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NL-07-1547

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

Joseph M. Farley Nuclear Plant – Unit 2
Proposed Alternative for Continued Operation With Pinhole Leaks
in Class 2 Valve Q2N11V003B

Ladies and Gentlemen:

Pursuant to 10 CFR 50.55a(a)(3)(ii), Southern Nuclear Operating Company (SNC) hereby requests NRC approval of proposed alternative FNP-ISI-ALT-07-02, Version 1.0 to allow continued operation with pinhole leaks in a bypass valve for a Main Steam Line Isolation Valve.

This alternative is to remain in effect until the start of refueling outage 2R19, which is currently scheduled for October 2008, or until a scheduled outage of sufficient duration. The details of the 10 CFR 50.55a request for alternative are contained in the enclosure.

Approval is requested by February 28, 2008 to support continued operation with the pinhole leaks.

If you have any questions, please advise.

Sincerely,

B. J. George
Manager, Nuclear Licensing

BJG/JLS/daj

Enclosure: FNP-ISI-ALT-07-02, Version 1.0, Proposed Alternative for Continued Operation With Pinhole Leaks in Class 2 Valve Q2N11V003B

A047

NRR

cc: Southern Nuclear Operating Company
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Mr. D. H. Jones, Vice President – Engineering
RType: CFA04.054; LC# 14620

U. S. Nuclear Regulatory Commission
Dr. W. D. Travers, Regional Administrator
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Enclosure

FNP-ISI-ALT-07-02, Version 1.0
Proposed Alternative for Continued Operation With Pinhole Leaks in Class 2 Valve
Q2N11V003B

Enclosure

SOUTHERN NUCLEAR OPERATING COMPANY
FNP-ISI-ALT-07-02, VERSION 1.0
PROPOSED ALTERNATIVE IN ACCORDANCE WITH 10 CFR 50.55a(a)(3)(ii)
FOR CONTINUED OPERATION WITH PINHOLE LEAKS IN CLASS 2 VALVE Q2N11V003B

Plant Site-Unit:

Farley Nuclear Plant Unit 2 (FNP-2)

Interval-Interval Dates:

ISI Interval extending from July 31, 2001 through July 30, 2011.

ASME Code Components Affected:

A small pinhole leak was discovered in Class 2 valve Q2N11V003B as shown in Figures 1-1, 1-2, and 1-3. Upon visual examination, the steam leakage was determined to be originating from the valve bonnet at a location just above the threaded area of this valve part. This leakage was conservatively considered to be the result of a through-wall defect in a pressure retaining part and was therefore an unacceptable condition.

This valve is located on the bypass line around the "B" inboard main steam line isolation valve (MSIV). It is a 3-inch, Class 600 lb, flexible wedge, gate valve with pneumatic actuator. The valve body and bonnet material are SA-105 carbon steel.

The valve is of a pressure seal design. That is, the body-to-bonnet seal is affected by a combination of bonnet preload and system pressure. The bonnet is preloaded by tightening a bonnet clamp (nut) that lifts the bonnet resulting in the compression of the seal gasket (ring) between the bonnet sealing surface and the body sealing surface. Subsequent system pressure tends to further compress the seal ring. The lower portion of the valve yoke contributes to the sealing function by securing the bonnet clamp in a "fixed" position relative to the bonnet.

Flaw Description:

Attempts to characterize the defect through the use of radiography (RT) and ultrasonic (UT) techniques were not definitive in determining the size and shape of the flaw or where the flaw originates on the inside diameter of the bonnet. UT straight beam confirmed the presence of an internal void, which was bounded by a rectangle 0.25 inch wide by 0.625 inch high.

The leaking flaw was initially visually characterized as a single rounded flaw. After surface preparation for UT, the initial leaking flaw was measured to be approximately 0.1 inch long and two other leaks surfaced nearby.

Requested Date for Approval and Basis:

An expedited NRC review by February 28, 2008 is requested to support continued operation with these pinhole leaks.

Applicable Code Edition and Addenda:

The 1989 Edition of ASME Section XI (no addenda).

Applicable Code Requirements:

IWA-4110 of ASME Section XI requires that repairs be performed in accordance with Article IWA-4000. IWA-4310 requires that defects be removed or reduced to an acceptable size.

