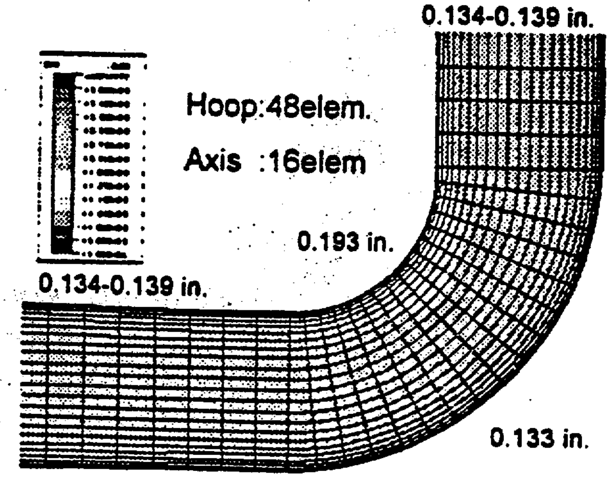
SH-6

STATIC ANALYSIS MODEL



SH-7

STATIC ANALYSIS MODEL(Close up)

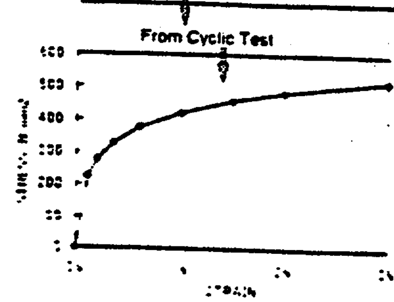


Thickness Distribution

SH-8

MATERIAL MODEL

	YIELD STRESS (N/mm²)	TENSILE STRENGTH (N/mm²)	ELONGATION (%)
[illegible] Sheet	234	562	52
Japanese Material Test	234	593	[illegible]



Young's Modulus :
195000N/mm²
Hardening rule :
COMBINATION Theory in ABAQUS

SH-9

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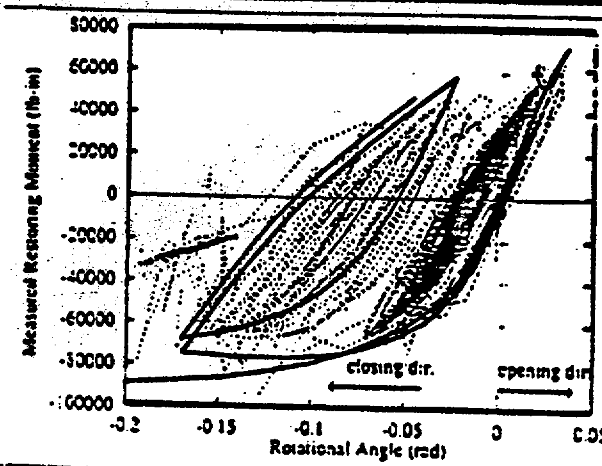
STATIC ANALYSIS RESULT(Moment-rotation)



Moment- Rotation

SHELL ELEMENT ANALYSIS
ELBOW ELEMENT ANALYSIS

SH-10

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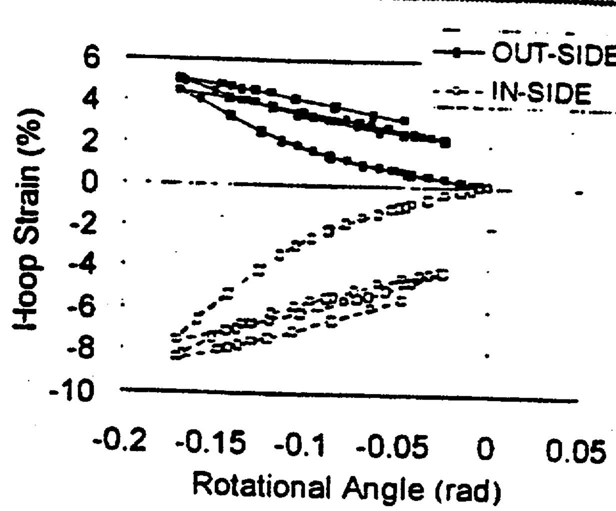
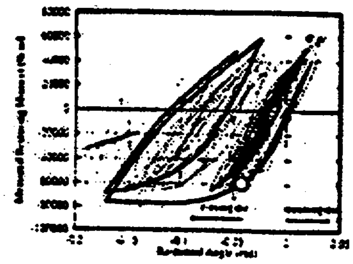
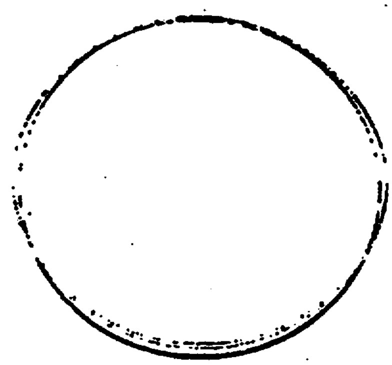
STATIC ANALYSIS RESULT (2)



