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CALCULATION REVIEW AND APPROVAL

T7.47

Calculation # 96-0280

Number of Pages 4 + 2 att. pages

Title of Calculation:
Uncertainty Associated with Instrumentation used in IT-14 for Fuel Oil Transfer Pumps

☒ Original Calculation ☒ QA-Scope

☐ Revised Calculation. Revision # _____

☐ Superseding Calculation. Supersedes Calculation # _____

Modification #	Description:

Other References:

Prepared By: Date: 12/18/96

This Calculation has been reviewed in accordance with NP 7.2.4. The review was accomplished by one or a combination of the following (as checked):

_____ A review of a representative sample of repetitive calculations.

✓ A detailed review of the original calculation.

_____ A review of the calculation against a similar calculation previously performed.

_____ A review by an alternate, simplified, or approximate method of calculation.

Comments:

Reviewed By: Date: 12/23/96

Approved By: Date: 12/27/96

Reference(s): NP 7.2.4

A. Purpose

The purpose of this calculation is to determine the uncertainty associated with the instrumentation used in inservice test procedure IT-14 for the fuel oil transfer pumps, (reference 2). The final uncertainty value must include a combination of the uncertainties for all the instrumentation used in the test that will have an impact on the ability to measure the IST acceptance value during the test performance for comparison to the design basis acceptance value.

B. Method

Instrument uncertainties will be calculated for instruments used in the fuel oil transfer pump Inservice Test procedure, IT-14, (reference 2). The fuel oil transfer pump acceptance value will be strictly a total flow value. The fuel oil transfer pump inservice test is performed by aligning the pump to recirculate back to the EDG Fuel Oil Storage Tank, and after waiting five minutes for the system to stabilize, recording the pressure and the flow. The fuel oil transfer pump design basis acceptance value is strictly a flow value, and these pumps are positive displacement pumps whose flow output is nearly independent of the discharge pressure seen by the pump. Since this calculation is only intended to support the design basis IST acceptance criteria, and it is not important what the pump developed head is when the flow value is satisfied, it is not necessary to consider the pressure instrument in this uncertainty calculation. The pressure instrument is important for ensuring the ASME Section XI acceptance criteria are satisfied since that criteria was established to monitor for pump degradation.

This calculation was written for P-206A and P-207A, evaluating the flow instrument FI-3905, but the results apply equally well to P-206B and P-207B which use flow instruments FI-3928, and FI-3929, respectively.

C. References

1. Fuel Oil Transfer Pump operability determination, 10/1/1996.
2. PBNP Inservice Test, IT-14, "Quarterly Inservice Test of Fuel Oil Transfer System Pumps and Valves", Revision 11, November 15, 1996.
3. E-Mail, Craig Neuser to Gene LeClair, "IT-14 Gauges", dated 12/27/1996, atached.
4. ITT Barton product/bulletin 226-10, Model 226 Indicator, Liquid Level Differential Pressure-Flow rate.
5. ITT Barton model 224 differential pressure unit, Component Instruction Manual, Control # 01035, dated 1983.
6. Plant walkdown information, dated 12/17/1996 from Dirk Raebel to Ed Mercier, attached.
7. DG-I01 "Instrument Setpoint Methodology", Revision 1, September 12, 1995.
8. "Process/Industrial Instruments and Controls Handbook", Fourth Edition, Douglas M. Considine, McGRAW-HILL, INC.
9. Duke Engineering & Services letter to WE, "SI Pump IST Flow Test Uncertainty Evaluation", September 25, 1996.

10. WE Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance", dated 9/25/1996.

D. Assumptions

1. The temperature effect on the instrumentation will be assumed to be negligible as the transmitters are calibrated and used in essentially the same temperature environment.

2. If manufacturer's data was not located, uncertainties associated with drift of an instrument have been assumed to be the smaller of either 0.5% of full scale, or the instrument calibration tolerance. This value (0.5%) is based on engineering judgment of the maximum expected drift between calibrations for the instrumentation involved. Alternatively, the calibration tolerance is used if smaller, because instrumentation found regularly out of calibration are typically either repaired or replaced.

3. The M&TE error is assumed to be the smaller of either 0.5% of the instrument range, or the calibration tolerance, for all IST instruments. This value (0.5%) is conservative based on the research performed for Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance" (reference 10). The instrument accuracy is used if smaller because it is the practice of I&C to use a calibration instrument which is at least as accurate as the instrument being calibrated.

