NUCLEAR ENERGY BUSINESS OPERATIONS — GENERAL ELECTRIC

23A1877AA REV 2 — SH NO. 1

ORIGINAL REVISION STATUS SHEET — SYS. 16,17

DOCUMENT TITLE REACTOR PROTECTION SYSTEM

LEGEND OR DESCRIPTION OF GROUPS — TYPE DESIGN SPECIFICATION DATA SHEET

THE SUPPLY SYSTEM IS RESPONSIBLE FOR DESIGN CHANGE CONTROL OF THIS DOCUMENT

~~FMC~~ HANFORD 2

MPL ITEM NO. C72-4010

|-Denotes Change

REVISIONS		C
0	Document Control Transfer per PWA 3608KK DMC-2414	
2	FJ Block 8/26/86 — Approved 4-1-86 CMWhitcomb Revised Per: 84-1281-0A-011 ChkD By: KAW 4/1/86	
1	Dwg. Transferred To Supply System Control As Per Work Order 4300 EMR-83-1808 — 12/2/83 TL H DB KPA MLam 12/12	

Rev. No.	Revision	Date	Dwn.	Chkd.	Apvd. S.S. Engr.

BURNS AND ROE

Burns & Roe Is Responsible Only For That Information It Has Added To This Drawing In Accordance With Supply System Direction By The Above Revisions.

BURNS & ROE FILE NO. 2-14-1700

SUPPLY SYSTEM	CVI Number	CVI Sheet	Rev.	Dwg. Sheet
	02-02C72-03,	3	2.	—

PRINTS TO
~~PR~~
366A
740RS
754MR
432QM
722D

MADE BY	APPROVALS	DEPT	LOCATION
M MATA Aug 26, 1983	RA SIEMER 9rd '83	NED	SAN JOSE
CHKD BY AB ROGUE 9/20/83	ISSUED FM IKEMOTO SEP 20 1983	CONT ON SHEET 2	SH NO. 1

NEO 307A (REV. 10/81)

R

T-5223

4.1.12 Reactor Protection System Trip - Reactor Vessel High Pressure

4.1.12.1	Function - Limit positive pressure effect on reactor power. (Note 11) (See Paragraph 4.1.18 for Notes and Definitions)	
4.1.12.2	Trip Channel Sensor Identities (Note 11)	A1 B22-N023A A2 B22-N023C B1 B22-N023B B2 B22-N023D
4.1.12.3	Normal Range	920-1005 psig
4.1.12.4	Channel Instrument Accuracy	*
4.1.12.5	Channel Calibrational Accuracy	*
4.1.12.6	Channel Instrument Drift (Design)	*
4.1.12.7	Analytical Limit	*
4.1.12.8	Technical Specification Limit	*
4.1.12.9	Nominal Trip Setpoint	*
4.1.12.10	Alarm Setting	**
4.1.12.11	Transient	140 psi/second
4.1.12.12	Trip Channel Sensor Response Time	0.5 seconds
4.1.12.13	Trip System Trip Logic	1:2

* See Reference 2.1.2.g for these requirements.
** See Reference 2.1.2.r for this requirement.

DD2

4.1.5 Reactor Protection System Trip - Reactor Vessel Low Water Level

4.1.5.1 Function - Reduce possibility of uncovering reactor core (Note 11) (See Paragraph 4.1.18 for Notes and Definitions)

4.1.5.2	Trip Channel Sensor Identities (Note 11)	A1 B22-N024A A2 B22-N024C B1 B22-N024B B2 B22-N024D
4.1.5.3	Normal Range	559 to 568 inches above vessel zero
4.1.5.4	Channel Instrument Accuracy	*
4.1.5.5	Channel Calibrational Accuracy	*
4.1.5.6	Channel Instrument Drift (Design)	*
4.1.5.7	Analytical Limit	*
4.1.5.8	Technical Specification Limit	*
4.1.5.9	Nominal Trip Setpoint	*
4.1.5.10	Alarm Setting	**
4.1.5.11	Transient	- 7 inches/second
4.1.5.12	Trip Channel Sensor Response Time	1 second
4.1.5.13	Trip System Trip Logic	1:2

* See Reference 2.1.2.g for these requirements.
** See Reference 2.1.2.r for these requirements.

