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February 23, 2010

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555-0001

Subject: Duke Energy Carolinas, LLC
Oconee Nuclear Site, Units 1, 2, and 3
Docket Numbers 50-269, 50-270, and 50-287
Request for Additional Information for License Amendment Request for Low Temperature Overpressure Protection System Technical Specification 3.4.12, Surveillance Requirement 3.4.12.7
License Amendment Request (LAR) No. 2008-04

In accordance with 10 CFR 50.90, Duke Energy Carolinas, LLC (Duke Energy) proposes to amend Appendix A, Technical Specifications, for Renewed Facility Operating Licenses Nos. DPR-38, DPR-47, and DPR-55 for Oconee Nuclear Station (ONS), Units 1, 2, and 3. This LAR requests the Nuclear Regulatory Commission (NRC) to review and approve a change to the technical specification (TS) 3.4.12, Low Temperature Overpressure Protection (LTOP) System, surveillance requirement (SR) frequency, specifically TS SR 3.4.12.7. TS SR 3.4.12.7 currently requires a channel calibration to be performed every 6 months. The proposed LAR changes the TS SR frequency from 6 months to 18 months. The LAR was submitted August 6, 2009.

On February 12, 2010, a request for additional information (RAI) was received from the NRC concerning documentation of the total loop uncertainty and drift for the new instrumentation. Enclosure 1 contains the RAI responses. Attachments 1 and 2, respectively, contain applicable sections of the calculations for the LTOP pressure instrument total loop uncertainty. Attachment 3 contains the requested vendor information.

In accordance with Duke Energy administrative procedures and the Quality Assurance Program Topical Report, this response is still bounded by the initial review and approval of the Plant Operations Review Committee. Additionally, a copy of this response is being sent to the State of South Carolina in accordance with 10 CFR 50.91 requirements.

Duke Energy requests that this proposed license amendment be reviewed and approved in support of the Spring, 2010 refueling outage. Duke Energy will also update applicable sections of the Oconee UFSAR, as necessary, and submit these changes per 10 CFR 50.71(e). There are no new commitments being made as a result of this proposed change.

A001
NRR

Inquiries on this proposed amendment request should be directed to Reene' Gambrell of the Oconee Regulatory Compliance Group at (864) 873-3364.

I declare under penalty of perjury that the foregoing is true and correct. Executed on February 23, 2010.

Sincerely,

Dave Baxter, Vice President
Oconee Nuclear Site

Enclosure:

1. Request for Additional Information, License Amendment Request for Low Temperature Overpressure Protection System Technical Specification 3.4.12, Surveillance Requirement 3.4.12.7

Attachments:

1. Calculation OSC-3862, Revision 7, Appendix F, OAC Low Range RCS Pressure Indication Uncertainty Following Implementation of NSMs OD100453, OD200454, & OD300452.
2. Calculation OSC-5123, Revision 10, Appendix C, Low Range RCS Pressure Control Room Indication Uncertainty Following Implementation of NSMs OD100453, OD200454, & OD300452.
3. Calculation OSC-3862, Attachment 3, Rosemount Nuclear, Model 1154 Series H Alphaline Nuclear Pressure Transmitter

bc w/enclosures and attachments:

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## ENCLOSURE 1

## REQUEST FOR ADDITIONAL INFORMATION

## LICENSE AMENDMENT REQUEST FOR LOW TEMPERATURE OVERPRESSURE PROTECTION SYSTEM TECHNICAL SPECIFICATION 3.4.12, SURVEILLANCE REQUIREMENT 3.4.12.7

Request for Additional Information
License Amendment Request for Low Temperature Overpressure Protection System
Technical Specification 3.4.12, Surveillance Requirement 3.4.12.7

**RAI #1:**

Provide the documentation (including sample calculations) of total loop uncertainty for the new pressure transmitter (Rosemount 1154SH9RB) to confirm that this total loop uncertainty will support existing Low Temperature Overpressure Protection (LTOP) set point evaluation analysis.

**RAI #1 RESPONSE:**

The documentation for total loop uncertainty for the new pressure transmitter is provided in Attachments 1 and 2. Attachment 1 provides the total loop uncertainty for the normal operating condition for the Operator Aid Computer (OAC) low range RCS indicator, while Attachment 2 provides the total loop uncertainty for the normal operating condition for the Control Room low range RCS pressure indicator.

**RAI #2:**

Provide the vendor information supporting the drift of 0.2% URL over a 30 months period.

**RAI #2 RESPONSE:**

The vendor information supporting the drift of 0.2% URL over a 30 months period is included in Attachment 3.

**ATTACHMENT 1**

**Calculation OSC-3862, Revision 7, Appendix F, OAC Low Range RCS Pressure Indication Uncertainty Following Implementation of NSMs OD100453, OD200454, & OD300452.**

# Appendix F

**OAC Low Range RCS Pressure Indication Uncertainty Following Implementation of NSMs OD100453, OD200454 & OD300452**

## Objective

This Appendix will evaluate the instrument uncertainty for the Low Range RCS Pressure channels following implementation of NSMs OD100453, OD200454 & OD300452.

## Background

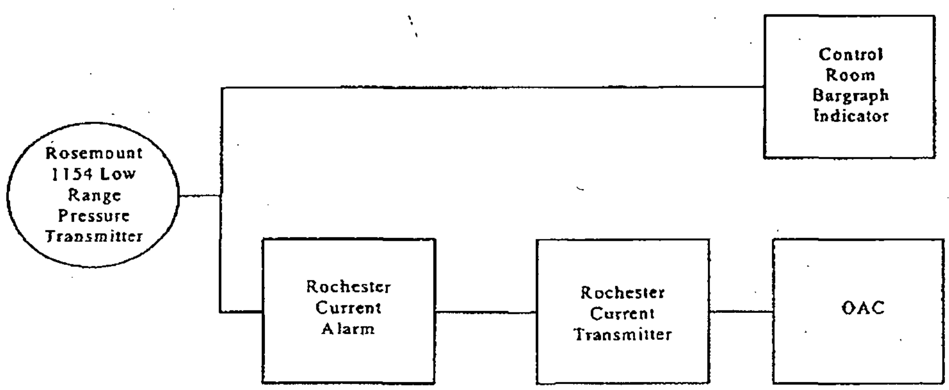
Oconee Nuclear Station is performing a Low Temperature Overpressure Protection (LTOP) System Upgrade which will upgrade the existing Train "A" of the Low Range RCS Pressure instrument loop to meet safety related, seismic and environmental qualification (EQ) requirements. This modification will also add a new redundant Train "B" instrument loop.

