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OAK RIDGE K-25 SITE

MARTIN MARIETTA

CYLINDER YARD INSPECTIONS AND CORRECTIVE ACTIONS

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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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ABSTRACT

Inspection of valves on stored uranium hexafluoride (UF_6) cylinders was initiated at the three diffusion plant sites in Oak Ridge, Tennessee, Paducah, Kentucky, and Portsmouth, Ohio as the result of the discovery of valve defects and evidence of valve leaks at the Oak Ridge K-25 plant. The coordinated inspection culminated in the identification of additional factors related to long-term safe storage of UF_6, and plans for correction of such deficiencies are presently being developed and implemented. These corrective actions supplement existing programs aimed at assurance of safe storage as summarized in the report.

INTRODUCTION

In a mini-audit of the K-1066-E cylinder storage yard on May 30, 1990, green deposits were found on a valve body and packing nut, accompanied by unusual, severe corrosion of the packing nut and valve stem (Fig. 1). The audit was conducted as an aid in planning for long-term corrosion monitoring of cylinder steels. Other evidence of valve leakage included corrosion and staining of the cylinder head below the valve and a stained and pitted area on the concrete pad in the drip area below the valve (Fig. 2). Further visual examinations indicated several more valves which exhibited evidence of less extensive leakage (Fig. 3) and one valve where removal of the port cap resulted in discharge of several milliliters of water containing uranium salts in solution. These findings were disseminated to the diffusion plants management, and to the Department of Energy (DOE) and resulted in a full-scale inspection for valve conditions in all cylinder storage areas at enrichment plant sites.

This inspection was completed* and resulted in discovery and documentation at the Oak Ridge plant of 195 valves which gave evidence of present or past leakage as indicated by radioactivity levels above plant-allowable limits, either as alpha count on the valves themselves or as transferrable alpha or beta/gamma in a wipe sample. The valves were also inspected for other defects, such as cracked packing nuts, missing (or cracked) port caps, bent or sheared valve stems, bent valve bodies (illustrated in Figs. 4 through 9), and any other conditions that could affect the integrity of storage-containment or transfer capability.

A corrective action plan and schedule were developed† as a result of the inspection observations that includes (1) decontamination of leaking valves to furnish a starting point for continuing observations for possible leakage; (2) a safety review, operator training, and equipment assembly for valve changeout and cylinder burping; and (3) a program for replacing defective valves and defective or missing valve parts. This plan for immediate and near-term corrective actions also requires an evaluation of the need for restacking some cylinders in contact with the ground where corrosion of cylinder walls could be accelerated, and an inspection for pitting corrosion which might affect transfer capability, transportability, or containment integrity.

SUMMARY

A recent in-house audit of a UF_6 cylinder storage yard at the Oak Ridge K-25 plant revealed indications of valve leakage and a resulting severely corroded valve stem and cracked packing nuts and port caps. The survey results were reported to management at the gaseous diffusion plants, and inspections of all cylinders in storage were initiated at the three sites. Corrective actions have been planned and are being executed, and

*See Appendix A. Holes were discovered in two storage cylinders during inspection at the Portsmouth, Ohio, plant and are being investigated separately by an appointed committee.

†See Appendix B.

recommendations for maintaining safe storage conditions address periodic inspections for conditions of valves, plugs, and cylinder-wall corrosion. Storage upgrading to permit plug-end inspection and wall-thickness measurements will require cylinder restacking, which will afford opportunities for replacement of corrosion-enhancing wooden chocks, for identifying and disposing of cylinders damaged by on-ground corrosion in earlier storage experience, and for cleaning and painting cylinders to fit them for truly long term storage with minimized requirements for surveillance.

High-volume air monitoring for uranium by K-25 Health Physics and air sampling for hydrogen fluoride (HF) by environmental personnel during valve inspection, decontamination, and sampling activities gave no indications of active material releases. However, periodic monitoring of this type, along with provisions for soil and drainage run-off sampling, can furnish added assurance of safe storage through enhancing the sensitivity of early leak detection in the cylinder yards. Other programs directed toward improving the safety and reliability of long-term UF_6 storage are in place and have been functioning for some time. Currently these include

1. A study of disposition options for depleted feed materials.
2. A cylinder-yard corrosion-monitoring program and cylinder life-cycle study.
3. A rupture test program whose object is to assess the safety of present cylinder designs and of damaged or defective cylinder conditions.
4. Safety-analysis reviews of cylinder storage activities.

