Part 21 (PAR) Event # 49809

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County:		**License #:**	
State:	MA		
NRC Notified by:	ARTHUR BUTTERS	**Notifications:**	GLENN DENTEL R1DO
HQ Ops Officer:	JEFF ROTTON		PART 21 REACTORS GRP EMAIL
Emergency Class:	NON EMERGENCY		
10 CFR Section:			
21.21(a)(2)	INTERIM EVAL OF DEVIATION		

PART 21 INTERIM REPORTING REGARDING TRICENTRIC TRIPLE OFFSET BUTTERFLY VALVES

The following is a summary of information provided via facsimile:

"Based on recent testing conducted on a 24 inch Class 150 TRICENTRIC [triple offset butterfly valve] to evaluate bearing coefficients of friction (COF), it has been determined that there exists an unseating load that has not been accounted for on our TRICENTRIC Triple Offset Product Line.

"Weir has not experienced a field failure of the product, but recent testing by a customer indicated anomalies that required review by Weir. The review of the unseating anomaly relates to two inputs; the inputted seating torque and increases in differential pressure across the disc after initial closure. Weir has developed a conservative approach for calculating this additional loading.

"Weir has reviewed data from customers for several recent orders, and has determined that there is a minimal risk of failure of an item to perform its safety function. However, based on the safety related functions of these items, Weir cannot provide absolute assurance of operability on items in service without confirming with the end user. Weir will be releasing an industry notice that will address our initial findings, continue with the detailed investigation, and advise customers concerning the recommended corrective actions."

Known customer - PSEG

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IE19
NRR

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February 7, 2014

NRC's Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

RE: 10CFR Part 21 Interim Reporting of TRICENTRIC Triple Offset Butterfly Valves

Dear Sir/Madam:

Weir Valves and Controls USA is filing an interim report for a Potential Failure in order to comply with the requirements of10CFR Part 21. Based on recent testing conducted on a 24" Class 150 TRICENTRIC to evaluate bearing coefficients of friction (COF), it has been determined that there exists an unseating load that has not been accounted for on our TRICENTRIC Triple Offset Product Line. A potential impact exists on units where safety related transfer open function during an event is required.

Up to this point in time, Weir has not experienced a field failure of the product, but recent testing by a customer indicated anomalies that required review by Weir. The review of the unseating anomaly relates to two inputs; the inputted seating torque and increases in differential pressure across the disc after initial closure. Weir has developed a conservative approach for calculating these additional loading.

Weir has reviewed data from customers for several recent orders, and has determined that there is a minimal risk of failure of an item to perform its safety function. However, based on the safety related functions of these items, Weir cannot provide absolute assurance of operability on items in service without confirming with the end user. Weir will be releasing an industry notice that will address our initial findings, continue with the a detailed investigation, and advise customers concerning the recommended corrective actions.

Discovery Information

Weir Valves and Controls (and previous owners of the TRICENTRIC product line) has accepted for 35 years that the torque required to unseat a metal seated triple offset butterfly valve was negligible. During testing by PSEG (performed in 2012) to establish

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bearing COF, an anomaly was identified in several of the torque traces under differential pressure. The testing was conducted on a valve for a couple of days over their outage.

During the as-found testing, the torque to unseat the valve never exceeded the closing torque. After replacing the bearings, testing revealed that the as-left traces showed a substantial drop in the required torque; however the data did not allow the COF to be accurately determined due to the torque peak at the initial opening position of the valve. After reviewing the testing results and the collection method, PSEG, MPR and Weir had no concerns in returning the tested unit to service based on the measured torque levels.

PSEG and MPR then reviewed and selected a unit for testing in December 2013 that could be taken out of service and a spare unit placed into service to allow for more time to test and troubleshoot the valve. Based on the testing conducted at Alden Laboratories, it was determined that the anomaly with the torque peak existed on this unit also. Therefore, an alternate test was conducted where the seal stack was slightly disengaged off the valve seat; then the unit was stroked open which clearly established a bearing coefficient of friction for the unit. Once the testing with the seal stack and seat separated established the components of torque to overcome packing and bearing friction, further testing was conducted to determine causative variables for the anomaly.

1. The testing of the unit with the seat in the sealing position and no change in differential pressure showed a consistent unseating load occurring when the unit was opened, and the torque required was not insignificant and should not be neglected.
2. The testing also revealed that the torque was affected by seating the valve under low differential pressure and unseated under high differential pressure.
3. The testing showed differences in valves that were reworked/new versus having seen service life.