Modifications to Train "A" will include a replacement transmitter, power supply, current alarm module, current transmitter module and control board indicators. A safety related Train "B" will be created using the same components.

Per Reference 44, the following components will be used as replacements in Train "A" and to create Train "B" of the Low Range RCS Pressure channel.

- Rosemount Model Number 1154SH9RB pressure transmitters
- Rochester XSC-1302-20012 current transmitters
- Rochester XET-1215-T10-20012 current alarms
- Acopian VA24MT210M 24 VDC or VA36MT130M 36 VDC power supplies
- Dixson SH101P Single Bargraph Indicators

## Instrument Block Diagram



## Device/Loop Uncertainty Term Identification

Rosemount Model 1154SH9RB Differential Pressure Transmitters

All uncertainties given in this section are for the Rosemount Model 1154SH9RB Pressure Transmitter installed in the reactor coolant system (Reference 45). The output range for the pressure transmitters is 4 - 20 mAdc corresponding to a calibrated range of 0 - 600 psi.

All uncertainties given below are random-independent terms unless stated otherwise.

PT3CA - Transmitter Accuracy

Per Reference 45, reference accuracy is specified as ± 0.25 % of calibrated span. Includes the combined effects of linearity, hysteresis and repeatability.

$$PT3CA := 0.25\%\,span$$

PT3D - Transmitter Drift

Per Reference 45 the drift is specified as 0.2 % URL/30 months. The URL for the the Rosemount 1154SH9RB transmitter is 3000 psig while the calibrated span is 0 - 600 psig. Assuming a surveillance interval of 24 months + 25% grace period (30 months) the transmitter drift is:

$$PT3D := \frac{0.2\%\cdot 3000psi}{600psi}$$

$$PT3D = 1.0\% \quad span$$

PT3TE - Transmitter Temperature Effect

Per Reference 45 the temperature effect is (0.25 % URL + 0.5 % span)/50°F between 40 °F and 130 °F. Per Table EP-1 of Reference 46, the normal reactor building temperature varies between 60 - 130 °F. It is assumed that a nominal average temperature at the time of channel calibration is 80 °F. Allowing a potential temperature variation of ± 50 °F about this nominal temperature will cover the expected reactor building temeprature range. Therefore, the transmitter temperature effect is:

$$PT3TE := \left[\left(\frac{0.25\%\cdot 3000psi}{600psi}\right) + 0.5\%\right]$$

$$PT3TE = 1.75\% \quad span$$

PT3TEACC - Transmitter Temperature Effect (Accident Conditions)

Per Reference 45 the accident temperature effect is (2.0 % URL + 0.5 % span) for a temperature profile between 420 °F at the beginning of an accident to 265 °F after 56 hours. Per Table EP-1 of Reference 46, the design basis accident reactor building temperature profile varies between 290 °F and 200 °F at 3.6 days (86.4 hours). Therefore, the transmitter qualifications are bounding with respect to the qualification temperature profile given in Reference 45. This term will be conservatively treated as a two-sided bias. The transmitter temperature effect is:

$$PT3TEACC := \left[\left(\frac{2.0\% \cdot 3000psi}{600psi}\right) + 0.5\%\right]$$

$$PT3TEACC = 10.5\% \quad span$$

PT3PSE - Transmitter Power Supply Effect

The Acopian 24 Vdc or 36 Vdc power supply modules will be used to supply to the transmitter. Per Reference 47, the DC loop power supply variations are less than ± 0.5% of the nominal supply voltage for both the VA24MT210M and VA36MT130M power supply models. Reference 45, gives a power supply effect of 0.005 % span/volt. Therefore, a conservative transmitter power supply effect using the 36 Vdc model is:

$$PSvar := 36volt \cdot 0.5\% \quad PSvar = 0.18\,volt$$

$$PT3PSE := \left(0.005\frac{\%}{volt}\right) \cdot PSvar$$

$$PT3PSE = 0.0009\,\%\ span$$

PT3CTE -Transmitter Calibration Tolerance Effect

The transmitter calibration tolerance is assumed to be equal to the reference accuracy of 0.25 % span.

$$PT3CTE := 0.25\% \quad span$$

PT3SP -Transmitter Static Pressure Effect

Per Reference 45 the transmitter static pressure effect is systematic and can be calibrated out for a particular pressure before installation. The correction uncertainty is 0.5% of input reading/1,000 psi. Assuming a reading of 600 psi:

$$PT3SP := \frac{600psi}{1000psi} \cdot 0.5\%$$

$$PT3SP = 0.3\% \text{ span}$$

PT3MTE - Transmitter Measurement and Test Equipment

Per Reference 19 the transmitter calibration is performed using an Fluke 45 DMM or equivalent which has an uncertainty of $\pm 0.021$ mAdc on a 4 - 20 mAdc range (Reference 48). Also, a Heise PTE-1 with HQS-2 module Pressure Gauge with a range of 0 to 1000 psig is used. The uncertainty, as given in Reference 48 for the Heise pressure gauge, is ± 1.7942 psig. Both allowances above assume transmitter calibration occurs at containment temperatures between 55 °F and 92 °F.

$$Fluke\_range := 20 - 4 \quad mAdc$$

$$MTE\_Fluke45 := 0.021 \quad mAdc$$

$$MTE\_Unc\_Fluke := \frac{MTE\_Fluke45}{Fluke\_range}$$

$$MTE\_Unc\_Fluke = 0.13\% \text{ span}$$

$$Heise\_range := 1000psi - 0psi$$

$$MTE\_Heise := 1.7942psi$$

$$MTE\_Unc\_Heise := \frac{MTE\_Heise}{Heise\_range}$$

$$MTE\_Unc\_Heise = 0.18\% \text{ span}$$

$$PT3MTE := \sqrt{MTE\_Unc\_Fluke^2 + MTE\_Unc\_Heise^2}$$

$$PT3MTE = 0.22\% \quad \text{span}$$

PT3RE - Transmitter Radiation Effect (Accident Conditions)