SH-11

STATIC ANALYSIS RESULT (3)



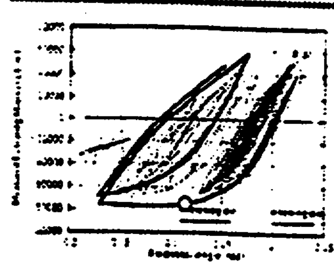


A-A SECTION

DEFORMATION

SH-12

STATIC ANALYSIS RESULT (4)

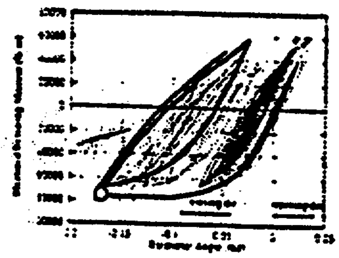


A-A SECTION

DEFORMATION

SH-13

STATIC ANALYSIS RESULT (5)

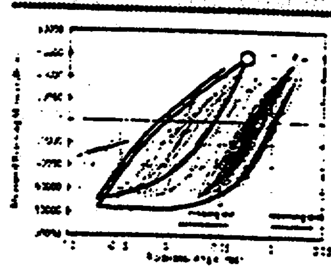


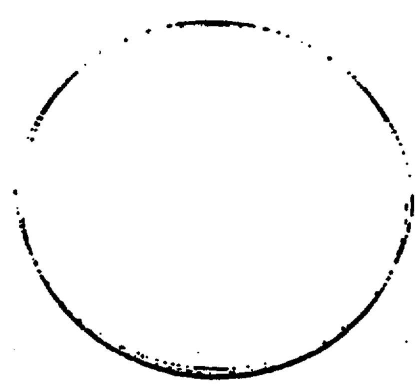
A-A SECTION

DEFORMATION

SH-14

STATIC ANALYSIS RESULT (6)