Reason for Request:

This valve is not isolable from main steam conditions and replacement of the degraded components would impose a hardship by necessitating the shutdown of the unit to a cold shutdown condition. Shutting down from 100% power, cooling down the valve, making the replacement, and returning to 100% power would take approximately six days.

Proposed Alternative:

In lieu of the IWA-4110 ASME Section XI requirements, Southern Nuclear Operating Company (SNC) requests to continue to operate with the degraded valve until the next refueling (scheduled for October 2008) or until an outage of sufficient duration occurs.

Basis for Use:

SNC performed an engineering evaluation to justify continued operation with the degraded valve. Additionally, as a conservative measure, SNC had Structural Integrity Associates, Inc. (SIA) perform an independent evaluation of the degraded valve. As part of the evaluation SIA identified potential mechanisms that may have caused the leak, determined ASME Section XI allowable flaw sizes in both the axial and circumferential direction, and performed a flaw growth analysis based on full pressure cycling. A report documenting the SIA evaluation and calculations is attached. Key elements of the two evaluations are presented below as the basis for continued operation with the degraded valve.

Valve Functional Requirements

This valve is normally closed during plant operations. The valve may be opened during plant start-up activities to warm the downstream piping and to equalize the pressure across the MSIVs prior to opening. The valve can be opened or closed by remote manual operator action via a main control board hand switch. The valve receives an automatic closure signal in response to either a Main Steam Line Isolation Actuation Signal or an open signal from the

associated Main Steam Isolation Valve. The valve, equipped with a reverse-acting, pneumatic piston actuator fails closed on loss of power or air pressure.

The valve performs an active safety function in the closed position to isolate the steam generator in the event of a LOCA or main steam line break to prevent main steam depressurization and the loss of SG pressure and inventory, thereby affecting reactor cool down. The valve also has a safety function to isolate the steam generator in the event of a steam generator tube rupture (SGTR) if that steam generator has the ruptured tube. The valve has no active opening safety function but may be opened as part of post-SGTR recovery to allow an alternate primary system cool down flow path as discussed herein.

To minimize leakage around the disc into the stuffing box, the valve disc is now positively maintained in the closed position by a combination of the pneumatic actuator and the manual operator. Additionally, the air supply to the actuator was isolated by closing the supply valve and venting the supply air regulator. Currently, no leakage is observed from the flaw. The valve is administratively controlled by a "Danger – Do Not Operate" tag.

<u>Potential Failure Mechanisms</u>

The following six failure mechanisms were each evaluated as the potential failure mechanism, but were eliminated as the probable cause of the leakage.

1. General corrosion and wastage
2. Hydrogen cracking
3. Stress corrosion cracking
4. Localized corrosion (pitting, crevice corrosion, under deposit corrosion, microbiologically influenced corrosion)
5. Flow sensitive mechanisms (erosion-cavitation, flow accelerated corrosion)
6. Fatigue (thermal stratification, cycling and striping, mechanical fatigue and thermal transients)

The most likely cause of the leakage was determined to be a latent manufacturing defect that, over time, resulted in leakage due to a combination of mechanical and pressure stresses from radial packing load and system pressure. This is supported by the lack of observed leakage on other valves of the same design, application, environment and manufacture as Q2N11V003B. The timing of the observed leakage can be explained by the changes to the valve packing configuration and applied loads at the flaw location.

The hypothesis is that a subsurface flaw existed in the forging that escaped detection during original valve manufacture. Due to the packing configuration shown in Figure 2-1, this flaw was not exposed to significant thermal or pressure loads for the majority of its operating history. During 2R17 (Fall 2005), the packing configuration was changed to that shown in Figure 2-2 and packing stud torque was increased. These changes resulted in a higher radial load in the area of the flaw, where there was a stress concentration due to the different diameter. These stresses, in combination with a pre-existing fabrication defect, may have resulted in a small crack on the inside surface. After the leak was detected, it was determined that the packing loading was less than the target value. This reduction was attributed to vibration causing the packing loading to relax. Subsequently, this allowed the system pressure to place additional stress at the flaw location, and the additional stress eventually drove the flaw to the surface.