DD2

TABLE 7.2-5

RPS RESPONSE TIME (DESIGN)

FUNCTION	SENSOR RESPONSE TIME	CHANNEL, ACTUATOR, AND LOGIC RESPONSE TIME	MAXIMUM OVERALL RESPONSE TIME
APRM*			
Flow Biased	0.06 Seconds	0.05 Seconds**	0.09 Seconds**
Simulated Thermal Power-Upscale		0.05 Seconds	
Fixed Neutron Flux-Upscale	0.06 Seconds		0.09 Seconds
Reactor Vessel High Pressure	0.5 Seconds	0.05 Seconds	0.55 Seconds
Reactor Vessel Low Water Level	1.0 Seconds	0.05 Seconds	1.05 Seconds
MSLIV Closure	0.01 Seconds	0.05 Seconds	0.06 Seconds
Turbine Stop Valve Closure	0.01 Seconds	0.05 Seconds	0.06 Seconds
Turbine Control Valve Fast Closure	0.03 Seconds	0.05 Seconds	0.08 Seconds#

* Neutron detectors are exempt from response time testing. Response time shall be measured from the detector output or from the input of the first electronic component in the channel.

** Total response time of 6 ± 1 seconds including simulated thermal power time constant.

Measured from start of turbine control valve fast closure.

RAW BENCH TEST RTT DATA (SENSORS)

4785

9:30 Am

Bill 4679

Terry Meade. 582 7735

MS-PS-23B. 68-11-1770RA — 1079 psig

slow (.04 sec) | fast (.04 sec)

MS-PS-23A1 68-11-1769RA — 1079 psig

slow (.02 sec) | fast (.06 sec)

MS-PS-23C 68-11-1771RA — 1078

check

SLOW (.23 sec) | fast (.07 sec)

PO 96811 item 1 88-7-1940 — 1077

about 630

SLOW (.20 sec) | fast (.08 sec)

PO 225541 item 1 92-7-7123 — 135

(MS-LS-61A)

SW #1 (.61 SEC
SW #2 (.50 SEC
SLOW

SW #1 (.465 sec
SW #2 (.39 sec
fast

PO 225541 item 1 92-7-7124 — 135

SW #1 (.80 sec)
SLOW SW #2 (.27 sec)

SW #1 (.44 sec)
FAST SW #2 (.43 sec)

VHIH 1111111 STORES

PAS

By: WLL Date: 4/14/97
CHECKED PAS 4/15/97

MS-LIS-61A, B,C, D Sensor
One sided upper tolerance bounds

(Data is in Seconds)

$$D_1 := \begin{bmatrix} .685 \\ .78 \\ .5 \\ .432 \\ .675 \\ .605 \\ .53 \\ .554 \end{bmatrix} \qquad D_2 := \begin{pmatrix} .465 \\ .44 \end{pmatrix} \qquad Data := stack(D_1, D_2)$$

Establish mean and standard deviation using standard Mathcad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data) \qquad n = 10$

$Mean := mean(Data) \qquad Mean = 0.5666 \qquad s := stdev(Data) \cdot \sqrt{\frac{n}{n-1}} \qquad s = 0.117$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MathCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \\ 30 & 2.22 \\ 40 & 2.13 \\ 60 & 2.02 \end{bmatrix}$$

$TF := linterp(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n) \qquad TF = 2.91$

One-sided upper tolerance bound

$T_{upper} := Mean + s \cdot TF$ $\quad T_{upper} = 0.907$

Establish normality plot:

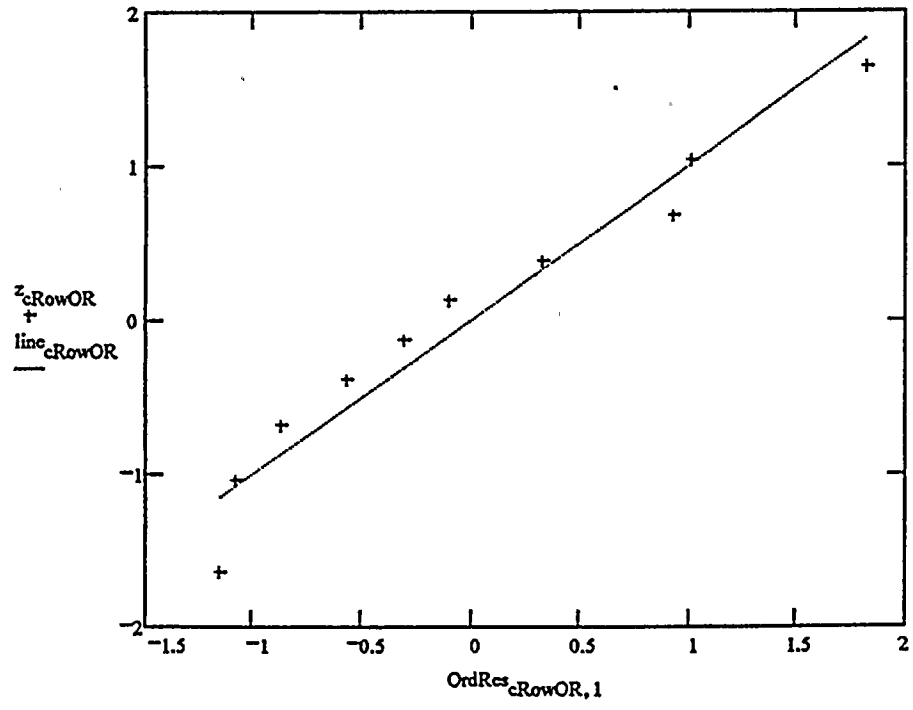
$Residuals := Data - Mean$ $\quad Standard_{Residuals} := \frac{Residuals}{s}$

$OrdRes := csort(Standard_{Residuals}, 1)$ $\quad cRowOR := 1 .. rows(OrdRes)$

$Prob_{cRowOR} := \frac{cRowOR - \frac{1}{2}}{rows(OrdRes)}$ $\quad OrdRes := augment(OrdRes, Prob)$

$x := 0$ $\quad z_{cRowOR} := root(normal(0, 1, x) - Prob_{cRowOR}, x)$

$m := 1$ $\quad intercept := 0$ $\quad line_{cRowOR} := m \cdot OrdRes_{cRowOR, 1} + intercept$



By: WLL Date: 4/14/97
CHECKED PAS 4/15/97

MS-PS-23A,B,C,D Sensor
One sided upper tolerance bounds

(Data in sec)

$$D_1 := \begin{bmatrix} .072 \\ .22 \\ .04 \\ .063 \\ .04 \\ .181 \\ .05 \end{bmatrix} \qquad D_2 := \begin{bmatrix} .04 \\ .06 \\ .07 \\ .08 \end{bmatrix} \qquad Data := stack(D_1, D_2)$$

Evaluate 0.22 and .181 as outliers:

$S^2 = 0.0362$

$S^2_{1,2} = 0.0019$

$\frac{S^2_{1,2}}{S^2} = \frac{.0019}{.0362} = 0.05$

$n = 10$

Per table 5 of ASTM E 178-94, those points are outliers at the 0.1% level of significance.

Establish mean and standard deviation using standard Mathcad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data) \qquad n = 11 \qquad Mean := mean(Data) \qquad Mean = 0.0833$

$s := stdev(Data) \cdot \sqrt{\frac{n}{n-1}} \qquad s = 0.0602 \qquad S := \sum_{i=1}^{n} (Data_i - Mean)^2 \qquad S = 0.0362$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MathCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \\ 30 & 2.22 \\ 40 & 2.13 \\ 60 & 2.02 \end{bmatrix} \qquad TF := linterp(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n) \qquad TF = 2.825$$

By: WLL Date: 4/14/97
PAS 4/15/97

One-sided upper tolerance bound

$T_{upper} := Mean + s \cdot TF$ $T_{upper} = 0.2533$

Establish normality plot:

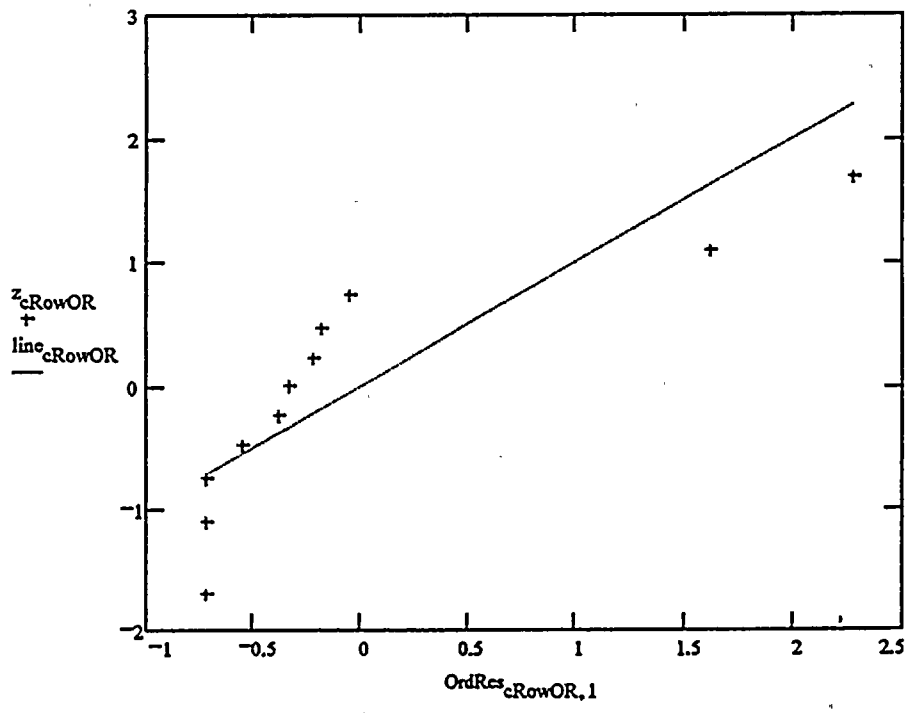
$Residuals := Data - Mean$ $Standard_{Residuals} := \frac{Residuals}{s}$

$OrdRes := csort(Standard_{Residuals}, 1)$ $cRowOR := 1 .. rows(OrdRes)$

$Prob_{cRowOR} := \frac{cRowOR - \frac{1}{2}}{rows(OrdRes)}$ $OrdRes := augment(OrdRes, Prob)$

$x := 0$ $z_{cRowOR} := root(normal(0, 1, x) - Prob_{cRowOR}, x)$

$m := 1$ $intercept := 0$ $line_{cRowOR} := m \cdot OrdRes_{cRowOR, 1} + intercept$



By: WLL Date: 4/14/97
PAS 4/15/97

MS-PS-23A,B,C,D Sensor
One sided upper tolerance bounds

$$D_1 := \begin{bmatrix} .072 \\ .04 \\ .063 \\ .04 \\ .05 \end{bmatrix} \qquad D_2 := \begin{bmatrix} .04 \\ .06 \\ .07 \\ .08 \end{bmatrix} \qquad Data := stack(D_1, D_2)$$

Establish mean and standard deviation using standard Mathcad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data) \qquad n = 9 \qquad Mean := mean(Data) \qquad Mean = 0.0572$

$$s := stdev(Data) \cdot \sqrt{\frac{n}{n-1}} \qquad s = 0.0153 \qquad S := \sum_{i=1}^{n} (Data_i - Mean)^2 \qquad S = 0.0019$$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MathCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \\ 30 & 2.22 \\ 40 & 2.13 \\ 60 & 2.02 \end{bmatrix} \qquad TF := linterp(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n) \qquad TF = 3.03$$

By: WLL Date: 4/14/97

PAS 4/15/97

One-sided upper tolerance bound

$T_{upper} := Mean + s \cdot TF$ $T_{upper} = 0.1037$

Establish normality plot:

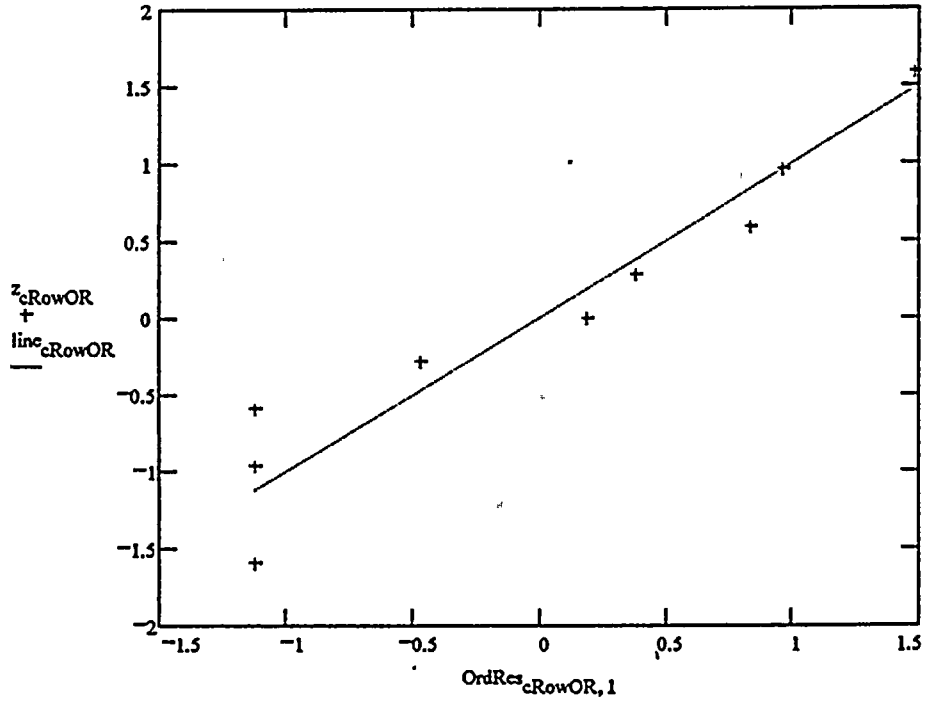
$Residuals := Data - Mean$ $Standard_{Residuals} := \frac{Residuals}{s}$