Per Table EP-1 of Reference 46, the design basis accident reactor building peak radiation following a design basis accident is 61 megarads. Per Reference 45 the accident radiation effect is (0.5 % URL + 1.0 % span) up to 55 megarads and (0.75 % URL + 1.0 % span) after a 110 megarads. Since the peak radiation effect is above 55 megarads and is not expected to be above 110 megarads the accident for 110 megarads will conservatively be used. This term will be conservatively treated as a two-sided bias. The transmitter radiation effect is:

$$PT3RE := \left[\left(\frac{0.75\% \cdot 3000psi}{600psi}\right) + 1.0\%\right]$$

$PT3RE = 4.75\%$ span

PT3PMA - Process Measurement Allowance (Normal Conditions)

Per Reference 51 the normal reactor building pressure can vary between -2.45 psig and +1.2 psig. Therefore, a conservative allowance of ± 3 psig is used bound this reactor building pressure variation. This term will be conservatively treated as a two-sided bias. The normal conditions process measurement allowance is:

$$PT3PMA := \frac{3.0psi}{600psi}$$

$PT3PMA = 0.5\%$ span

Combination of Normal Conditions Transmitter Error Terms

$$TLU\_LRPress\_Xmtr := \sqrt{PT3CA^2 + PT3D^2 + PT3TE^2 + PT3PSE^2 + PT3CTE^2 \ldots + PT3SP^2 + PT3MTE^2} + PT3PMA$$

$TLU\_LRPress\_Xmtr = 2.58\%$ span

CADHD - Current Alarm Hardware Effects

Per Reference 49, reference accuracy is specified as ± 0.1 % of span.

$CADHD := 0.1\%$ span

CADPSE - Current Alarm Power Supply Effect

The Acopian 24 Vdc or 36 Vdc power supply modules will be used to supply to the current alarm. Per Reference 47, the DC loop power supply variations are less than ± 0.5% of the nominal supply voltage for both the VA24MT210M and VA36MT130M power supply models. Reference 49, gives a power supply effect of 0.15 % for a variation in voltage of 20%. Therefore, a current alarm power supply effect is:

$$CADPSE := 0.15\% \quad \text{span}$$

CADCTE -Current Alarm Calibration Tolerance Effect

The transmitter calibration tolerance is assumed to be equal to the reference accuracy of 0.1 % span.

$$CADCTE := 0.1\% \quad \text{span}$$

CADMTE - Current Alarm Measurement and Test Equipment

Per Reference 19 the transmitter calibration is performed using a Heise PTE-1 with HQS-2 module Pressure Gauge with a range of 0 to 1000 psig. The uncertainty, as given in Reference 48 for the Heise pressure gauge, is ± 1.7942 psig.

$$CADMTE := MTE\_Unc\_Heise$$

$$CADMTE = 0.18\% \quad \text{span}$$

CTHD - Current Transmitter Hardware Effects

Per Reference 50, linearity and repeatability are each specified as ± 0.1% of span therefore, the reference accuracy is:

$$CTHD := \sqrt{(0.1\%)^2 + (0.1\%)^2}$$

$$CTHD = 0.141\% \quad \text{span}$$

CTPSE - Current Transmitter Power Supply Effect

The Acopian 24 Vdc or 36 Vdc power supply modules will be used to supply to the current transmitter. Per Reference 47, the DC loop power supply variations are less than ± 0.5% of the nominal supply voltage for both the VA24MT210M and VA36MT130M power supply models. Reference 50, gives a power supply effect of 0.15 % for a variation in voltage of 20%. Therefore, a current alarm power supply effect is:

$$CTPSE := 0.15\% \quad \text{span}$$

CTCTE -Current Transmitter Calibration Tolerance Effect

The transmitter calibration tolerance is assumed to be equal to the reference accuracy of 0.141 % span.

$$CTCTE := CTHD$$

$$CTCTE = 0.141\,\% \quad span$$

CTMTE - Current Transmitter Measurement and Test Equipment

Per Reference 19 the transmitter calibration is performed using a Heise PTE-1 with HQS-2 module Pressure Gauge with a range of 0 to 1000 psig. The uncertainty, as given in Reference 48 for the Heise pressure gauge, is ± 1.7942 psig.

$$CTMTE := MTE\_Unc\_Heise$$

$$CTMTE = 0.18\,\% \quad span$$

CTTE - Current Transmitter Temperature Effect

Per Reference 50 the temperature effect is 0.02 %/°F between 25 °F and 125 °F. Per Reference 48 the normal expected environmental conditions in the control complex are 74 - 80 °F. Therefore the temperature effect is:

$$CTTE := [0.02\% \cdot (80 - 74)]$$

$$CTTE = 0.12\,\% \quad span$$

OAC - Indicator Accuracy

Per Table 7.4 of Reference 52 for a 4 - 20 mA input the bounding OAC uncertainty is 0.156% span. This uncertainty includes the computer accuracy, temperature, drift and other miscellaneous effects.

$$OAC := 0.156\% \quad span$$

OAC Low Range RCS Pressure Total Loop Uncertainy (Normal Conditions)

$$TLU\_OAC\_LRPress := \sqrt{TLU\_LRPress\_Xmtr^2 + CADHD^2 + CADPSE^2 + CADCTE^2 + CADMTE^2 \ldots + CTHD^2 + CTPSE^2 + CTCTE^2 + CTMTE^2 + CTTE^2 + OAC^2}$$

$TLU\_OAC\_LRPress = 2.62\%$ span

$OAC\_Low\_Range\_Press := TLU\_OAC\_LRPress \cdot 600psi$

$OAC\_Low\_Range\_Press = 15.72psi$

OAC Low Range RCS Pressure Total Loop Uncertainy (Accident Conditions)

$$TLU\_OAC\_LRP\_Acc := \sqrt{\sqrt{TLU\_LRPress\_Xmtr^2 + CADHD^2 + CADPSE^2} \ldots + PT3TEACC + PT3RE + CADCTE^2 + CADMTE^2 + CTHD^2 + CTPSE^2 \ldots + CTCTE^2 + CTMTE^2 + CTTE^2 + OAC^2}$$

$TLU\_OAC\_LRP\_Acc = 17.87\%$ span

$OAC\_LR\_Press\_Acc := TLU\_OAC\_LRP\_Acc \cdot 600psi$

$OAC\_LR\_Press\_Acc = 107.22psi$

## Results

The Low Range Pressure uncertianties used to produce the OAC subcooling indication are summarized below.