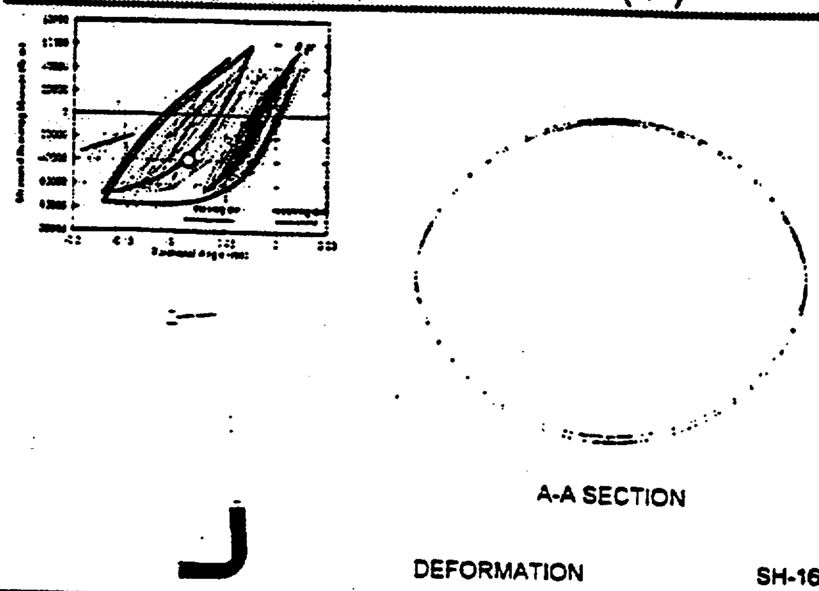


A-A SECTION

DEFORMATION

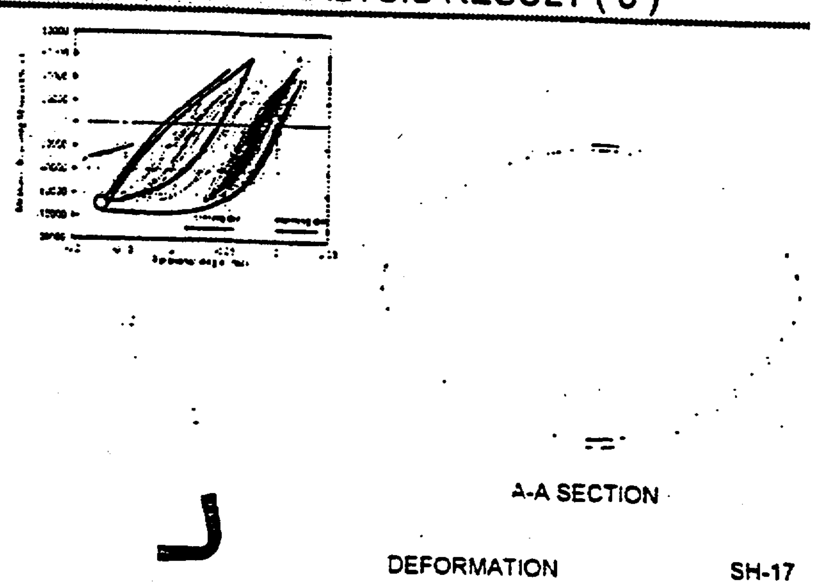
SH-15

STATIC ANALYSIS RESULT (7)



SH-16

STATIC ANALYSIS RESULT (8)



SH-17

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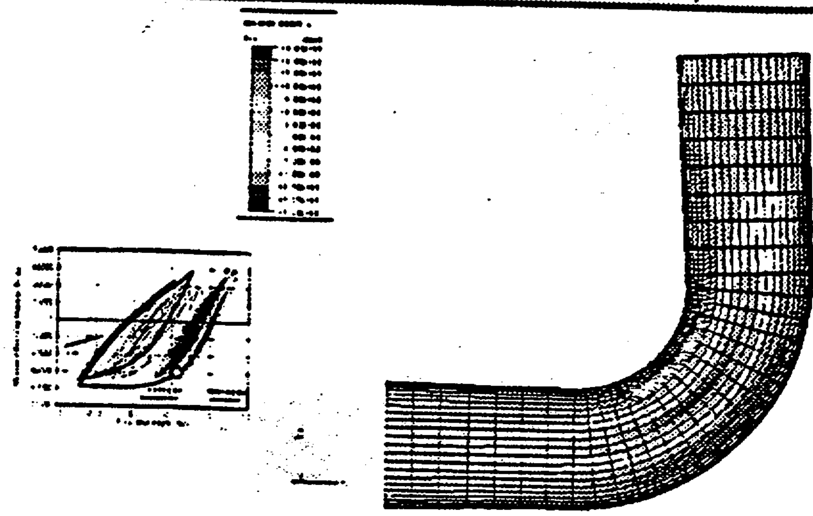
STATIC ANALYSIS RESULT (9)