DISCUSSION

ADDITIONAL VALVE OBSERVATIONS*

For purposes of the survey, leaking valves were defined as those where visible deposits had radioactivity levels in excess of plant allowable limits. It was not possible, however, to distinguish active leaks from past (or dormant) leaks, either on the basis of activity levels or by the character or color of the deposits, which showed a full range of colors from bright yellow through deep green or blue-green. Chemical analysis of deposits showed the yellow materials to be composed of uranium compounds only, while the green materials also contained large amounts of copper, in addition to the uranium compounds, indicating that their source was corrosion of bronze (or Monel) valve parts. It was not possible to distinguish between the green and the yellow, deposits solely on the basis of their uranium contents, and it would appear that all such deposits on the valves signify leakage of UF_6 from the cylinder. The yellow uranium-only deposits result from reaction with moist air and dissipation of the HF product, and the uranium-copper deposits show corrosion of the bronze valve parts by the HF product of the leaking UF_6. To identify actively leaking valves, deposits will be removed from the contaminated valves identified by Health Physics measurements, and the cleaned valves will be covered with a clear, nonreactive bag of a fluorinated plastic (Teflon) material. Continuing leakage of UF_6 will be made evident by the presence of decomposition products (mainly UO_2F_2) on the inner surfaces of the bag, to be determined at a later date by visual inspection of the covered valves. Following a

*Appendix B, items 1 through 5.

pressure check to verify cylinder internal pressure conditions, the valves will be retorqued to specifications, and new bags will be installed. If a second inspection indicates continuing leakage, the valves will be replaced with new valves.

A yearly visual inspection for indications of valve leakage is to be conducted on all cylinders in storage at K-25. Visual indications of discoloration will be verified, monitored, and corrected as outlined above.

REPLACEMENT OF DEFECTIVE VALVES*

Planning is under way for assembly of an equipment cart which will give an acceptable level of control for field valve exchanges. This will require a high-efficiency particulate air vacuum cleaner, a pressure/vacuum gage for attachment to a cylinder valve, a vacuum pump (or surge volume capability) with associated chemical traps, and the hand tools required for valve manipulation, repair, and replacement. In association with the preparation of this equipment cart, a safety review is to be conducted for valve changeout and cylinder burping, along with preparation of the necessary procedures and the required operator training. The equipment, procedures, and developed operator skills will not only be utilized in correcting the deficiencies noted in the audit but will provide the plant with a long-term capability for maintaining safe cylinder storage.

CYLINDER YARD UPGRADING

Nearly all of the K-25 storage facilities depend on contoured wooden saddles to maintain adequate ground clearance for ensuring good drainage and generally dry storage conditions. The wooden supports are porous, however, and absorb moisture in wet weather, retaining it for relatively long periods when the rest of the cylinder surfaces are dry. This extended presence of moisture results in localized pitting activity in the saddle contact areas, and when cylinders are moved, these pitted areas are readily apparent. Cylinder storage at the Portsmouth and Paducah Gaseous Diffusion Plants is phasing out wooden saddles and substituting cast concrete or steel supports which drain and dry more readily in order to eliminate a potential source of accelerated corrosion. It is recommended that such a program be adopted for the K-25 storage facilities and be implemented in coordination with any other cylinder-moving requirements.

In addition to the valve inspection which grew out of the previously mentioned mini-audit of K-1066-E, DOE also requested an examination for plug-end conditions. This examination could not be made in the same detail as was exercised in the valve inspections, since many cylinder storage arrays do not allow access to the plug ends of cylinders. The primary requirement in the original cylinder storage efforts was that the nameplate would be accessible for inventory purposes, and the double-row arrangement often gave plug-end clearances of <1 ft. Only a few storage areas allow walk-through space; a few more permit limited visual access to the plug end of the cylinder. Access is similarly limited to cylinder side-wall areas for purposes of thickness measurements. While some surfaces are accessible for instrument probe contact for ultrasonic measurement of thickness, it is not likely that

*Appendix B, items 6, 7, and 8.

pitted cylinders which had earlier been in contact with the ground (Fig. 10) can be discovered in this manner. Such cylinders can only be identified through visual inspection and spot ultrasonic measurements during restacking operations.