$OrdRes := csort(Standard_{Residuals}, 1)$ $cRowOR := 1 .. rows(OrdRes)$

$Prob_{cRowOR} := \frac{cRowOR - \frac{1}{2}}{rows(OrdRes)}$ $OrdRes := augment(OrdRes, Prob)$

$x := 0$ $z_{cRowOR} := root(normal(0, 1, x) - Prob_{cRowOR}, x)$

$m := 1$ $intercept := 0$ $line_{cRowOR} := m \cdot OrdRes_{cRowOR, 1} + intercept$



PKS

By: WLL Date: 4/14/97
CHECKED PAS 4/15/97

RPS Low Level
One sided upper tolerance bounds

Barton 288A
(Data in MSec)

$$D1 := \begin{bmatrix} 520 \\ 523 \\ 485 \\ 420 \\ 320 \\ 465 \\ 460 \\ 400 \\ 455 \\ 430 \\ 357 \\ 542 \\ 542 \\ 540 \\ 470 \\ 497 \\ 358 \end{bmatrix} \qquad D2 := \begin{bmatrix} 468 \\ 400 \\ 559 \\ 495 \\ 381 \\ 476 \\ 470 \\ 377 \end{bmatrix}$$

Data := stack(D1, D2)

By: WLL Date: 4/14/97
PAS 4/15/97

Establish mean and standard deviation using standard Mathcad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data)$ $n = 25$

$Mean := mean(Data)$ $Mean = 456.4$ $s := stdev(Data)\cdot\sqrt{\frac{n}{n-1}}$ $s = 65.8679$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MathCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \\ 30 & 2.22 \\ 40 & 2.13 \\ 60 & 2.02 \end{bmatrix} \quad TF := linterp\left(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n\right) \quad TF = 2.29$$

One-sided upper tolerance bound

$T_{upper} := Mean + s\cdot TF$ $T_{upper} = 607.2375$

By: WLL Date: 4/14/97
PRS 4/15/97

Establish normality plot:

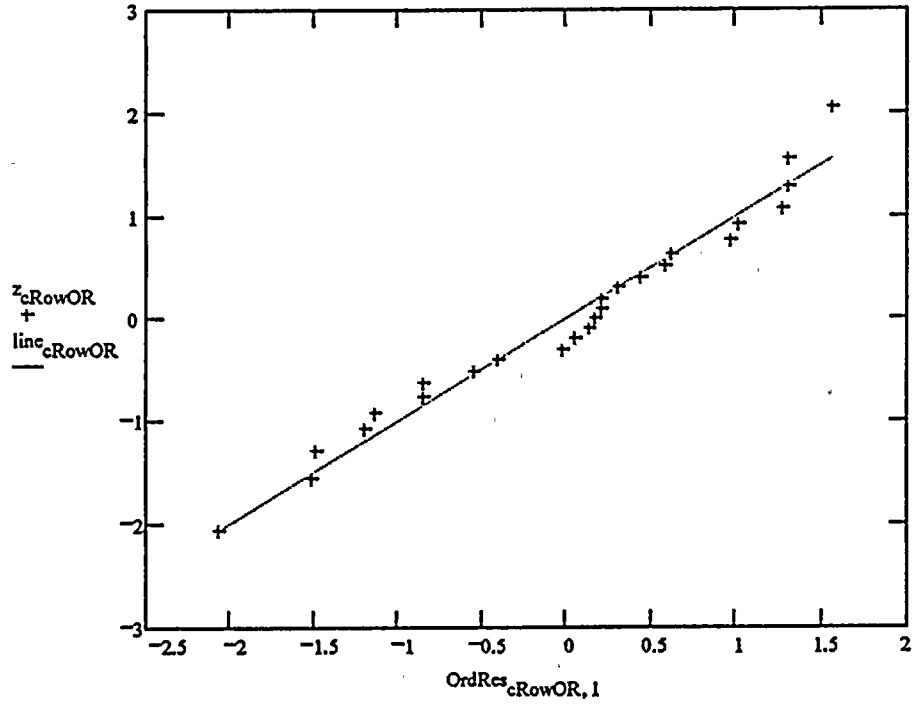
$$\text{Residuals} := \text{Data} - \text{Mean} \qquad \text{Standard}_{\text{Residuals}} := \frac{\text{Residuals}}{s}$$