Hoop strain : Inside

SH-18

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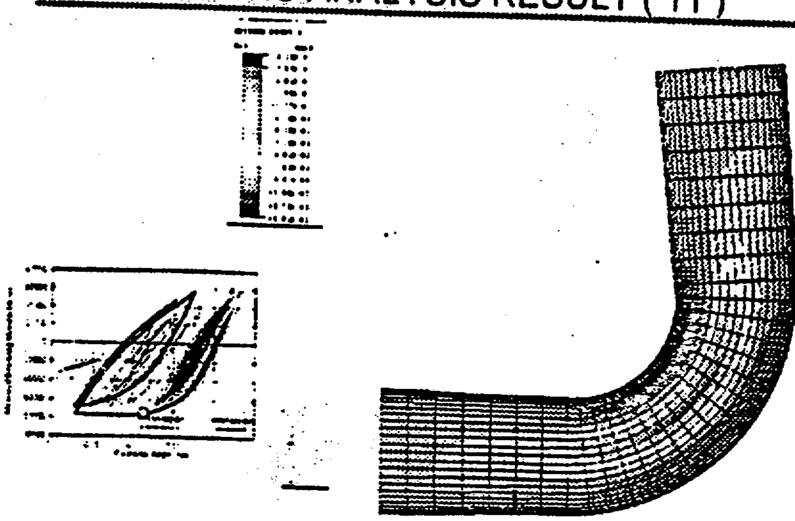
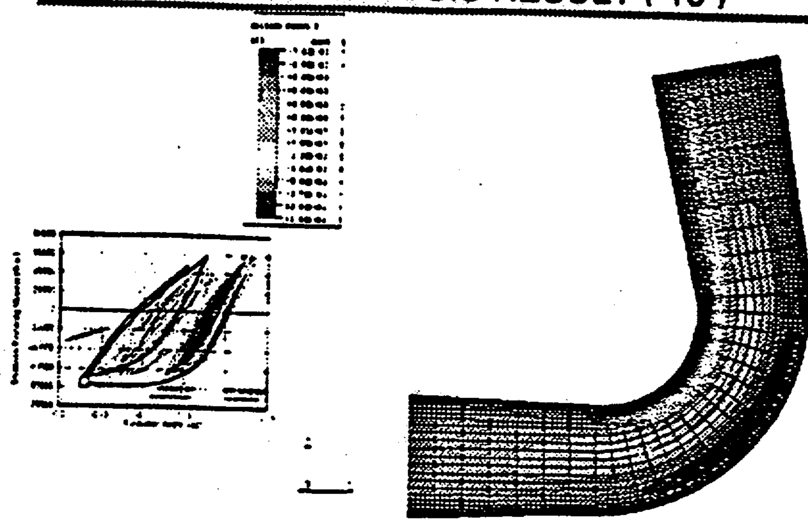
STATIC ANALYSIS RESULT (11)



Hoop strain : Inside

SH-19

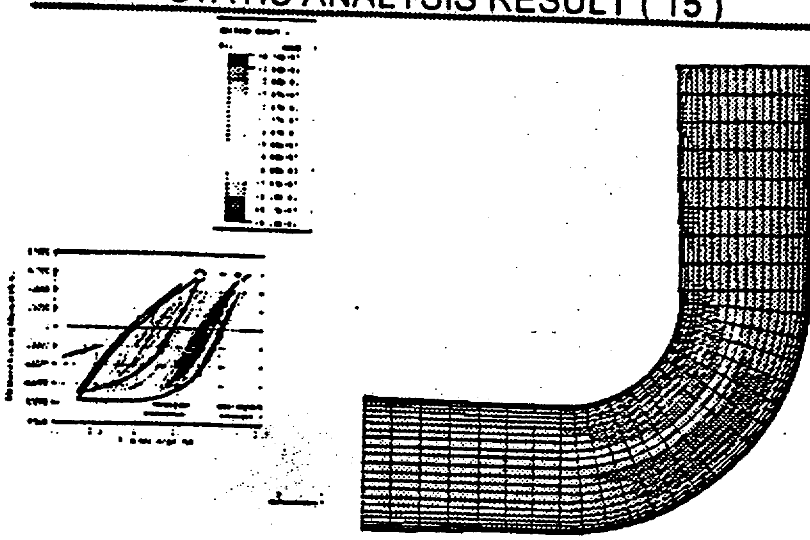
STATIC ANALYSIS RESULT (13)



Hoop strain : Inside

SH-20

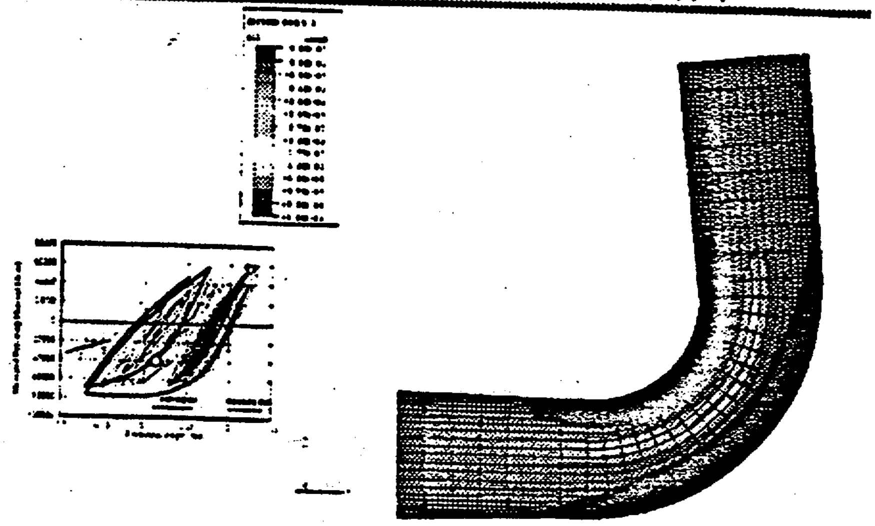
STATIC ANALYSIS RESULT (15)