4. Based on a walkdown of the flow indicator, FI-3905, it appeared that there should be little or no static head effects due to the upper and lower taps and transmitter elevations that is discussed in section 3.3.3.18 of reference 7. ✓

E. Inputs

For this calculation, the total uncertainty associated with the instrumentation used to perform the IST test must be accounted for when obtaining the minimum IST acceptance criteria. Contributors to this total uncertainty include:

- Instrument (transmitter & indicator) accuracy
- Indicator readability
- Tolerance
- Drift

F. Instrument Uncertainty Determination

1. Instrument Uncertainties for FI-3905, P-206A/P-207A G-01/G-02 EDG FOTP Test Line Flow Indication, Barton model 226 Differential Pressure Indicator, and Barton Model 224 Differential Pressure Unit, range 0-60 gpm.
   a. Indicator readability; Based on plant walkdown by Dirk Raebel, the meter face has smallest divisions of 0.5 gpm in the range of interest (between 25 and 60 gpm.) or 0.5/60 equals 0.833% of range. (reference 6)
   b. Indicator accuracy, ±0.5% (reference 4),

c. Differential Pressure Unit Accuracy ± 1.5% (reference 5)

d. Calibration Tolerance; Currently, the instruments are not included in a regular calibration callup procedure. Per Craig Neuser E-Mail, reference 3 attached, the as left tolerance for the instrument is assumed to be ± 2%. ✓

e. Drift; assumed to be ± 0.5%. (assumption 2)

f. M&TE (Instrumentation uncertainty due to calibration); assumed to be ± 0.5%. (assumption 3)

g. FE-3905, Daniel Orifice Fitting Co., model #500,
The nominal accuracy for a flow orifice is ±0.6% (reference 8).

Since the bellows in the indicator effectively acts as the square root converter, it is necessary to treat this instrument as a square root converter. All the above errors with the exception of the indicator readability, are treated as input errors.

Input errors:

$$a = \pm\sqrt{(0.005)^2 + (0.015)^2 + (0.02)^2 + (0.005)^2 + (0.005)^2 + (0.006)^2}$$ ✓

$$a = \pm 0.0271 = \pm 2.71\%$$

Using the transfer function for a square root device from Appendix D of reference 7.

Eq. 1 $b = \sqrt{(a / 2B)^2 + e^2}$ ✓

Where b = Output error from non - linear device
a = Input error to non - linear device
B = Point of Interest (0 - 100% of span = 0 to 1)
e = Device Uncertainty from non - linear device (indicator readability)

To determine the point of interest, it is necessary to look at Equation 1 and recognize that the smaller that B is, the greater that the output error will be. From a review of past IST data, the lowest value for this reading was about 37 gpm

$$B = \frac{\text{Point of interest}}{\text{Instrument range}} = \frac{37 \text{ gpm}}{60 \text{ gpm}} = \frac{61.6\%}{100\ \%} = 0.616$$

Evaluating Equation 1.

$b = \pm \sqrt{(0.0271 / 2*0.616)^2 + (0.00833)^2}$ ✓

$b = 0.0235 = \pm 2.35\%$

This error converted to gpm:

$b = \pm 2.35\% * 60 \text{ gpm} = \pm 1.41 \text{ gpm}$ ✓

G. Results

The total instrument uncertainty associated with the inservice test procedure for the fuel oil transfer pumps is ± 1.41 gpm

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* Printed For: *
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Date: Wednesday, 27 November 1996 11:39am CT
To:
Cc:

From:
Subject: IT-14 gauges

All of the discharge pressure and flow gauges used in IT-14 were calibrated in 1994. These gauges should be calibrated by the next scheduled IT-14 which is 12/26/96. However, the test will probably be ran early due to the holidays. Gene, please initiate the work orders and have the following gauges calibrated prior to 12/13/96 (tolerance less than or equal to +/-2% of full scale):

PI-3973A, PI-3974A, FI-3905, PI-3973B, FI-3928, PI-3974B, FI-3929

I will make sure ops does not run the test prior to 12/13/96. If you need more time please let me know.John, please incorporate the above mentioned ga uges into the appropriate calibration procedure. These instruments should be designated as "Special Use Instruments".I will initiate a condition report do cumenting that these instruments have not been calibrated since 94 and were not put into a calibration procedure. Please call with any questions or concerns.