Analysis

Weir has reviewed the dependence of the two loads. Based on the testing of the PSEG valve and units designed and constructed for other nuclear applications, Weir has formulated and performed initial validation of an analytical method to predict these loads. In correlating the current and future data, Weir considered the potential for discrepancies in the test equipment and potential effects of valve aging.

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Review 1: Seat versus Unseating Load

Weir has completed a regression analysis of the loads to seat then unseat the valve. The load to unseal the valve with packing and bearing loads removed is proportional to the input torque. Weir reviewed the variables that could contribute to the load. The TRICENTRIC surfaces employ a series of angles to create the seal, it was determined the seal stack on the shaft offset side was the point of drag on the unit. Additionally, Weir established that the torque could be conservatively described by:

$$T_{ULS}=[T_{s@0\ degrees}*\mu_{fs}*SIN\ \text{Approach Angle}\ ]/2$$

Where:

$T_{s@0\ degrees}$ is the applied sealing torque

μ_{fs} is the friction factor between the seat and seal stack

Approach Angle is the angle the seal approaches the seat on the offset side

Independently T_{ulp} could not exceed $T_{s@0\ degrees}$ as the approach angle and friction plus the additional normal load to create the seal exist and the sealing load must work on the entire seal perimeter. Therefore, this load will need to be captured and reported in Weir's actuator sizing calculations but does not have an impact on safety.

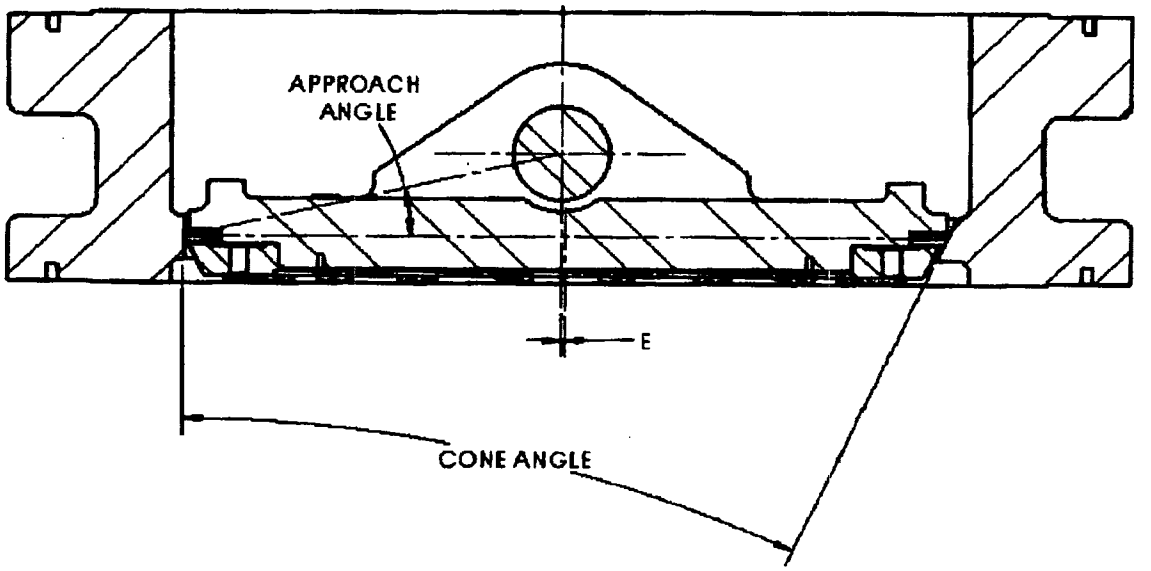

Figure: Critical Dimensional Characteristics Related to Unseating

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Review 2: Pressure Increase impact on Unseating Load

Weir has determined that the additional load to unseat the valve is due to a large change in the pressure delta from closure to opening. The unseating load is then related to the hydrostatic torque proportional to the material friction factor and the seat cone angle.

$$T_{ULP}=T_{h@0\ degrees}*\mu_{fs}*SIN\ Cone\ Angle$$

Where:

$T_{h@0\ degrees}$ is the torque created by the hydrostatic pressure
μ_{fs} is the friction factor between the seat and seal stack
Cone Angle is the angle the formed at the apex of the cone

Mathematically, this equation will not exceed the peak dynamic flow calculation provided in current reports based on the EPRI Method NP-7501, however older sizing calculation focused mainly on seating loads.