Hoop strain : Inside

SH-21

STATIC ANALYSIS RESULT (17)



Hoop strain : Inside

SH-22

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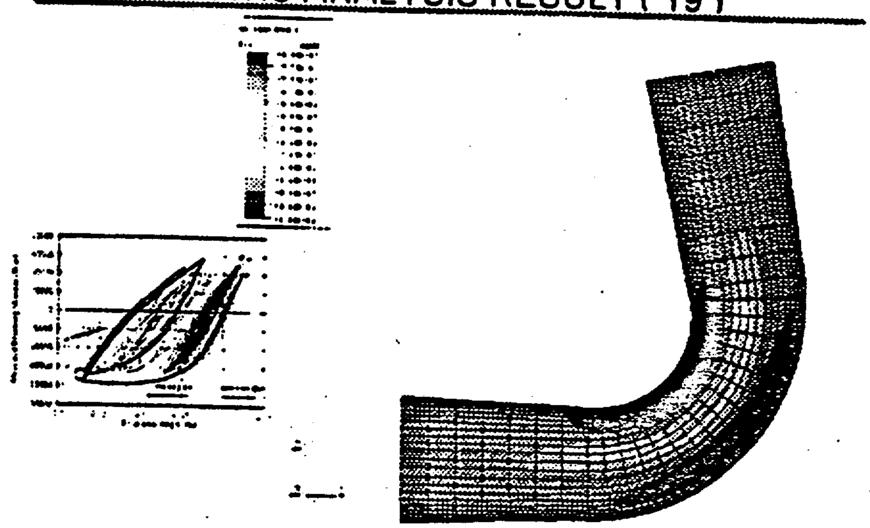
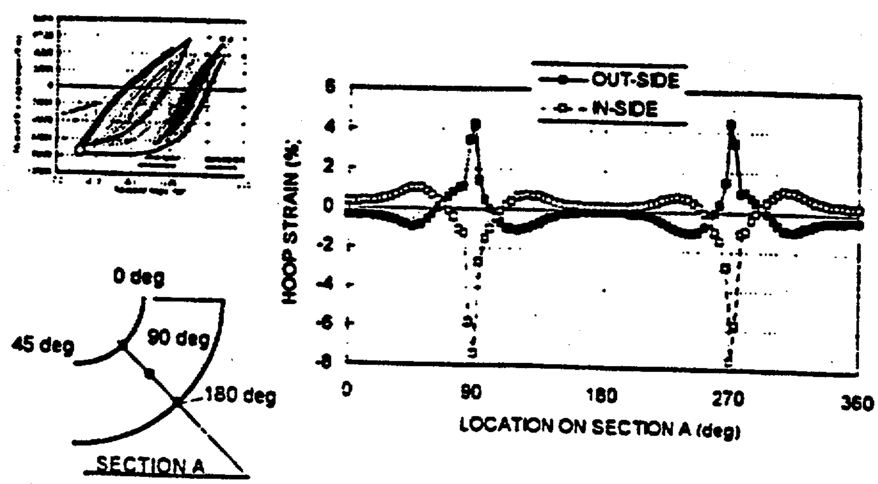
STATIC ANALYSIS RESULT (19)



Hoop strain : Inside

SH-23

STATIC ANALYSIS RESULT (20)



Hoop strain distribution

SH-

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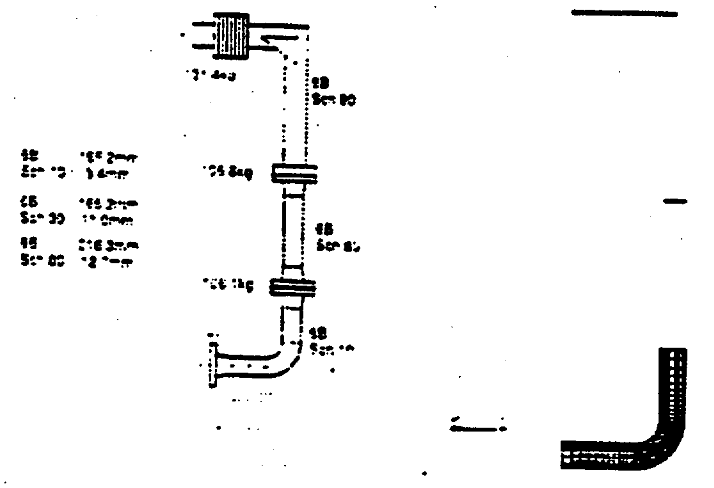
Dynamic Analysis Model for #37(Run 5)