ASME Section XI Allowable Flaw Sizes

The ASME Code recognizes that small leaks may occur in piping, and methods have been developed to evaluate conditions of leakage until repairs can be made. For example, Code Case N-513-1 allows a plant owner to perform an evaluation for temporary acceptance of leaking flaws in moderate energy Class 2 or Class 3 piping. While this valve is a Class 2 component, it is not within the scope of the Code Case since it is not a pipe and since its operating pressure and temperature exceed the Code Case moderate energy limits. The approach used to evaluate this flaw follows the methodology described in Code Case N-513-1, assuming the bonnet may be modeled as a pipe. While this is not a Code approved method, this approach has been used to evaluate similar through-wall flaws in support of alternatives to Section XI Code requirements. ASME service Level A/B safety factors were applied to determine the Code allowable flaw lengths. Transient loads from a main steam line break, from a steam generator tube rupture, from a turbine trip, and from spurious closure of the MSIVs were also evaluated using service level C/D safety factors; however, the Code allowable flaw lengths were the more conservative.

The allowable flaw sizes are determined considering the flaw to be a through-wall planar flaw. The allowable flaw size is the maximum flaw size permitted by ASME Code Section XI and employs a safety factor such that failure (limit load or brittle fracture) is prevented.

For an axial flaw, the stress of interest was determined to be the hoop stress resulting from operating pressure loading. The limiting axial through-wall length using limit load analyses was 8.3 inches, while the length using linear elastic fracture mechanics (LEFM) was 5.6 inches. This is compared to the maximum height of the observed indications from the NDE report of 0.625 inches.

For a circumferential flaw, the stress of interest was determined to be the axial stresses resulting from internal pressure, the bending stress resulting from seismic loads, and other (pressure + stem thrust) loads. The screening criteria in Code Case N-513-1 suggests the use of LEFM for this analysis, and the limiting through-wall length using LEFM was 3.8 inches. This is compared to the maximum width of indications from the NDE report of 0.25 inches.

Flaw Growth Analyses

Conservative fatigue analyses were performed to determine the beginning of cycle through-wall flaw length that will not reach the allowable through-wall flaw length, in one operating cycle. The analyses were performed using the fatigue crack growth methodology in Appendix A of the ASME Section XI Code using the QA software package pc-CRACK. At the location of the flaw, there are no thermal transients and the measured vibration levels were insignificant; therefore, the evaluation was performed by assuming 100 full pressure cycles for valve opening (0 to 750 psig). This is conservative relative to the time that this flaw is expected to be in service. The results of the fatigue crack growth analyses shows that fatigue growth is insignificant and the defect area defined by the 0.25 inch wide by 0.625 inch high rectangle will not grow.

Monitoring the Defect

The valve is being monitored by site personnel once per shift (12 hours) to ensure that there is not a significant increase in the amount of leakage. If there is a significant increase in leakage, an evaluation will be performed and consideration will be made for shutdown and replacement of the bonnet. Additionally, the defect area (that is defined by the 0.25 inch wide by 0.625 inch

high rectangle) will be ultrasonically examined approximately every 90 days to confirm that the cavity-like flaw has not appreciably increased in size.

Indirect Effects of Leakage on Other Safety Related Components

An unexpected failure resulting in jet impingement of steam on nearby safety related components including pipe, equipment, instruments, electrical wires and equipment may result in those items becoming inoperable. A walk down was conducted by site and corporate personnel to survey the area around the leak location for a distance of 10 pipe diameters (approximately 36 inches) in all directions around the leak location. In addition, the area below the leak location all the way to ground level was surveyed. No safety related components were found within the impingement or leak area that would affect any other safety related component not related to this valve.

Core Damage Frequency (CDF)

The existing leak area is contained in a rectangle of dimensions 0.25 inch x 0.625 inch as discussed earlier. Further, only a very small portion of this area is actually through wall. The results of the fatigue crack growth analyses shows that fatigue growth is insignificant and the defect area defined by the 0.25 inch wide by 0.625 inch high rectangle will not grow. Even if growth did unexpectedly occur, the actual flow out of the flaw would be highly restricted by the valve wedge/seat interface which is being maintained in the closed position. For steam flow through the flaw to increase to the point where a reactor trip could occur would require mechanical failure of internal valve components resulting in the separation of the wedge/stem interface. Therefore, the increase in the probability of the flawed valve to fail to an extent to possibly cause a reactor trip is considered insignificant. Hence, any increase in CDF over normal operating CDF is insignificant.