It is thus evident that any long-term storage program at K-25 will require restacking of all cylinders. Preparations for such a program should include an engineering evaluation of each of the storage yards for suitability of the paved surface to support the cylinder loads, provisions for environmental monitoring/sampling of drainage run-off, and procurement or fabrication of a suitable number of concrete chocks. The stacking geometry should provide for full walk-through access to both ends of each cylinder. At the time the cylinders are moved for restacking, it is strongly recommended that they be painted to halt degradation due to atmospheric corrosion. Such painting should be done on a surface that has been suitably prepared by grit blasting to remove accumulated oxides. A zinc-rich paint which will furnish some degree of galvanic protection in areas of handling or stacking damage is preferred for this application and can be expected to remain functional for 25 years or more.

TECHNICAL SUPPORT FOR UF_6 STORAGE

The current program for monitoring cylinder storage yards includes a yearly observation cycle for valve conditions and periodic measurement of wall thickness on selected cylinders. Health Physics and Environmental monitoring of air samples showed no dispersion of radioactive or toxic materials during the current survey; this type of sampling should be continued on a regular basis and should be extended to include some level of monitoring of soil samples and of rainwater run-off from the storage yards.

With these additions, the K-25 plant storage program will be in substantial compliance with the program controls to be recommended in the upcoming Rev. 6, ORO-651 and with a soon-to-be-issued *Guidebook to Safe Production, Transportation, Handling and Storage of* UF_6 of the International Atomic Energy Agency.