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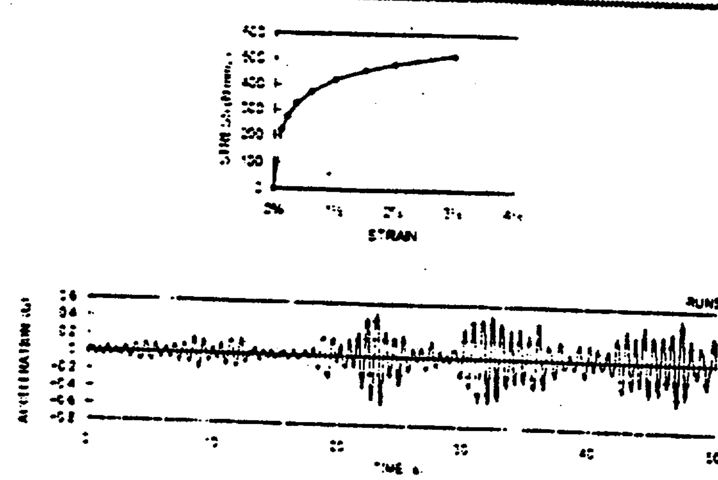
Input Data



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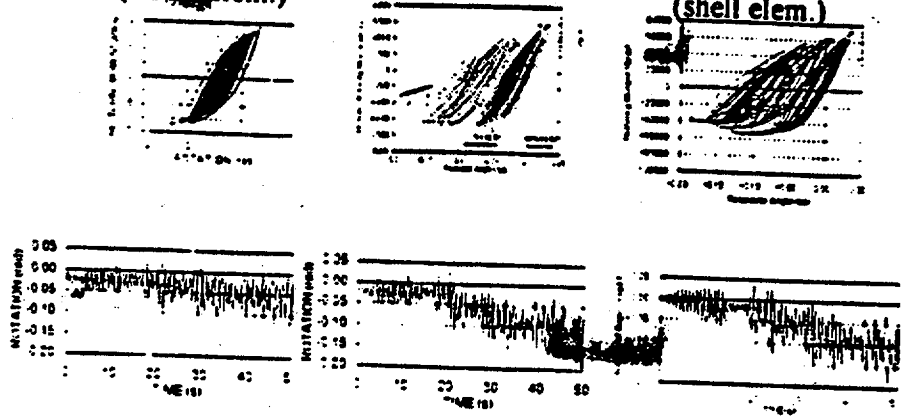
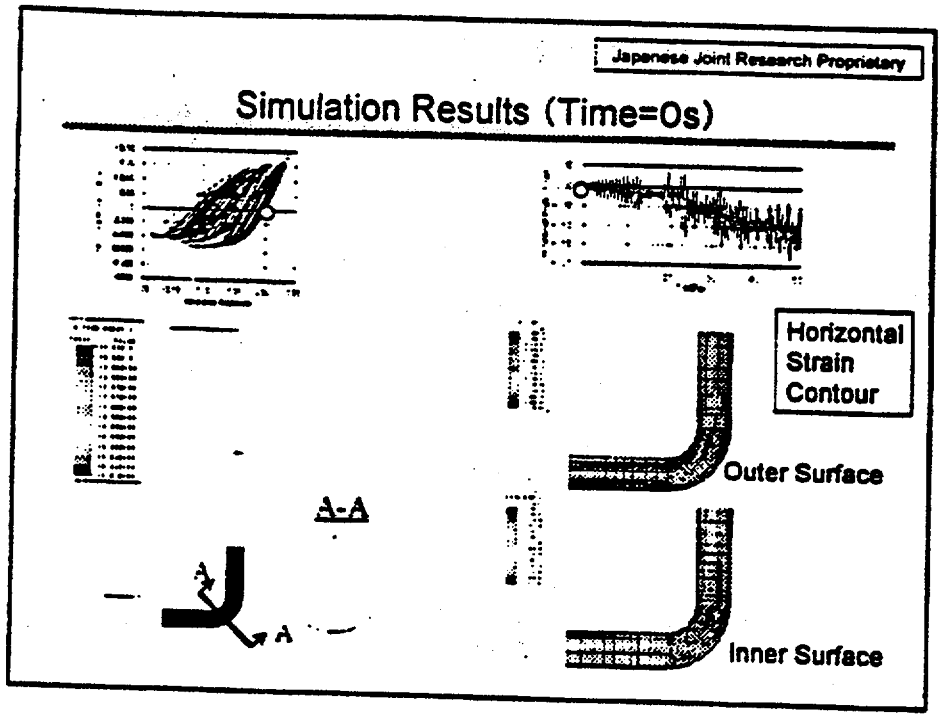
Simulation Results for #37 Run5