Review 3: Effects of Aging

During the review of the two anomalies, Weir struggled with the difference between testing at Alden and Weir. After reviewing test set ups and differences in valves tested, Weir determined that aging of the units appears to be a factor in the results. During the initial regression analysis, Weir set the friction factor at 0.78 based on clean, dry steel. Weir made this assumption for simplicity; however it had good correlation on the results shown with the PSEG testing once the seal stack was replaced and testing on new valves in process. The combined calculated values were 5-10% over estimation of the actual test results. A slight positive variance was seen on several of PSEG actuals for the torque only portion on some strokes; however 0.78 may not be the exact proper friction for the Inconel 625 seal stack with a Buna based binder on Cn3Mn seats or it could be related to equipment variations.

Based on the PSEG unit in service valve, Weir determined that the friction was increasing with age. The degradation of performance will be based on several factors including;

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1. Water quality
2. Materials
3. Applied load.

Based on the complexity of this issue, Weir will add a safety factor on the friction factor for both of the calculations. The PSEG testing revealed that after 9 years of service in aggressive water conditions, friction had increased to 150% of the calculated friction. When maintenance was performed on only the seal stack and seat, the unit was returned to the calculated values of torque.

Weir has determined that a conservative safety factor of 4 will be utilized in calculations to ensure no issues will occur after lengthy in-service runs that would be detrimental to safety of these units. The factor of 4 is based on a 40 year life, and was determined by the following equation:

$$SF_{\mu}=\text{Initial}+\frac{\Delta\text{Friction}}{\Delta\text{Time}} * \text{design life}$$

Based on PSEG Test Unit:

ΔFriction= 1.5-1

ΔTime=9 years

Design Life=40 years

$SF_{\mu}=3.22$ rounded conservatively to $SF_{\mu}=4$

This is a conservative model for the requirements of most plants based on the severity of the service water application to other applications and the required length of service. When information exists that either the degradation or service life must be adjusted the above formula will be utilized.

Continuing Action Plan

Weir has reviewed the general actuator sizing calculations, and derived an accurate and conservative methodology to update these calculations. While Weir can provide accurate calculations, we still need to ensure the data used for the analysis based on the following. Weir is contacting customers to ensure that following data:

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1) As part of the safety-related function of the unit does the unit need to transfer open?
2) If the unit is required to transfer open:
    a. To which side is pressure applied at closing? What is the pressure that the unit closes under?
    b. To which side is pressure applied at signal initiation of opening? What is the pressure on the unit at signal initiation of opening?
3) Water quality that the valve will operate in?
4) Is the unit on a monitoring program?

Based on the information above, Weir will develop accurate sizing calculations for each customer application. Weir will work with customers to provide an acceptable resolution to any issues discover on items in service. These actions may include monitoring, service plans and upgrades.

Regards,

Arthur C. Butters
Director of Engineering; Nuclear

WEIR	10 CFR PART 21 EVALUATION Evaluation of Deviation or Potential Failure to Comply	DOCUMENT 10CFR 121813	PAGE 1 of 4

Part 1: Identification of Concern and Preliminary Evaluation

1A Identify the source of the information on the **deviation** or potential **failure to comply**:
Condition was found by Dan Maxey and Ed Ciemeiwicz of PSEG during bearing coefficient of friction testing at Alden Labs.

1B Describe the **deviation** or potential **failure to comply** that has been discovered:
Previously not recgonized unseating torque factors in TRICENTRIC® valves have the potential keep valve from transferring open under certain operating conditions.

1C If the issue concerns ☐ *a potential **failure to comply**, go to Section 1D* ; ☒ *a **deviation**, go to Section 1E*

1D Does the potential failure to comply represent a violation of the Atomic Energy Act of 1954, as amended, or any applicable rule, regulation, order, or license of the NRC, including technical specification limits?

If **Yes** or **Uncertain**, check ☐ and complete Section 1E.
If **No**, check ☐ and complete Section 1F.

1E(1) Does the **deviation** affect the functionality of items or services provided by Weir Valves & Controls USA?