PHOTO NO. K/PH-90-1716

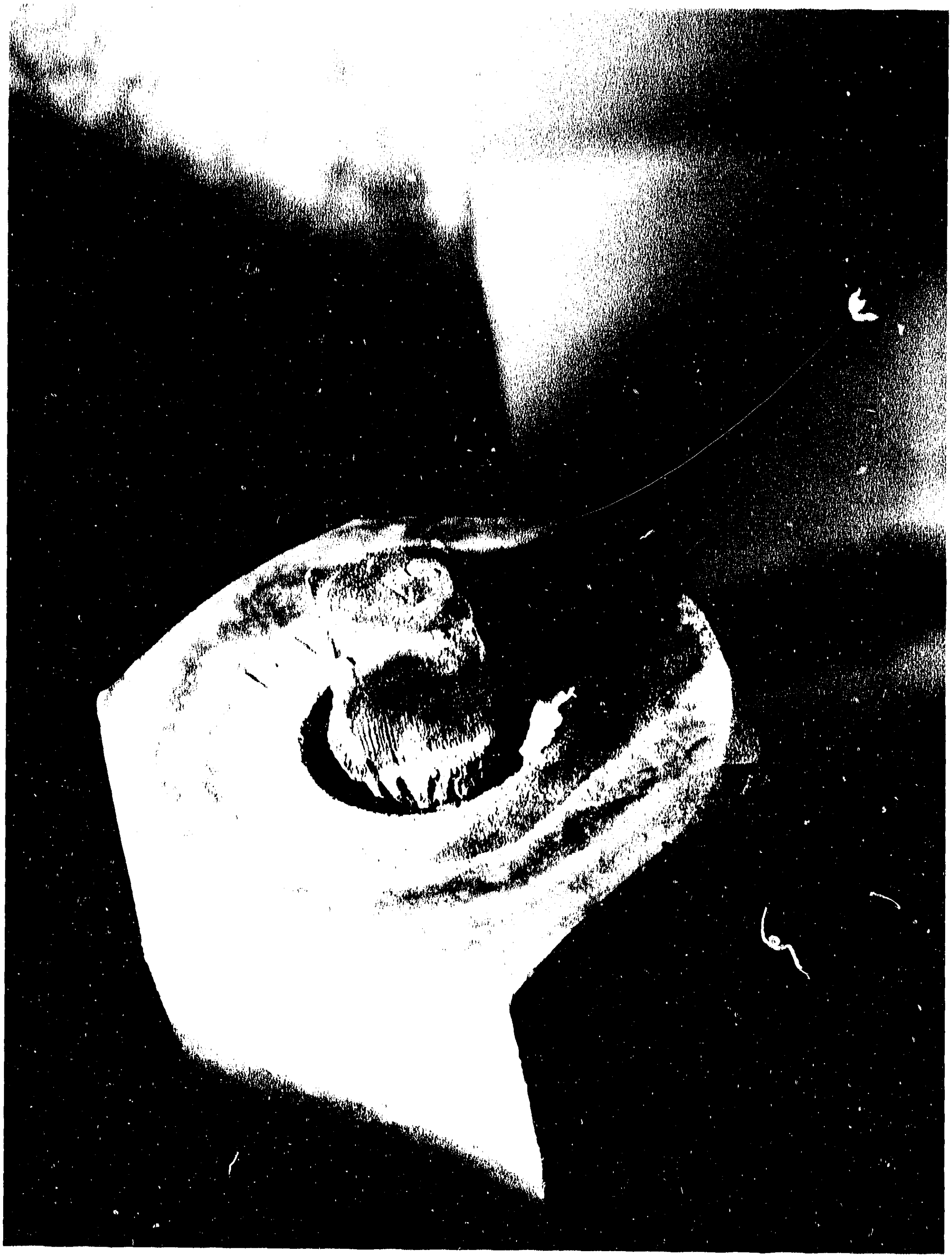


Figure 1
CORRODED VALVE IN K-1066-E STORAGE YARD

PHOTO NO. K/PH-90-1716