Simulation Results (elbow elem.) | Test Results | Simulation Results (shell elem.)

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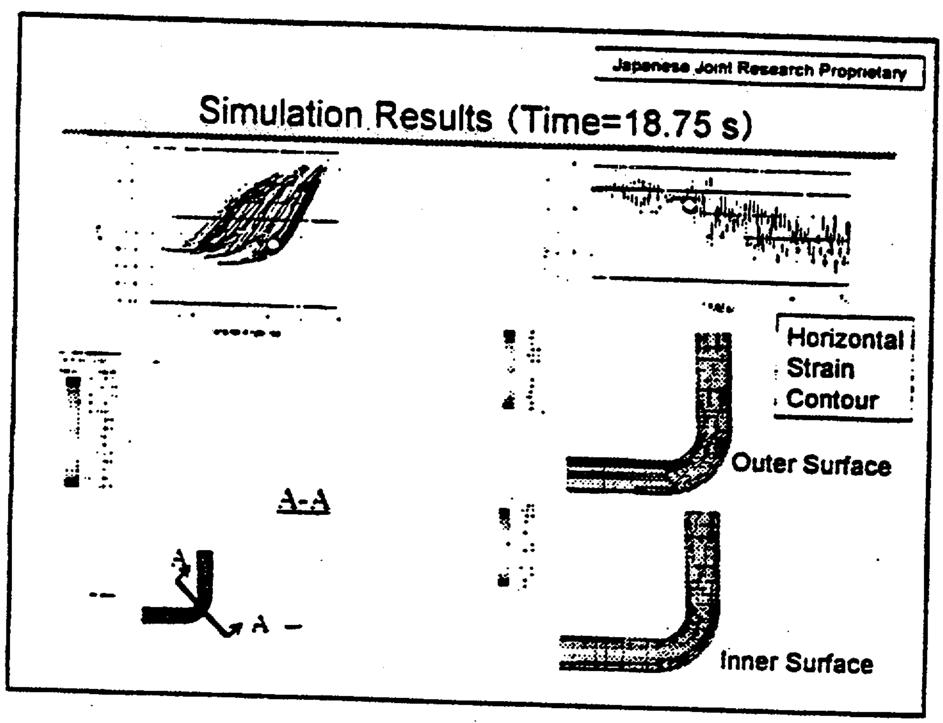
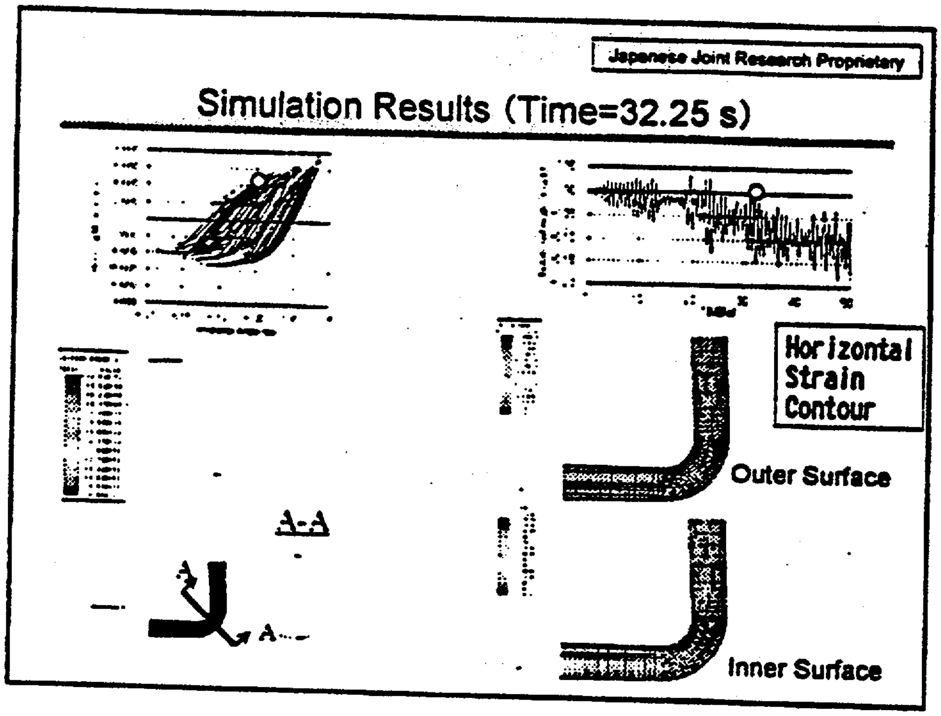
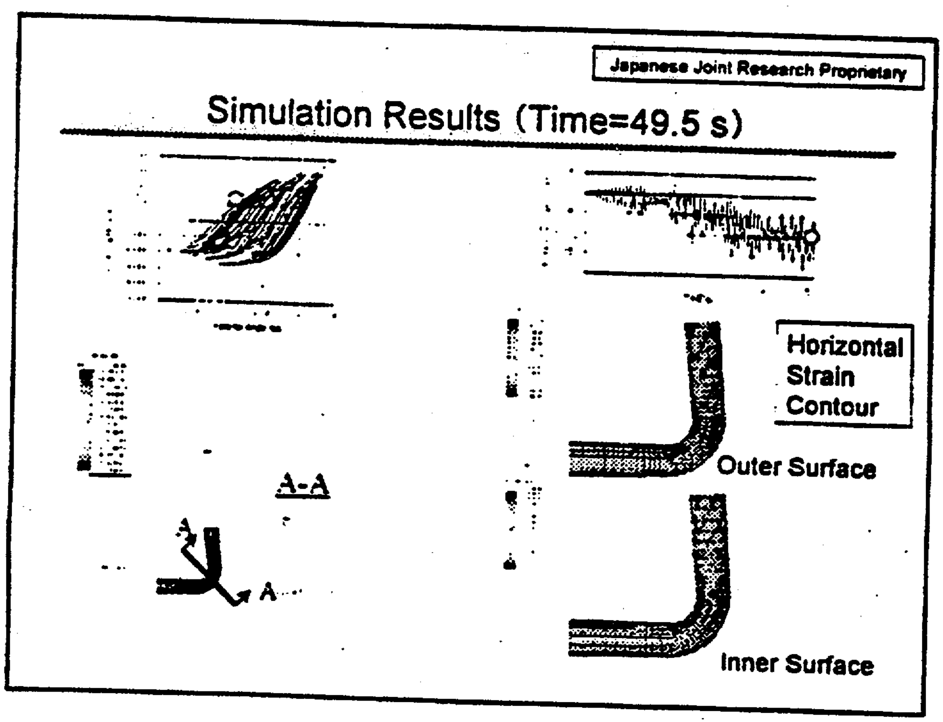
Simulation Results (Time=0s)
Horizontal Strain Contour
Outer Surface
Inner Surface
A-A
A
A


Japanese Joint Research Proprietary
Simulation Results (Time=18.75 s)
Horizontal Strain Contour
Outer Surface
Inner Surface
A-A
A
A


Japanese Joint Research Proprietary
Simulation Results (Time=32.25 s)
Horizontal Strain Contour
Outer Surface
A-A
Inner Surface


Japanese Joint Research Proprietary
Simulation Results (Time=49.5 s)
Horizontal Strain Contour
Outer Surface
A-A
Inner Surface

CONCLUSION

- Excessive deformation observed at run5 can be simulated by FEM analysis using shell element.
- Excessive deformation at run5 was progressed by stiffness reduction of elbow due to ovalization of cross section.
- Stress condition of run 5 is out of current seismic stress limits (over 20Sm)
- FEM by elbow elem. can reproduce response up to 0.1rad. in rotation(run4:0.07rad. & 10Sm)