OAC Low Range RCS Pressure Total Loop Uncertainy

Normal Conditions:

$OAC\_Low\_Range\_Press = 15.7psi$

Accident Conditions:

$OAC\_LR\_Press\_Acc = 107.2psi$

## Conclusions

The normal condition Low Range Pressure uncertainty results calculated above are within the results calculated previously for this channel (15.7 psi vs. 18.8 psi). An uncertainty allowance of ± 25.0 psi was used previously to develop the OAC subcooled margin monitor curves in Tables 16, 18 and 20. Therefore, the curves in Tables 16, 18 and 20 and their associated polynomials will not need to be revised.

The accident condition Low Range Pressure uncertainties presented above are for possible future use as it may be desirable to use the new instrumentation under degraded reactor building conditions for post accident monitoring.

## ATTACHMENT 2

**Calculation OSC-5123, Revision 10, Appendix C, Low Range RCS Pressure Control Room Indication Uncertainty Following Implementation of NSMs OD100453, OD200454, & OD300452.**

# Appendix C

**Low Range RCS Pressure Control Room Indication Uncertainty Following Implementation of NSMs OD100453, OD200454 & OD300452**

## Objective

This Appendix will evaluate the instrument uncertainty for the Low Range RCS Pressure control room indication following implementation of NSMs OD100453, OD200454 & OD300452.

## Background

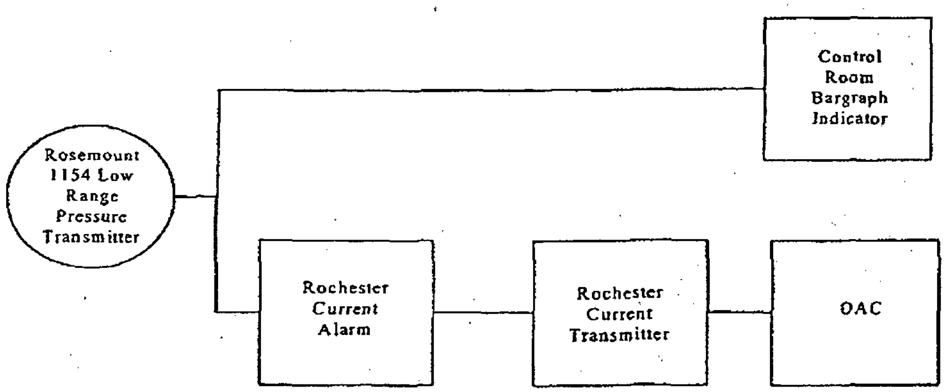
Oconee Nuclear Station is performing a Low Temperature Overpressure Protection (LTOP) System Upgrade which will upgrade the existing Train "A" of the Low Range RCS Pressure instrument loop to meet safety related, seismic and environmental qualification (EQ) requirements. This modification will also add a new redundant Train "B" instrument loop.

Modifications to Train "A" will include a replacement transmitter, power supply, current alarm module, current transmitter module and control board indicators. A safety related Train "B" will be created using the same components.

Per Reference 8.34, the following components will be used as replacements in Train "A" and to create Train "B" of the Low Range RCS Pressure channel.

- Rosemount Model Number 1154SH9RB pressure transmitters
- Rochester XSC-1302-20012 current transmitters
- Rochester XET-1215-T10-20012 current alarms
- Acopian VA24MT210M 24 VDC or VA36MT130M 36 VDC power supplies
- Dixson SH101P Single Bargraph Indicators

## Instrument Block Diagram



## Device/Loop Uncertainty Term Identification

Rosemount Model 1154SH9RB Differential Pressure Transmitters

All uncertainties given in this section are for the Rosemount Model 1154SH9RB Pressure Transmitter installed in the reactor coolant system (Reference 8.35). The output range for the pressure transmitters is 4 - 20 mAdc corresponding to a calibrated range of 0 - 600 psi.

All uncertainties given below are random-independent terms unless stated otherwise.

P4PTCA - Transmitter Accuracy

Per Reference 8.35, reference accuracy is specified as ± 0.25 % of calibrated span. Includes the combined effects of linearity, hysteresis and repeatability.

$$P4PTCA := 0.25\%\ span$$

P4PTD - Transmitter Drift

Per Reference 8.35 the drift is specified as 0.2 % URL/30 months. The URL for the the Rosemount 1154SH9RB transmitter is 3000 psig while the calibrated span is 0 - 600 psig. Assuming a surveillance interval of 24 months + 25% grace period (30 months) the transmitter drift is:

$$P4PTD := \frac{0.2\% \cdot 3000psi}{600psi}$$

$$P4PTD = 1.0\%\ span$$

P4PTTE - Transmitter Temperature Effect

Per Reference 8.35 the temperature effect is (0.25 % URL + 0.5 % span)/50°F between 40 °F and 130 °F. Per Table EP-1 of Reference 8.36, the normal reactor building temperature varies between 60 - 130 °F. It is assumed that a nominal average temperature at the time of channel calibration is 80 °F. Allowing a potential temperature variation of ± 50 °F about this nominal temperature will cover the expected reactor building temeprature range. Therefore, the transmitter temperature effect is:

$$P4PTTE := \left[\left(\frac{0.25\% \cdot 3000psi}{600psi}\right) + 0.5\%\right]$$

$$P4PTTE = 1.75\%\ span$$

P4PTTEACC - Transmitter Temperature Effect (Accident Conditions)