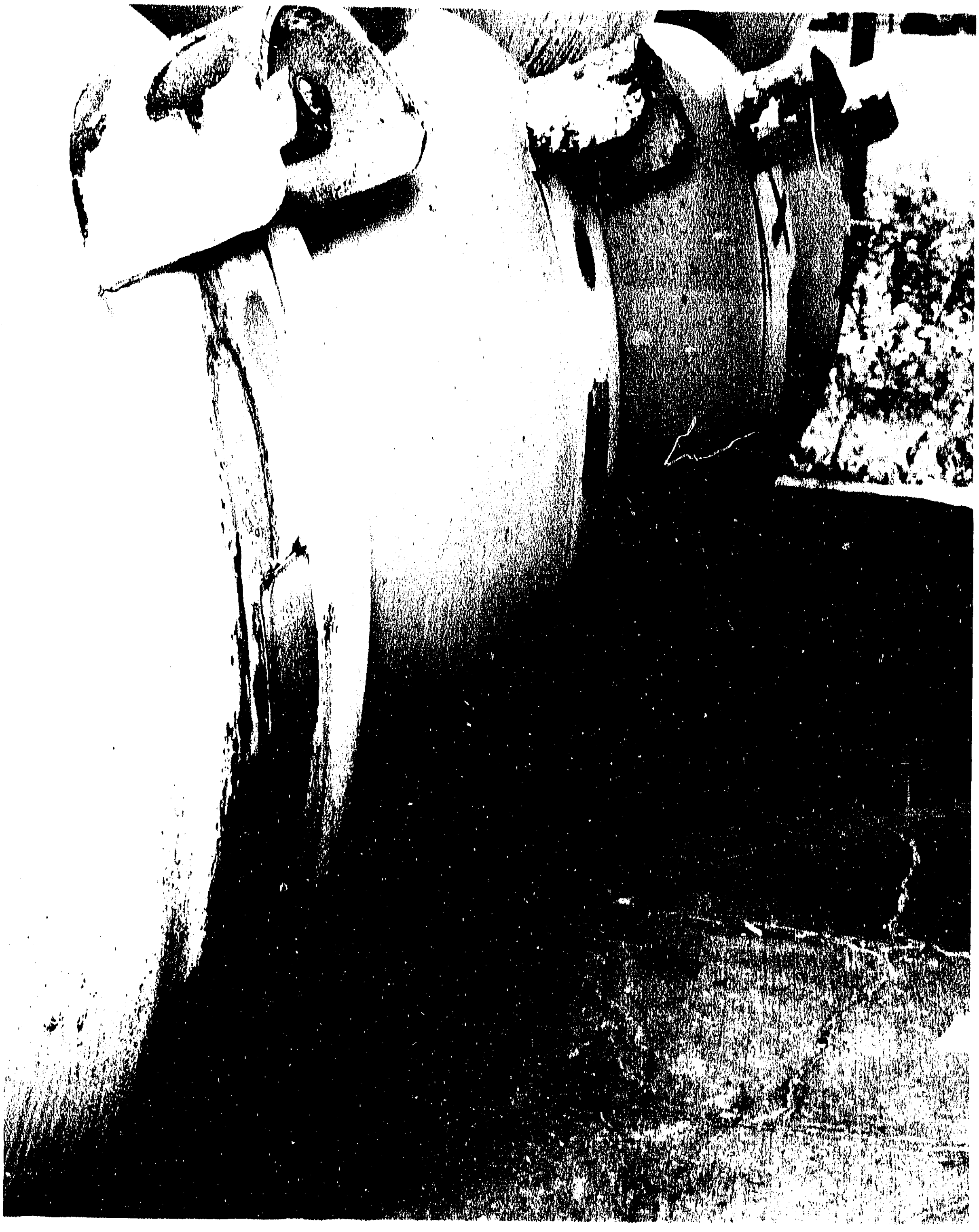


Figure 2
EVIDENCE OF LEAKAGE BELOW CORRODED VALVE
Note also the etched area on the concrete pad.