Thanks,

TITLE Uncertainty Associated with Instrumentation Used in IT-14 for Fuel Oil Transfer Pumps

	METER FACE INFO	ELEVATION (PIPE TO INSTRU. CENTERLINE)	HIEGHT ABOVE FLOOR	Plant Level
1PI-184		See attached page	90.75"	26' PAB
1PI-108	The meter range is 0-160 psi. The major labeled divisions are 20 psi. The mid size divisions between the 20 psi divisions indicate 10 psi divisions. Four marks between the 10 psi marks are 2 psi divisions.	See attached page	36.5"	26' PAB
PI-3973A	The meter range is 0-160 psi. The major labeled divisions are 20 psi. The mid size divisions between the 20 psi divisions indicate 10 psi divisions. Four marks between the 10 psi marks are 2 psi divisions.	See attached page	51	28' DGB
FI-3929, FI-3928, FI3905	These gauges are the same. They have non-linear faces.			
Range(Numbers indicated on gage)	Marks between divisions			
0 to 10	None			
10 to 15	4 divisions; 1 gpm each			
15 to 20	4 divisions; 1 gpm each			
20 to 25	4 divisions; 1 gpm each			
25 to 30	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
30 to 35	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
35 to 40	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
40 to 45	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
45 to 50	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
50 to 55	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			
55 to 60	4 Major divisions, 1 gpm each, w/ 5 minor divisions, 0.5 gpm each, between each major division			

Post-It® Fax Note 7671 | Date 12/17/96 | # of pages ▶ 3
To | From
Co./Dept. | Co.
Phone # | Phone # 755 6499
Fax # 221 2010 | Fax #

CR 96 - 416

OPERABILITY DETERMINATION

1. Degraded or potentially nonconforming equipment:

   Fuel oil transfer pumps P-206A, P-206B, P-207A, and P-207B.

2. Safety function(s) performed:

   The fuel oil transfer pumps support emergency diesel generator operation by transferring oil from underground fuel oil storage tanks T-175A and T-175B to their respective EDG day tanks. Either fuel oil transfer pump is capable of serving either emergency diesel generator unit in that train and by use of a manual cross-connect between the Train A and Train B fuel oil systems, any of the four pumps is capable of serving any of the four emergency diesel generator units.

3. Circumstances of potential nonconformance, including possible failure mechanisms:

   Condition Report 96-416 identified a potential concern for adequacy of the IST Program to ensure that pumps in the program meet design basis as well as ASME Section XI requirements. This evaluation supports determination of operability pending completion of detailed analysis.

4. Requirement or commitment established for the equipment, and why it may not be met:

   TS Requirement

   TS 15.3.7.A.1.e requires a fuel supply of 11,000 gallons available in each tank which is being relied upon to supply any operable emergency diesel generators. The Basis for TS 15.3.7 states that the EDG fuel oil system is considered operable when 1) 11,000 gal. of fuel oil is initially available in the fuel oil storage tank which supplies the diesel generators [Because the EDGs consume approximately 205 gallons of fuel per hour when fully loaded, the 11,000 gallon fuel supply in the emergency fuel tank provides sufficient fuel to operate one EDG at design load for more than 48 hours.], 2) the EDG day tank for that EDG is operable and for G-01 and G-02 the associated motor-operated fill valve is operable, 3) for G-01 and G-02, at least one of the two base-mounted sump tank fuel oil transfer pumps is operable, and 4) **the fuel oil transfer system associated with the EDG is operable**. However, the fuel oil transfer system is allowed to be out-of-service for four hours for G-01 and G-02 due to a combined four-hour supply of fuel oil in the diesel base and day tanks which do not require a fuel oil transfer pump for flow to the associated EDG. The fuel oil transfer system is allowed to be out-of-service for two hours for G-03 and G-04 due to a two-hour supply of fuel oil in the day tank. The transfer system may be out-of-service for longer periods if an appropriate alternate source of fuel is made available to the diesel generators.

   Commitment

   VPNPD-93-171, "Design Summary for the Installation of Two Additional Emergency Diesel Generators, Point Beach Nuclear Plants, Units 1 and 2," dated September 24, 1993 provided design information for the diesel generator fuel oil transfer system. This document states that all four fuel oil transfer pumps were sized to transfer oil to the associated day tank at a rate at least six times the maximum rate of fuel consumption. Based on a consumption rate of 205 gallons per hour, the fuel oil transfer pumps were sized to deliver at least 1230 gph, or 20.5 gpm.