Per Reference 8.35 the accident temperature effect is (2.0 % URL + 0.5 % span) for a temperature profile between 420 °F at the beginning of an accident to 265 °F after 56 hours. Per Table EP-1 of Reference 8.36, the design basis accident reactor building temperature profile varies between 290 °F and 200 °F at 3.6 days (86.4 hours). Therefore, the transmitter qualifications are bounding with respect to the qualification temperature profile given in Reference 8.35. This term will be conservatively treated as a two-sided bias. The transmitter temperature effect is:

$$P4PTTEACC := \left[\left(\frac{2.0\%\cdot 3000psi}{600psi}\right) + 0.5\%\right]$$

$$P4PTTEACC = 10.5\% \quad span$$

P4PTPSE - Transmitter Power Supply Effect

The Acopian 24 Vdc or 36 Vdc power supply modules will be used to supply to the transmitter. Per Reference 8.37, the DC loop power supply variations are less than ± 0.5% of the nominal supply voltage for both the VA24MT210M and VA36MT130M power supply models. Reference 8.35, gives a power supply effect of 0.005 % span/volt. Therefore, a conservative transmitter power supply effect using the 36 Vdc model is:

$$PSvar := 36volt\cdot 0.5\% \quad PSvar = 0.18\,volt$$

$$P4PTPSE := \left(0.005\frac{\%}{volt}\right)\cdot PSvar$$

$$P4PTPSE = 0.0009\% \quad span$$

P4PTCTE -Transmitter Calibration Tolerance Effect

The transmitter calibration tolerance is assumed to be equal to the reference accuracy of 0.25 % span.

$$P4PTCTE := 0.25\% \; span$$

P4PTSP -Transmitter Static Pressure Effect

Per Reference 8.35 the transmitter static pressure effect is systematic and can be calibrated out for a particular pressure before installation. The correction uncertainty is 0.5% of input reading/1,000 psi. Assuming a reading of 600 psi:

$$P4PTSP := \frac{600psi}{1000psi} 0.5\%$$

$$P4PTSP = 0.3\% \quad span$$

P4PTMTE - Transmitter Measurement and Test Equipment

Per Reference 8.38 the transmitter calibration is performed using an Fluke 45 DMM or equivalent which has an uncertainty of ± 0.021 mAdc on a 4 - 20 mAdc range (Reference 8.39). Also, a Heise PTE-1 with HQS-2 module Pressure Gauge with a range of 0 to 1000 psig is used. The uncertainty, as given in Reference 8.39 for the Heise pressure gauge, is ± 1.7942 psig. Both allowances above assume transmitter calibration occurs at containment temperatures between 55 °F and 92 °F.

$$Fluke\_range := 20 - 4 \quad mAdc$$

$$MTE\_Fluke45 := 0.021\, mAdc$$

$$MTE\_Unc\_Fluke := \frac{MTE\_Fluke45}{Fluke\_range}$$

$$MTE\_Unc\_Fluke = 0.13\% \, span$$

$$Heise\_range := 1000psi - 0psi$$

$$MTE\_Heise := 1.7942psi$$

$$MTE\_Unc\_Heise := \frac{MTE\_Heise}{Heise\_range}$$

$$MTE\_Unc\_Heise = 0.18\% \, span$$

$$P4PTMTE := \sqrt{MTE\_Unc\_Fluke^2 + MTE\_Unc\_Heise^2}$$

$$P4PTMTE = 0.22\% \quad span$$

P4PTRE - Transmitter Radiation Effect (Accident Conditions)

Per Table EP-1 of Reference 8.36 design basis accident reactor building peak radiation following a design basis accident is 61 megarads. Per Reference 8.35 accident radiation effect is (0.5 % URL + 1.0 % span) up to 55 megarads and (0.75 % URL + 1.0 % span) after a 110 megarads. Since the peak radiation effect is above 55 megarads and is not expected to be above 110 megarads the accuracy for 110 megarads will conservatively be used. This term will be conservatively treated as a two-sided bias. The transmitter radiation effect is:

$$P4PTRE := \left[\left(\frac{0.75\% \cdot 3000psi}{600psi}\right) + 1.0\%\right]$$

$P4PTRE = 4.75\%$ span

P4PTPMA - Process Measurement Allowance (Normal Conditions)

Per Reference 8.11 the normal reactor building pressure can vary between -2.45 psig and +1.2 psig. Therefore, a conservative allowance of ± 3 psig is used bound this reactor building pressure variation. This term will be conservatively treated as a two-sided bias. The normal conditions process measurement allowance is:

$$P4PTPMA := \frac{3.0psi}{600psi}$$

$P4PTPMA = 0.5\%$ span

Combination of Normal Conditions Transmitter Error Terms

$$TLU\_LRPress\_Xmtr := \sqrt{P4PTCA^2 + P4PTD^2 + P4PTTE^2 + P4PTPSE^2 \ldots + P4PTCTE^2 + P4PTSP^2 + P4PTMTE^2} + P4PTPMA$$

$TLU\_LRPress\_Xmtr = 2.58\%$ span

P4ICA - Indicator Reference Accuracy

Per Reference 8.40, the indicator reference accuracy is specified as ± 0.04 % of calibrated span ± 1 count. 1 count is defined as the ± unit value of the rightmost digit. Since the display is a four digit display 1 count will equal 0.1 psig.

$$P4ICA := \frac{0.04\% \cdot 600psi + 0.1psi}{600psi}$$

$P4ICA = 0.057\%$ span

P4ID - Indicator Drift

Per Reference 8.40, the indicator drift is ± 0.015% of calibrated span per month. Assuming a surveillance interval of 24 months + 25% grace period (30 months) the indicator drift is:

$$mon := 30day$$

$$P4ID := 0.015\frac{\%}{mon}\cdot 30mon$$

$$P4ID = 0.5\% \quad span$$

P4IRA -Indicator Readability

Per Reference 8.40, the display is a four digit display capable of displaying any value between -9999 and +9999. Therefore, the rightmost digit on a 0 - 600 psig range will be able to resolve pressure at 0.1 psig increments.