Large Early Release Frequency (LERF) Considerations

The existing leak area is contained in a rectangle of dimensions 0.25 inch x 0.625 inch as discussed earlier. Only a very small portion of this area is actually through wall. Assuming however that this whole area begins to leak, the area would still be significantly less than a two inch nominal pipe size making LERF considerations acceptable. Even if growth did unexpectedly occur, the actual flow out of the flaw would be highly restricted by the valve wedge/seat interface which is being maintained in the closed position.

Off Site Dose Considerations

During a steam generator tube rupture, a leak rate of less than 2470 lb/hr results in an acceptable off-site dose based on the premise that the leak will be terminated within eight hours as the plant is de-pressurized and cooled. Since the maximum leakage observed was only an occasional wisp, and since the valve leakage is monitored once per shift to ensure that there is no significant increase in leakage; the off-site dose would be acceptable in case of a tube rupture.

Conclusions

This valve is not isolable from main steam conditions and replacement of the degraded components would require shutting down the unit to a cold shutdown condition. Shutting down

from 100% power, cooling down the valve, making the replacement, and returning to 100% power would take approximately six days.

The calculated maximum Section XI allowable axial and circumferential through-wall flaw lengths are significantly greater than the bounding 0.25 inch wide by 0.625 inch rectangle for the existing defect. There is a factor of 9 for the assumed axial flaw and a factor of 15.2 for the assumed circumferential flaw. Additionally, flaw growth was determined to be insignificant. Monitoring will ensure that in the unlikely case that the flaw does grow in size that appropriate actions will be taken well before the allowable lengths are reached. Additionally, the valve will be maintained in the closed position, except for possible use described above in Valve Functional Requirements. While in the closed position, the valve disc/seat interface limits the amount of leakage into the bonnet. This demonstrates that there is reasonable assurance that the structural integrity of the bonnet will be maintained for the current operating cycle, even under the most severe normal and accident loading conditions.

Since there is reasonable assurance that the structural integrity of the valve will be maintained during the current cycle, compliance with the specified Section XI Code requirements would result in a hardship without a compensating increase in the level of quality and safety. Therefore approval of this alternative is requested per 10 CFR 50.55a(a)(3)(ii).

Duration of Proposed Alternative:

Until December 1, 2007 when FNP-2 will start performing ASME Section XI activities to a later Edition of the Code.

Precedents:

July 24, 2007 submittal for McGuire Unit 1.

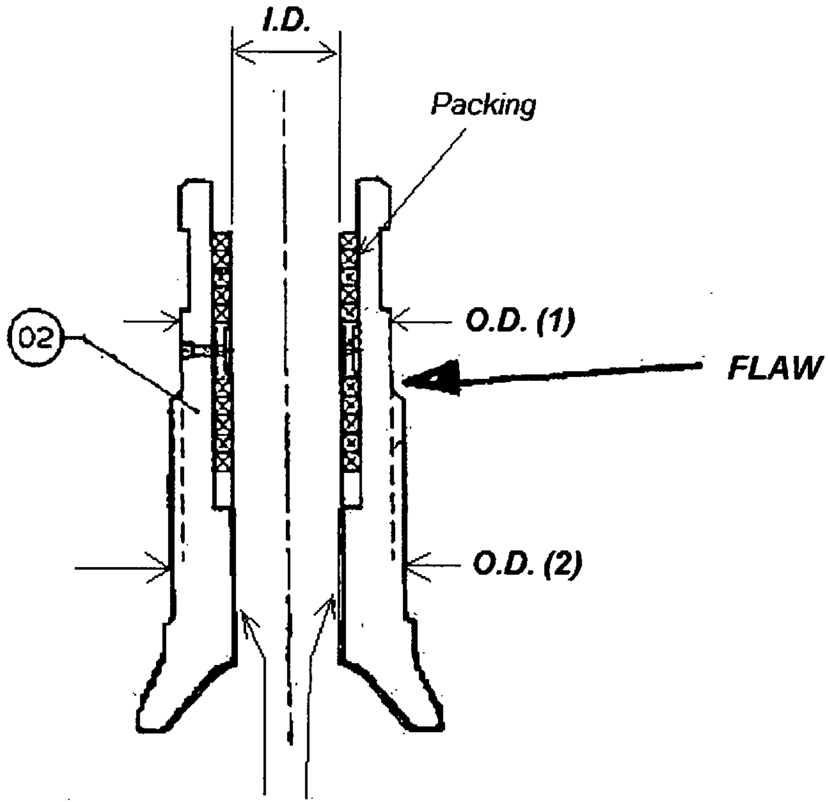
References:

Structural Integrity Associates, Inc. Report Number SIR-07-221-NPS, Revision 0, *Degradation Mechanisms and Flaw Evaluation Associated with a Leak Identified in Main Steam System Bypass Valve Q2N11V0003B at Farley Unit 2.*

Status:

Awaiting NRC approval.

Bonnet Showing Location of Flaw



Pressure Boundary

Figure 1-1. Approximate Location of Flaw in Valve Q2N11V003B

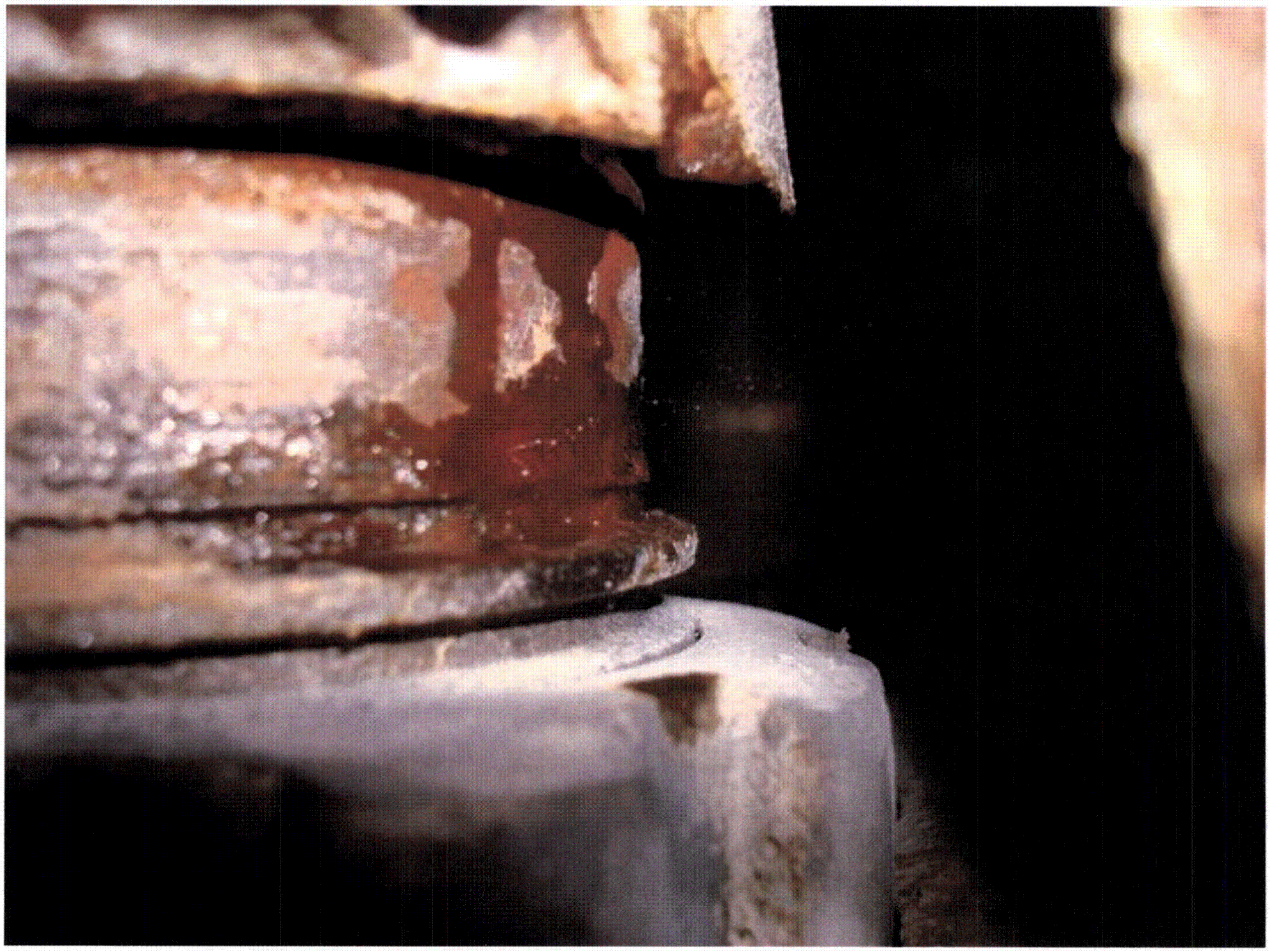


Figure 1-2. Picture of Leak in Valve Bonnet

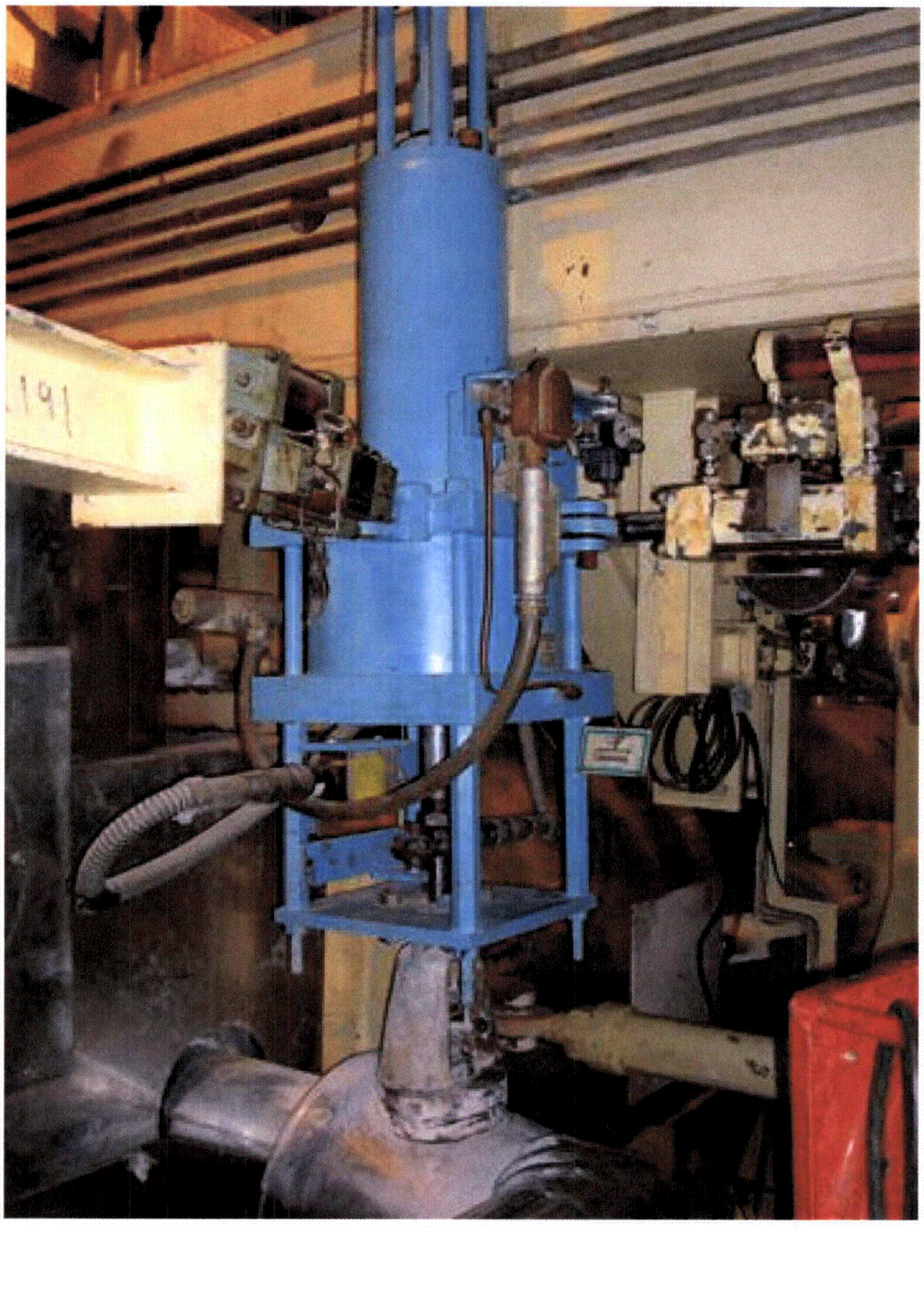
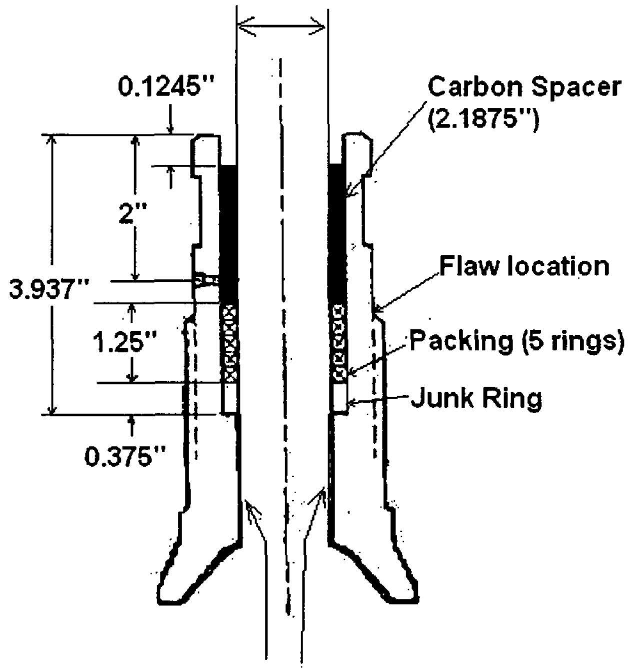