PHOTO NO. K/PH 90-1837

Figure 3
SAMPLING OF DEPOSITS INDICATING VALVE LEAKAGE

PHOTO NO. K/PH-90-1710

Figure 4
CRACKED PACKING NUT

PHOTO NO. K/PH-90-1875

Figure 5
CRACKED PORT CAP

PHOTO NO. K/PH 90 1834

Figure 6
SHEARED VALVE STEM

PHOTO NO K/PH 90 1871

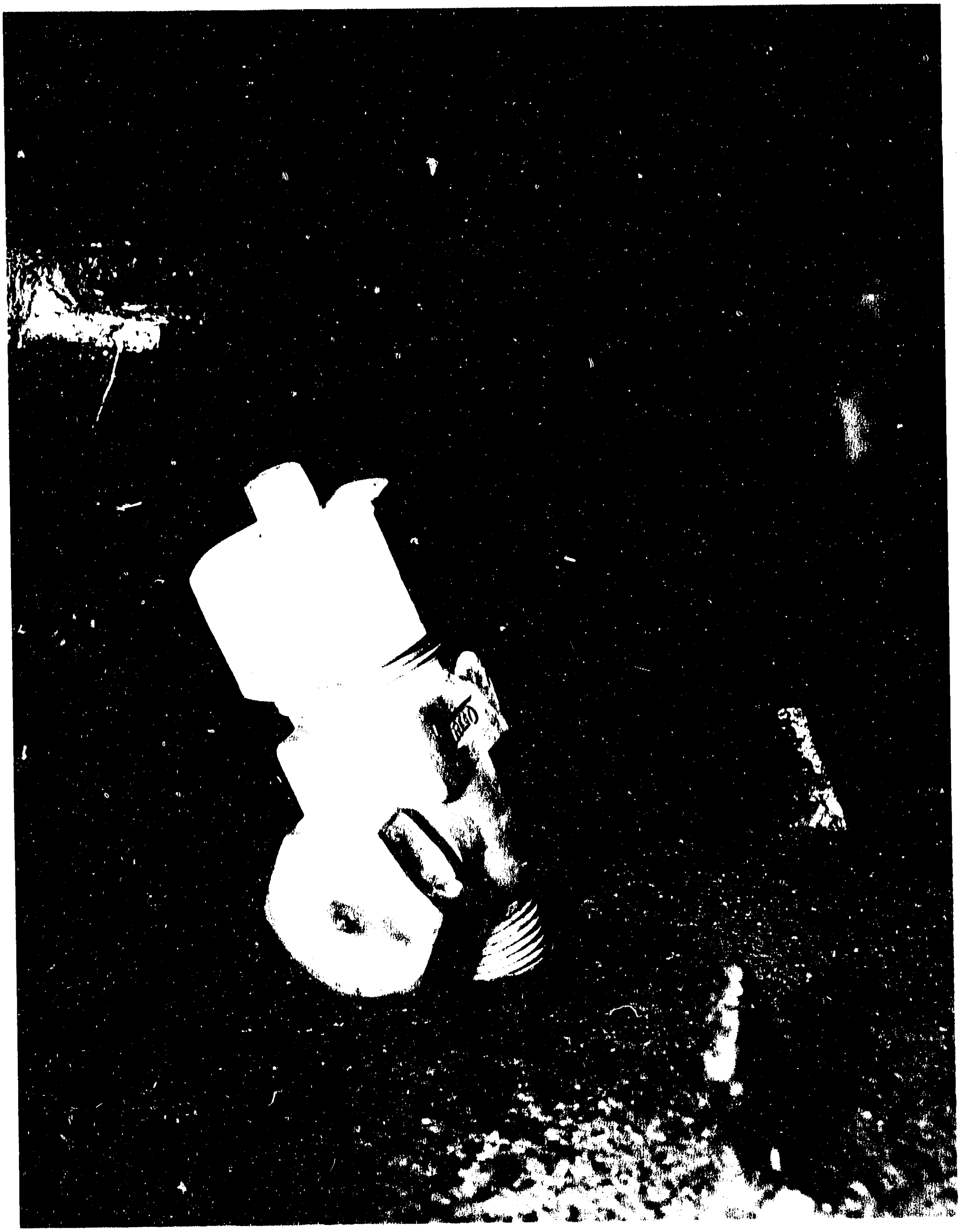


Figure 7
BENT VALVE

PHOTO NO K/PH 90 1878

Figure 8
MISSING PORT CAP
Green deposits are evidence of seat leakage

PHOTO NO. K/PH 90 1725

Figure 9
PORT CAP REMOVAL SHOWS TRAPPED WATER

PHOTO NO. K/PH 90 1841

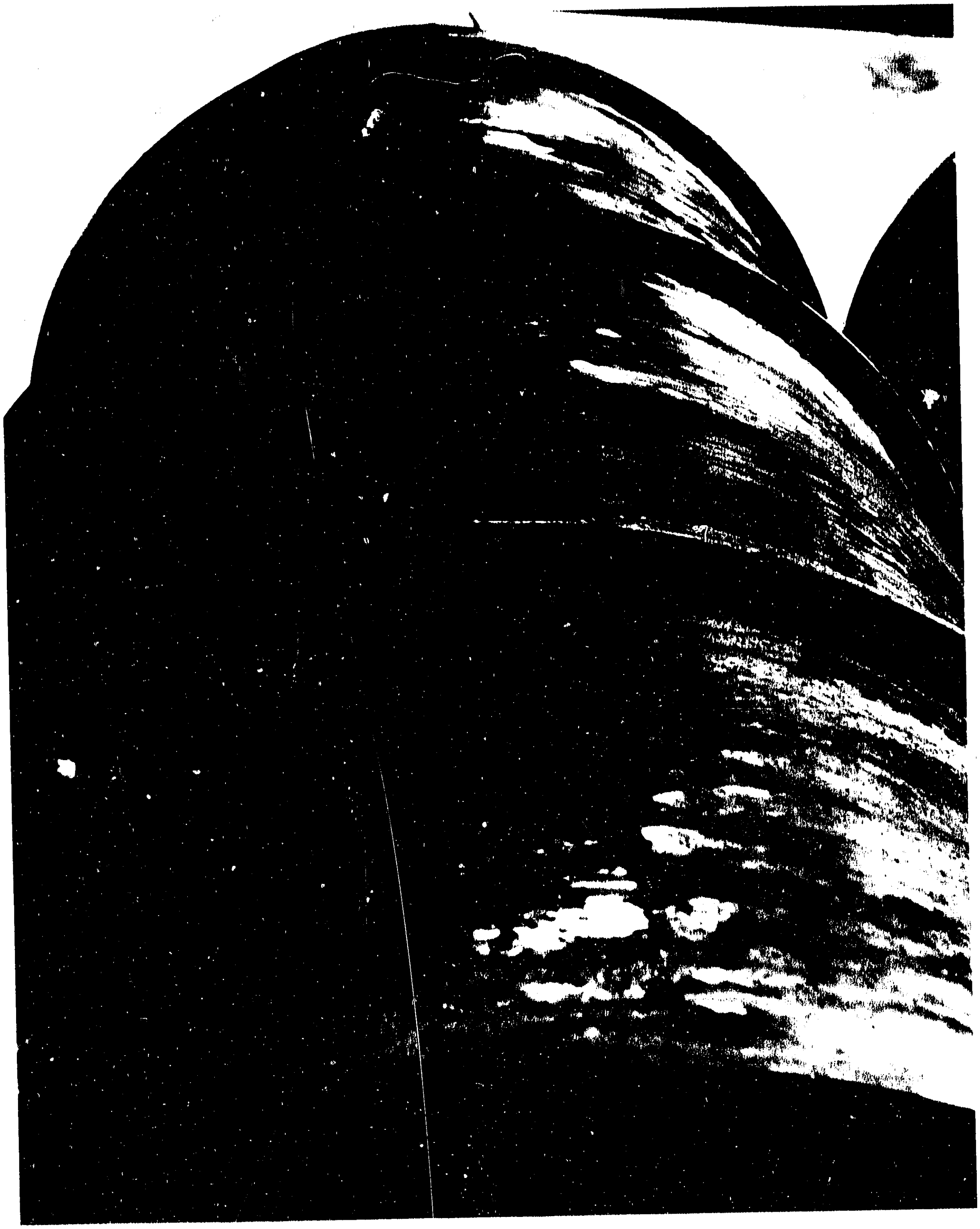


Figure 10
PITTING ALONG LINE OF GROUND CONTACT
A minimum thickness of 0.203 inches was observed.

APPENDIX A

SUMMARY OF INSPECTION RESULTS AT K-25

CYLINDER INSPECTION INFORMATION

SUMMARY DATA	ORGDP	PGDP	PORTS
Total Cylinders	7,036	35,499	13,576
Percent Complete	100%	100%	100%
DEFECTS			
Missing Packing Nuts	0	0	1,326*
Cracked Packing Nuts	24	11	0
Bent Valves	2	36	10
Defective Valve Stems	66	0	0
Port-Cap Missing	34	7	25
Visible Material	195**	28	523
Cracked Port-Caps	2	0	0

* 846 of the packing nuts have been replaced since the inspection.

** An additional 206 valves with visible material identified by inspection were below the plant allowable limits for surface and transferable contamination.

APPENDIX B

FOLLOW-UP ACTIVITIES ON CYLINDER YARD INSPECTIONS

FOLLOWUP ACTIVITIES ON CYLINDER YARD INSPECTIONS