$$P4IRA := \frac{0.1psi}{600psi}$$

$$P4IRA = 0.017\% \ span$$

P4IOTE - Indicator Ambient Temperature Change Offset Error

Per Reference 8.40 the ambient temperature change offset error is 0.01 % calibrated span/°C. Per Reference 8.36 Table EP-3, the normal expected environmental conditions in the control complex are 74 - 80 °F (23.3 - 26.7 °C). Therefore the temperature change offset error is:

$$P4IOTE := 0.01\%\cdot(26.7 - 23.3)$$

$$P4IOTE = 0.034\% \quad span$$

P4IGTE - Indicator Ambient Temperature Change Gain Error

Per Reference 8.40 the ambient temperature change gain error is 0.02 % full scale/°C. Per Reference 8.36 Table EP-3, the normal expected environmental conditions in the control complex are 74 - 80 °F (23.3 - 26.7 °C). Therefore the temperature change offset error is:

$$P4IGTE := 0.02\%\cdot(26.7 - 23.3)$$

$$P4IGTE = 0.068\% \quad span$$

P4ICTE -Indicator Calibration Tolerance Effect

Per Reference 8.38 the indicator calibration tolerance is 0.1 % span.

$$P4ICTE := 0.1\% \quad span$$

P4IMTE - Indicator Measurement and Test Equipment

Per Reference 8.38 the indicator calibration is performed using a Heise PTE-1 with HQS-2 module Pressure Gauge with a range of 0 to 1000 psig. The uncertainty, as given in Reference 8.39 for the Heise pressure gauge, is ± 1.7942 psig.

$$P4IMTE := MTE\_Unc\_Heise$$

$$P4IMTE = 0.18\% \quad span$$

Control Room Indication Low Range RCS Pressure Total Loop Uncertainy (Normal Conditions)

$$TLU\_CRI\_LRPress := \sqrt{TLU\_LRPress\_Xmtr^2 + P4ICA^2 + P4ID^2 + P4IRA^2 + P4IOTE^2 \ldots + P4IGTE^2 + P4ICTE^2 + P4IMTE^2}$$

$$TLU\_CRI\_LRPress = 2.63\% \quad span$$

$$IND\_Low\_Range\_Press := TLU\_CRI\_LRPress \cdot 600psi$$

$$IND\_Low\_Range\_Press = 15.77psi$$

Control Room Indication Low Range RCS Pressure Total Loop Uncertainy (Accident Conditions)

$$TLU\_CRI\_LRP\_Acc := \sqrt{TLU\_LRPress\_Xmtr^2 + P4ICA^2 + P4ID^2 \ldots + P4IRA^2 + P4IOTE^2 + P4IGTE^2 \ldots + P4ICTE^2 + P4IMTE^2} + P4PTTEACC + P4PTRE$$

$$TLU\_CRI\_LRP\_Acc = 17.88\% \quad span$$

$$IND\_LR\_Press\_Acc := TLU\_CRI\_LRP\_Acc \cdot 600psi$$

$$IND\_LR\_Press\_Acc = 107.27psi$$

## Results

The Low Range Pressure uncertianties used to produce the control room indication are summarized below.

Control Room Indication Low Range RCS Pressure Total Loop Uncertainy

Normal Conditions:

Two-sided:

$$IND\_Low\_Range\_Press = 15.8\,psi$$

One-sided:

$$OS\_IND\_Low\_Range\_Press := IND\_Low\_Range\_Press \cdot 0.84$$

$$OS\_IND\_Low\_Range\_Press = 13.2\,psi$$

Accident Conditions:

Two-sided:

$$IND\_LR\_Press\_Acc = 107.3\,psi$$

One-sided:

$$OS\_IND\_LR\_Press\_Acc := IND\_LR\_Press\_Acc \cdot 0.84$$

$$OS\_IND\_LR\_Press\_Acc = 90.1\,psi$$

## Conclusions

The normal condition Low Range Pressure uncertainty results calculated above are within the results calculated previously for this channel indication (13.2 psi vs. 20.6 psi). The results for the new instrumentation is also within the low pressure indication uncertainty sensitivity case results presented in Tables C-2 and C-3 (13.2 psi vs. 13.86 and 15.43 psi). Therefore, the sensitivity cases will not be reanaylzed for the new instrumentation in this appendix.

The accident condition Low Range Pressure indication uncertainties presented above are for possible future use as it may be desirable to use the new instrumentation under degraded reactor building conditions.