If **Yes** or **Uncertain**, check ☒ and complete Section 1E(2).
If **No**, check ☐ and complete Section 1F and Explain:

1E(2) Does the **deviation** involve a **basic component**?

If **Yes** or **Uncertain**, check ☒ and complete Section 1E(3).
If **No**, check ☐ and complete Section 1F and Explain:

1E(3) Has the **basic component** been delivered to a customer?

If **Yes** or **Uncertain**, check ☒ and complete Section 1E(4).
If **No**, check ☐ and complete Section 1F and Explain:

1E(4) Does the **basic component** deviate from the requirements of the customer's procurement document?

If **Yes** or **Uncertain**, check ☒ and complete Section 1G.
If **No**, check ☐ and complete Section 1F and Explain:

1F The **deviation** or potential **failure to comply** is not reportable in accordance to 10CFR21.

Originator (signature)	Originator (print)	Date
Designated Responsible Officer (signature)	Designated Responsible Officer (print)	Date

Have local Director, Quality Assurance retain this form on file for 5 years

Discovery

1G The **deviation** or potential **failure to comply** warrants further **evaluation** in accordance with 10CFR21.

Originator (signature)	Originator (print)	Date
Memarie Burke	Memarie Burke	12/18/13

Forward this form with relevant information to the Designated Responsible Officer.

1H I have reviewed Part 1 and determined that the **deviation** or potential **failure to comply** should be evaluated based on the basis below for reportability in accordance with 10CFR21. (Start of 60-day clock)

Designated Responsible Officer (signature)	Date	Initial Due Date:
	12/20/13	2/1/14

Within the 60-day clock started above, I will evaluate the **deviation** or potential **failure to comply** discovered in Part 1 to determine reportability in accordance with 10CFR21.

Cognizant Technical Engineer (signature)	Date
Memarie Burke	12/30/13

WEIR	10 CFR PART 21 EVALUATION Evaluation of Deviation or Potential Failure to Comply	DOCUMENT 10CFR121813.docx	PAGE 2 of 4

Part 2: Technical Evaluation

2A Identification of the company supplying the **basic component** or activity which contains a **deviation** or potential **failure to comply:**

Weir Valves and Controls provided the basic components with the failure to comply.

2B ☒ Confirm the information in Part 1. Note any discrepancies that need to be addressed:

No discrepencies need to be addressed.

2C Provide A) Technical Justificaiton of Unit Acceptability; or B) Proposed Technical Solution

Weir can not provide independent Technical Justification. Weir has reviewed the available data, and is able to provide a Technical Solution. Weir can perform the calculation, but to obtain reasonable assurance will require input from the industry. Because of the age of items, Weir will need to confirm the information with the affected operating units.

Weir will provide a technical bulletin to the industry cover the addressing:
1) All Transfer Open Safety Function Items need to be reviewed
2) The effects of the Dp on the Unseating Torque.

Because Weir can not complete this evaluations within the remaining time clock, an informational reporting will be submitted to the NRC.

☐ This issue is reportable pursuant to 10CFR21.
☐ This issue is not reportable pursuant to 10CFR21.
☒ A decision on reportability cannot be made based on the available information.

Memarie Buck — 2/7/14
Cognizant Technical Engineer (signature) — Date

Review with the DRO within 5 days of completion

2/7/14
Designated Responsible Officer (signature) — Date

The DRO will finalize the reporting requirements and submit the reports to the NRC and any affected facilities within 30 days.

WEIR	10 CFR PART 21 EVALUATION Evaluation of Deviation or Potential Failure to Comply	DOCUMENT 10CFR121813.docx	PAGE 3 of 4

Part 3: Conclusion of Reportability Evaluation

3A Basis for decision:

While Weir has identified the source of the anamolies, it can not make an uunilateral determintation about the potential safety inpacts with out reviewing with the customer.

At this juncture, Weir is filing an interim report and will provide an update to this report by May 7th.

3B Number and location of all affected components:

Based on scope of issue, Weir is collecting this data and is in the process of contacting all customers.

3C I have evaluated the information and technical assessment developed and

- ☐ This issue is reportable pursuant to 10CFR21.
- ☐ This issue is not reportable pursuant to 10CFR21.
- ☒ A decision on reportability cannot be made based on the available information.

Based on this determination, I will proceed with all proper notifications within the allowable timeframes.

Designated Responsible Officer (signature) — Date: 2/7/14

H. Butters
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