Figure 1-3. Picture of Entire Valve Body and Actuator

Bonnet Showing Location of Flaw

Packing Configuration (prior to 11/05)

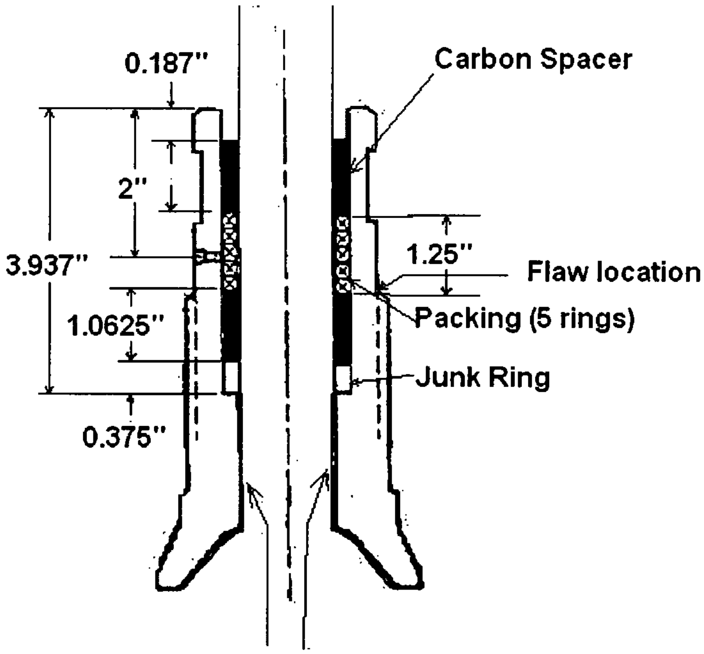


Pressure Boundary

Figure 2-1: Packing Configuration Prior to November 2005

Bonnet Showing Location of Flaw

Packing Configuration (after 11/05)



Pressure Boundary

Figure 2-2: Packing Configuration After November 2005