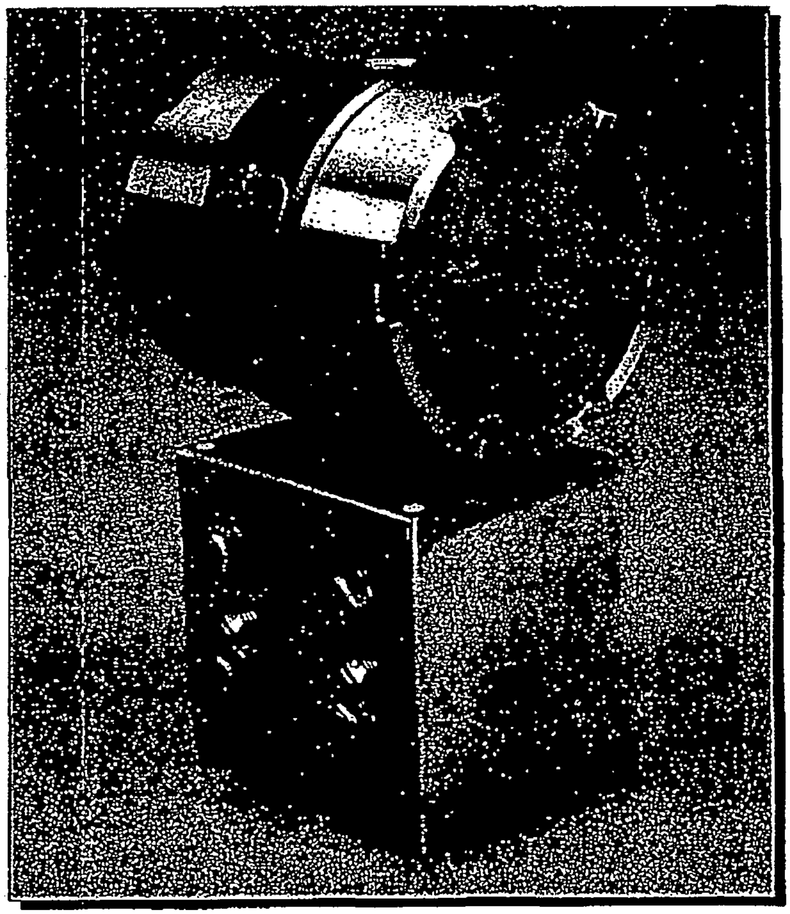
## ATTACHMENT 3

## OSC-3862, Attachment 3
## Rosemount Nuclear
## Model 1154 Series H Alphaline Nuclear Pressure Transmitter

Attachment 3

00813-0100-4631
English
June 1999
Rev. AA

# Model 1154 Series H Alphaline® Nuclear Pressure Transmitter



ROSEMOUNT® NUCLEAR

FISHER-ROSEMOUNT™ Managing The Process Better™



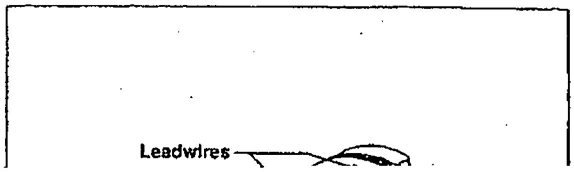
OSC-3862

Attachment 2



## FEATURES

- *Qualified per IEEE Std 323-1974 and IEEE Std 344-1975*
- $1.1 \times 10^8$ rads-TID gamma radiation



# SPECIFICATIONS

## Nuclear Specifications

Qualified per IEEE Std. 323-1974 and 344-1975, as stated in Rosemount Report D8700096

### Radiation

Accuracy within ±(0.25% of upper range limit + 0.75% of span) during first 30 minutes; ±(0.5% of upper range limit + 1.0% of span) thereafter up to 55 megarads total integrated dosage (TID); ±(0.75% of upper range limit + 1.0% of span) after 110 megarads TID gamma radiation exposure

### Seismic

Accuracy within ±0.5% of upper range limit during and after a disturbance defined by a required response spectrum with a horizontal ZPA of 8.5 g, and a vertical ZPA of 5.2 g

### Steam Pressure/Temperature

Accuracy within ±(1.0% of upper range limit + 1.0% of span) for range codes 4-8; ±(2.0% of upper range limit + 0.5% of span) for range code 9 during and after sequential exposure to steam at the following temperatures and pressures, concurrent with chemical spray for the first 24 hours

420 °F (215.6 °C), 85 psig for 3 minutes

350 °F (176.6 °C), 85 psig for 7 minutes

320 °F (160 °C), 75 psig for 8 hours

265 °F (129.4 °C), 24 psig for 56 hours

### Chemical Spray

Chemical spray composition is 0.28 molar boric acid, 0.064 sodium thiosulfate, and sodium hydroxide, to make an initial pH of 11.0 and a subsequent pH ranging from 8.5 to 11.0. Chemical spray is sprayed at a rate of 0.25 gal/min/ft$^2$.

### Post DBE Operation

Accuracy at reference conditions shall be within ±2.5% of upper range limit for one year following DBE.

### Quality Assurance Program

In accordance with NQA-1, 10CFR50 Appendix B, and ISO 9001

### Nuclear Cleaning

To 1 ppm maximum chloride content

### Hydrostatic Testing

To 150% of maximum working pressure or 2,000 psi (13.8 MPa), whichever is greater

### Traceability

In accordance with NQA-1 and 10CFR50 Appendix B; chemical and physical material certification of pressure-retaining parts

### Qualified Life

Dependent on continuous ambient temperature at the installation site, illustrated in Figure 3. Replacement of amplifier and calibration circuit boards at the end of their qualified life permits extension of the transmitter's qualified life to the module's qualified life. See Rosemount Report D8700096.

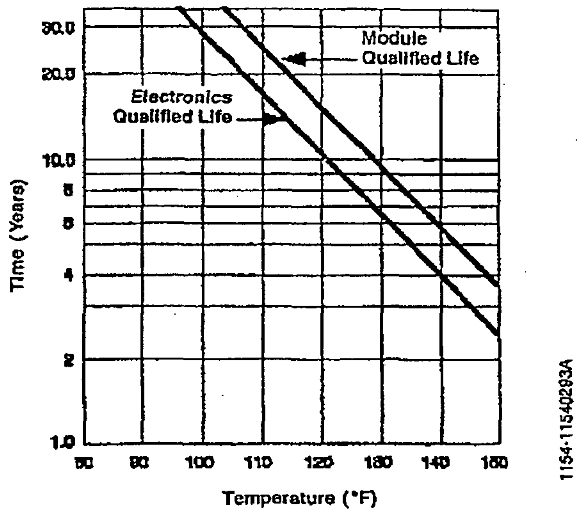



FIGURE 3. Qualified Life vs. Ambient Temperature.

## Performance Specifications

Based on zero-based ranges under reference conditions

### Accuracy

±0.25% of calibrated span; includes combined effects of linearity, hysteresis, and repeatability

### Dead Band

None

### Drift

±0.2% of upper range limit for thirty months

### Temperature Effect

**Ranges 4-8:**
±(0.15% upper range limit + 0.35% span) per 50 °F (27.8 °C) ambient temperature change between 40 °F (4.4 °C) and 130 °F (54.4 °C)

**Range 9:**
±(0.25% of upper range limit + 0.5% span) per 50 °F (27.8 °C) ambient temperature change between 40 °F (4.4 °C) and 130 °F (54.4 °C)

**All Ranges:**
±(0.75% of upper range limit + 0.5% span) per 100 °F (55.6 °C) ambient temperature change between 40 °F (4.4 °C) and 200 °F (93.3 °C)