$$\text{OrdRes} := \text{csort}\left(\text{Standard}_{\text{Residuals}}, 1\right) \qquad \text{cRowOR} := 1 .. \text{rows}(\text{OrdRes})$$

$$\text{Prob}_{\text{cRowOR}} := \frac{\text{cRowOR} - \frac{1}{2}}{\text{rows}(\text{OrdRes})} \qquad \text{OrdRes} := \text{augment}(\text{OrdRes}, \text{Prob})$$

$$x := 0 \qquad z_{\text{cRowOR}} := \text{root}\left(\text{normal}(0,1,x) - \text{Prob}_{\text{cRowOR}}, x\right)$$

$$m := 1 \quad \text{intercept} := 0 \quad \text{line}_{\text{cRowOR}} := m \cdot \text{OrdRes}_{\text{cRowOR},1} + \text{intercept}$$



By: WLL Date: 4/14/97
CHECKED TRS 4/15/99

MS-LIS-61A,B,C,D and MS-DPIS-8A,B,C,D Logic
One sided upper tolerance bounds

(Data in msec)

$$D_1 := \begin{bmatrix} 30 \\ 20 \\ 30 \\ 25 \\ 25 \\ 10 \\ 20 \\ 20 \end{bmatrix} \qquad D_2 := \begin{bmatrix} 17 \\ 14 \\ 30 \\ 20 \\ 26 \\ 24 \\ 12 \end{bmatrix} \qquad Data := stack(D_1, D_2)$$

Establish mean and standard deviation using standard Mathcad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data) \qquad n = 15$

$Mean := mean(Data) \qquad Mean = 21.5333 \qquad s := stdev(Data) \cdot \sqrt{\frac{n}{n-1}} \qquad s = 6.4128$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MatCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \end{bmatrix} \qquad TF := linterp(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n) \qquad TF = 2.57$$

By: WLL Date: 4/14/97
PAS 4/15/97

One-sided upper tolerance bound

$T_{upper} := Mean + s \cdot TF$ $T_{upper} = 38.0142$

Establish normality plot:

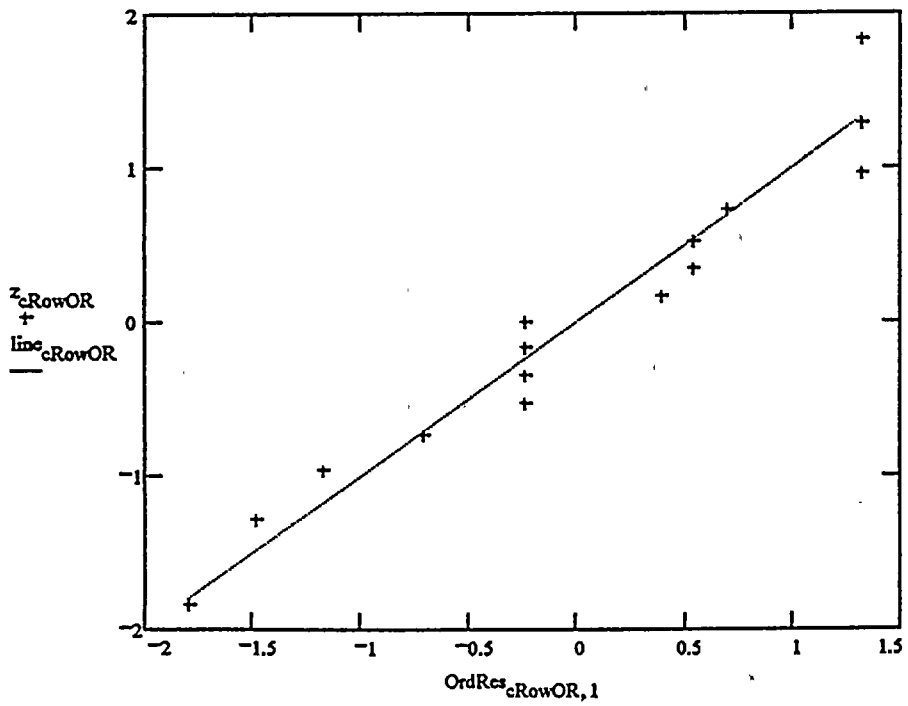
$Residuals := Data - Mean$ $Standard_{Residuals} := \frac{Residuals}{s}$