   It was questioned whether the flow requirements established by IT-14 are sufficient to verify fuel oil transfer pump operability.

5. How and when the potentially nonconforming equipment was first discovered:

   This generic concern was first identified in June 1996 as a specific concern for safety injection pump acceptance criteria from ASME Section XI versus design requirements.

6. Basis for declaring affected equipment operable:

   Operability of the fuel oil transfer pumps is periodically verified by IT-14, "Quarterly Inservice Test of Fuel Oil Transfer System Pumps and Valves." The IST flow requirements for each of the four pumps and the flow measured during the most recent test are presented in the attached table. The ASME flow requirements for the fuel oil transfer pumps ensure that the pump flow is far above that required to support diesel operation. Although the fuel oil transfer pumps were sized to deliver six times the fuel consumption rate of a single EDG (20.5 gpm), the installed pumps are actually rated at 35 gpm at 35 psig discharge pressure(Ref. CIM 01533). During inservice testing, the P-206A and P-207A pumps are run through a recirculation path back to fuel oil storage tank T-175A. This results in a discharge pressure of approximately 2 to 3 psig. For P-206B and P-207B, the inservice test is accomplished by pumping fuel oil to a day tank, resulting in a discharge

pressure of approximately 26 psig. The difference in discharge pressure is not significant because the flow requirements established by the IST Program are far in excess of the flow needed to support EDG operation. Additionally, the fuel oil transfer pumps are screw-type pumps (rotary positive displacement pumps) whose flow rate is relatively independent of pump discharge pressure. Furthermore, the ability of the P-206A and P-207A transfer pumps to pump fuel oil to the G-01 and G-02 day tanks is verified on a monthly basis during diesel generator testing. Therefore, the ASME flow requirements established by IT-14 are conservative and sufficient for proving operability of the fuel oil transfer pumps. By comparing the flow measured during the most recent IT-14 to the flow limits established by the IST Program, it is concluded that the fuel oil transfer pumps are operable.

Prepared By: ___ Date: 10/1/96

Approved By: ___ /RES Manager Date: 10/1/96

Reviewed By: DQS Date: 10/1/96

Table 1

Pump	Design Requirement	ASME Requirement	Most Recent (9/28/96) Test
P-206A	≥ 20.5 gpm	40.73 - 48.18 gpm	43 gpm
P-206B	≥ 20.5 gpm	34.41 - 40.70 gpm	37 gpm
P-207A	≥ 20.5 gpm	40.76 - 47.85 gpm	43.5 gpm
07B	≥ 20.5 gpm	38.60 - 45.65 gpm	41.5 gpm

FLOW TEST

Pump Flow Reference Values and Limits

Pump#: P206A IT-014

Date Established: 9/14/95
Entered By: LEH

REFERENCE VALUES

Reference Pressure: ~ 3.00 Flow: 43.80 gpm

Vibration	Motor End		Pump End	
	Point C:	.005 ips	Point A:	.006 ips
	Point D:	.011 ips	Point B:	.013 ips
	Point E:	.005 ips		

ACCEPTABLE RANGE

Flow: 41.61 gpm to 48.18 gpm

Vibration	Motor End		Pump End	
	Point C: ≤	.013 ips	Point A: ≤	.015 ips
	Point D: ≤	.028 ips	Point B: ≤	.033 ips
	Point E: ≤	.013 ips		

ALERT RANGE

Low Flow: 40.73 gpm to 41.61 gpm

Vibration	Motor End		Pump End	
Point C:	.013 ips to	.030 ips	Point A:	.015 ips to .036 ips
Point D:	.028 ips to	.066 ips	Point B:	.033 ips to .078 ips
Point E:	.013 ips to	.030 ips		

REQUIRED ACTION RANGE

Low Flow: 40.73 gpm
High Flow: 48.18 gpm

Vibration	Motor End		Pump End	
	Point C: >	.030 ips	Point A: >	.036 ips
	Point D: >	.066 ips	Point B: >	.078 ips
	Point E: >	.030 ips		

COMMENT:

Last Test: 2.5 psig discharge
43 gpm

FLOW TEST

Pump Flow Reference Values and Limits

Pump#: P206B IT-014

Date Established: 9/14/95
Entered By: LEH

REFERENCE VALUES

Reference Pressure: ~ 26.50 Flow: 37.00 gpm

Vibration	Motor End		Pump End	
	Point C:	.017 ips	Point A:	.015 ips
	Point D:	.037 ips	Point B:	.022 ips
	Point E:	.017 ips		

ACCEPTABLE RANGE

Flow: 35.15 gpm to 40.70 gpm

Vibration	Motor End		Pump End	
	Point C: ≤	.043 ips	Point A: ≤	.038 ips
	Point D: ≤	.093 ips	Point B: ≤	.055 ips
	Point E: ≤	.043 ips		

ALERT RANGE

Low Flow: 34.41 gpm to 35.15 gpm

Vibration	Motor End			Pump End		
Point C:	.043 ips to	.104 ips		Point A:	.038 ips to	.090 ips
Point D:	.093 ips to	.222 ips		Point B:	.055 ips to	.131 ips
Point E:	.043 ips to	.104 ips				

REQUIRED ACTION RANGE

Low Flow: 34.41 gpm
High Flow: 40.70 gpm

Vibration	Motor End		Pump End	
	Point C: >	.104 ips	Point A: >	.090 ips
	Point D: >	.222 ips	Point B: >	.131 ips
	Point E: >	.104 ips		

COMMENT: Low Test 26 discharge pressure
37 gpm

FLOW TEST

Pump Flow Reference Values and Limits

Pump#: P207A IT-014

Date Established: 9/14/95
Entered By: LEH

REFERENCE VALUES

Reference Pressure: ~ 2.20 Flow: 43.50 gpm

Vibration	Motor End		Pump End	
	Point C:	.012 ips	Point A:	.004 ips
	Point D:	.014 ips	Point B:	.003 ips
	Point E:	.004 ips		

ACCEPTABLE RANGE

Flow: 41.33 gpm to 47.85 gpm

Vibration	Motor End		Pump End	
	Point C: ≤	.005 ips	Point A: ≤	.010 ips
	Point D: ≤	.010 ips	Point B: ≤	.008 ips
	Point E: ≤	.010 ips		

ALERT RANGE

Low Flow: 40.76 gpm to 41.33 gpm

Vibration	Motor End		Pump End	
Point C:	.005 ips to	.012 ips	Point A:	.010 ips to .024 ips
Point D:	.010 ips to	.024 ips	Point B:	.008 ips to .018 ips
Point E:	.010 ips to	.024 ips		

REQUIRED ACTION RANGE

Low Flow: 40.76 gpm
High Flow: 47.85 gpm

Vibration	Motor End		Pump End	
	Point C: >	.012 ips	Point A: >	.024 ips
	Point D: >	.024 ips	Point B: >	.018 ips
	Point E: >	.024 ips		

COMMENT: Last test 2 psig discharge
43.5 gpm

FLOW TEST

Pump Flow Reference Values and Limits

Date Established: 9/14/95

Pump#: P207B IT-014 Entered By: LEH

REFERENCE VALUES

Reference Pressure: ~ 28.00 Flow: 41.50 gpm

Vibration	Motor End		Pump End	
	Point C:	.013 ips	Point A:	.019 ips
	Point D:	.023 ips	Point B:	.015 ips
	Point E:	.017 ips		

ACCEPTABLE RANGE

Flow: 39.40 gpm to 45.65 gpm

Vibration	Motor End		Pump End	
	Point C: ≤	.032 ips	Point A: ≤	.048 ips
	Point D: ≤	.057 ips	Point B: ≤	.038 ips
	Point E: ≤	.043 ips		

ALERT RANGE

Low Flow: 38.60 gpm to 39.40 gpm

Vibration	Motor End		Pump End	
Point C:	.032 ips to	.077 ips	Point A:	.048 ips to .115 ips
Point D:	.057 ips to	.136 ips	Point B:	.038 ips to .090 ips
Point E:	.043 ips to	.103 ips		

REQUIRED ACTION RANGE

Low Flow: 38.60 gpm
High Flow: 45.65 gpm

Vibration	Motor End		Pump End	
	Point C: >	.077 ips	Point A: >	.115 ips
	Point D: >	.136 ips	Point B: >	.090 ips
	Point E: >	.103 ips		

COMMENT:

Last Test 28 psig discharge
41.5 gpm