### Overpressure Effect

**Model 1154DH:**
Maximum zero shift after 2,000 psi (13.8 MPa) overpressure:

| Range Code | Overpressure Effect |
|---|---|
| 4 | ±0.25% of upper range limit |
| 5 | ±1.0% of upper range limit |
| 6–7 | ±3.0% of upper range limit |
| 8 | ±6.0% of upper range limit |

**Model 1154HH:**
Maximum zero shift after 3,000 psi (20.68 MPa) overpressure:

| Range Code | Overpressure Effect |
|---|---|
| 4 | ±1.0% of upper range limit |
| 5 | ±2.0% of upper range limit |
| 6–7 | ±5.0% of upper range limit |

**Model 1154SH:**
Maximum zero shift after 4,500 psi (31.0 MPa) overpressure:

| Range Code | Overpressure Effect |
|---|---|
| 9 | ±0.5% of upper range limit |

### Static Pressure Zero Effect

**Model 1154DH:**
Per 1,000 psi (6.89 MPa):

| Range Code | Static Pressure Zero Effect |
|---|---|
| 4–5 | ±0.2% of upper range limit |
| 6–8 | ±0.5% of upper range limit |

**Model 1154HH:**
Per 1,000 psi (6.89 MPa):

| Range Code | Static Pressure Zero Effect |
|---|---|
| 4–7 | ±0.66% of upper range limit |

### Static Pressure Span Effect

Effect is systematic and can be calibrated out for a particular pressure before installation; correction uncertainty: ±0.5% of input reading/1,000 psi (6.89 MPa)

### Power Supply Effect

Less than 0.005% of output span/volt

### Load Effect

No load effect other than the change in voltage supplied to the transmitter

### Mounting Position Effect

No span effect; zero shift of up to 1.5 $inH_2O$ (372 Pa), which can be calibrated out

### Response Time

Fixed time constant (63%) at 100 °F (37.8 °C):

| Range Code | Response Time |
|---|---|
| 4 | 0.5 seconds or less |
| all others | 0.2 seconds or less |

Adjustable damping option is available through special N-Option.

## Functional Specifications

### Service

Liquid, gas, or vapor

### Output

4-20 mA dc

### Power Supply

Design limits are as shown in Figure 4. See Rosemount Report D8700096 for additional detail.

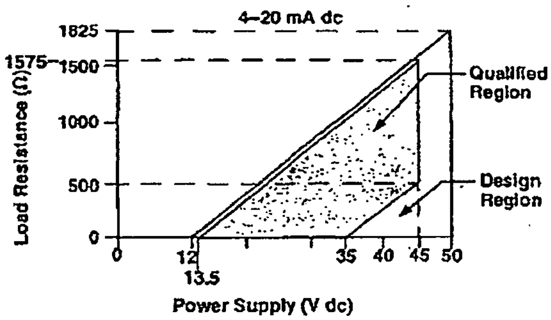



FIGURE 4. Load Limitations.

### Span and Zero

Continuously adjustable, externally

### Zero Elevation and Suppression

Maximum Zero Elevation: 600% of calibrated span
Maximum Zero Suppression: 500% of calibrated span

Zero elevation and suppression must be such that neither the calibrated span nor upper or lower range value exceeds 100% of upper range limit.

### Temperature Limits

Normal Operating Limits: 40 to 200 °F (4.4 to 93.3 °C)
Qualified Storage Limits: –40 to 120 °F (–40.0 to 48.9 °C)

### Humidity Limits

0–100% relative humidity (NEMA 4X)

### Volumetric Displacement

Less than 0.01 cubic in. (0.16 $cm^3$)

### Turn-On Time

2 seconds maximum. No warm-up required

Pressure Ranges

Models 1154DH and 1154HH:

| Range Code | Pressure Range |
|---|---|
| 4 | 0–25 to 0–150 $inH_2O$ (0–6.22 to 0–37.3 kPa) |
| 5 | 0–125 to 0–750 $inH_2O$ (0–31.08 to 0–186.4 kPa) |
| 6 | 0–17 to 0–100 psi (0–0.12 to 0–0.69 MPa) |
| 7 | 0–50 to 0–300 psi (0–0.34 to 0–2.07 MPa) |
| 8 | 0–170 to 0–1,000 psi (Model 1154 D only) (0–1.17 to 0–6.89 MPa) |

Model 1154SH:

| Range Code | Pressure Ranges |
|---|---|
| 9 | 0–500 to 0–3,000 psi (0–3.45 to 0–20.68 MPa) |

Maximum Working Pressure

Model 1154DH and 1154HH:
Static Pressure Limit

Model 1154SH:
Upper range limit

Static Pressure and Overpressure Limits

Model 1154DH:
0.5 psia to 2,000 psig (3.4 kPa abs to 13.8 MPa) maximum rated static pressure for operation within specifications; overpressure limit is 2,000 psig (13.8 MPa) on either side without damage to the transmitter

Model 1154HH:
0.5 psia to 3,000 psig (3.4 kPa abs to 20.7 MPa) maximum rated static pressure for operation within specifications; overpressure limit is 3,000 psig (20.7 MPa) on either side without damage to the transmitter

Overpressure Limits

Model 1154SH:

Operates within specification from 0.5 psia (3.4 kPa abs) to upper range limit; overpressure limit is 4,500 psig (31.0 MPa) for range code 9, without damage to the transmitter

## Physical Specifications

### Materials of Construction

Isolating Diaphragms:
316L SST

Drain/Vent Valves:
316 SST

Process Flanges:
CF-8M (cast version of 316 SST)

Process O-rings:
316L SST

Electronics Housing O-rings:
Ethylene Propylene

Fill Fluid:
Silicone Oil

Flange Bolts:
Plated Alloy Steel, per ASTM A-540

Electronics Housing:
316 SST

Module Shroud:
304L SST

Module Shroud Potting:
Silicone RTV

Mounting Bracket:
316L SST

Mounting Bolts:
SAE J429 Carbon Steel, Grade 2 or Grade 5

Weight

26.6 lb (12.1 kg) including mounting bracket

Electrical Connections

½–14 NPT conduit with screw terminals

Process Connections

⅜-inch Swagelok compression fitting, 316 SST (¼–18 NPT optional)