$OrdRes := csort(Standard_{Residuals}, 1)$ $cRowOR := 1 .. rows(OrdRes)$

$Prob_{cRowOR} := \frac{cRowOR - \frac{1}{2}}{rows(OrdRes)}$ $OrdRes := augment(OrdRes, Prob)$

$x := 0$ $z_{cRowOR} := root(normal(0, 1, x) - Prob_{cRowOR}, x)$

$m := 1$ $intercept := 0$ $line_{cRowOR} := m \cdot OrdRes_{cRowOR, 1} + intercept$



PAS

By: WLL Date: 4/14/97
CHECKED PAS 4/15/97

MS-PS 23A,B,C,D and MS-LIS-24A,B,C,D LOGIC
One sided upper tolerance bounds

(Data in msec)

$$D_1 := \begin{bmatrix} 33 \\ 30 \\ 35 \\ 30 \\ 21 \\ 32 \end{bmatrix} \qquad D_2 := \begin{bmatrix} 30 \\ 25 \\ 30 \\ 40 \\ 15 \\ 25 \\ 30 \\ 30 \end{bmatrix} \qquad Data := stack(D_1, D_2)$$

Establish mean and standard deviation using standard MathCad functions:

Notation as follows:

n = number of data points
Mean = mean of the data
s = standard deviation

$n := rows(Data) \qquad n = 14$

$Mean := mean(Data) \qquad Mean = 29 \qquad s := stdev(Data) \cdot \sqrt{\frac{n}{n-1}} \qquad s = 6.0764$

The following analysis establishes the 95%/ 95% one sided upper tolerance interval. The tolerance interval is obtained from the matrix Tol_{95} using MathCad's linterp function.

$$Tol_{95} := \begin{bmatrix} 4 & 5.14 \\ 5 & 4.2 \\ 6 & 3.71 \\ 7 & 3.4 \\ 8 & 3.19 \\ 9 & 3.03 \\ 10 & 2.91 \\ 12 & 2.74 \\ 15 & 2.57 \\ 20 & 2.4 \\ 25 & 2.29 \end{bmatrix} \qquad TF := linterp(Tol_{95}^{\langle 1 \rangle}, Tol_{95}^{\langle 2 \rangle}, n) \qquad TF = 2.6267$$

By: WLL Date: 4/14/97
PAS 4/15/97

One-sided upper tolerance bound

$T_{upper} := Mean + s \cdot TF$ $T_{upper} = 44.9608$

Establish normality plot:

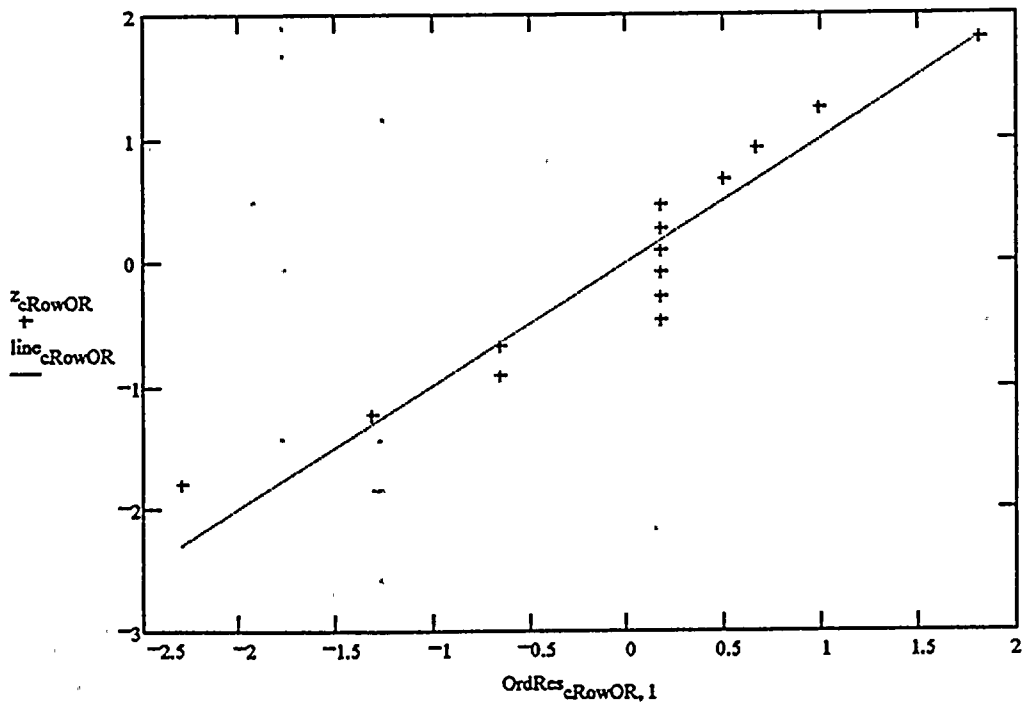
$Residuals := Data - Mean$ $Standard_{Residuals} := \frac{Residuals}{s}$

$OrdRes := csort(Standard_{Residuals}, 1)$ $cRowOR := 1 .. rows(OrdRes)$

$Prob_{cRowOR} := \frac{cRowOR - \frac{1}{2}}{rows(OrdRes)}$ $OrdRes := augment(OrdRes, Prob)$

$x := 0$ $z_{cRowOR} := root(normal(0, 1, x) - Prob_{cRowOR}, x)$

$m := 1$ $intercept := 0$ $line_{cRowOR} := m \cdot OrdRes_{cRowOR, 1} + intercept$



GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

OG97-121-964
February 12, 1997

TO: BWR Owners' Group Response Time Testing (RTT) Committee

SUBJECT: ***Response Time Testing Committee Meeting Notice for March 12, 1997***

Attachments: (1) Draft NEDO-32291 Supplement 1, "BWR Owners' Group Licensing Topical Report - - System Analyses for the Simplification of Selected Response Time Testing Requirements", dated February 1997
(2) Washington, DC subway map
(3) Driving directions to meeting location

A BWR Owners' Group Response Time Testing (RTT) Committee meeting will be held on Wednesday, March 12, 1997 in Washington, DC. The purpose of this meeting is to discuss the draft NEDO-32291 Supplement 1 (see Attachment 1). Appropriate comments will be incorporated and the Committee will be asked to approve the revised document. This document supplements NEDO-32291-A, "System Analyses for the Elimination of Selected Response Time Testing Requirements" by providing technical justification for the further simplification of response time testing requirements of selected Reactor Protection System (RPS) and (2) Isolation Actuation System (IAS) instrumentation loops. The technical justification methods utilized include Failure Modes and Effects Analysis (FMEA), failure experience reviews, and identification of functional surveillance testing other than response time testing that adequately confirms the ability of the selected instrumentation loops to meet response time requirements.

RTT Committee members are requested to carefully review the attached draft Licensing Topical Report and provide your comments to the undersigned no later than Wednesday, March 5, 1997. The report is complete except for the FMEA information for the GE CR120A relays. That is expected to be available before the meeting. As we discussed in conference calls last fall, the fast response RTTs are not included. In addition, main steam line radiation loop for MSIV closure is not included because it has been addressed by other BWROG action. Four radiation monitoring loops, each applying to a single plant, are not included because it appeared unlikely that the FMEA could provide adequate justification (due to complexity). Finally, one Drywell High Pressure (RPS) loop for a single plant is not included because there are other ways to address that one with greater likelihood of success.

The Response Time Testing Committee will meet in the morning at the Embassy Suites Hotel at Friendship Heights, and then will travel to NRC headquarters in Rockville to discuss the report conclusions, the schedule for Licensing Topical Report submittal, and the review/approval cycle. Following the meeting with the NRC we will return to the Embassy Suites Hotel to closeout open issues if required.