Continuing Assessment of Outleakage Concerns

Corrective Actions	Responsibilities	Comp. Date	Status
1. Complete Health Physics survey of valves with visible material.	R. K. Johnson	6-26-90	Complete
2. Sample visible material to distinguish between corrosion and uranium compounds.	H. H. Sullivan	7-6-90	Complete
3. Based on HP valve survey results, reassess the potential for future outleakage.	C. R. Barlow	7-6-90	Bags will be installed over all valves with contamination levels greater than plant allowable limits.
4. After completing step 3, decontaminate valves to below plant allowable limits.	G. D. Conner	12-1-90	Scheduled
5. If step 3 identifies a valve of concern, install fluorocarbon plastic bags to further assess valve outleakage.	C. R. Barlow	12-15-90	Will install when decontaminated.
6. Complete safety review for burping cylinders and changeout of valves.	B. A. Hannaford	7-31-90	Draft issued for comment.

Corrective Actions	Responsibilities	Comp. Date	Status
7. Prepare or update procedures and conduct operator training on cylinder burping and valve changeout.	J. L. Guthrie	7-13-90	Complete
8. Identify and obtain appropriate safety and emergency equipment for burping cylinders and valve changeout.	R. A. Kite	8-18-90	Underway
9. Replace all valves which are bent, have corroded stem damage or show evidence of continuing leakage.	J. K. Keith	TBD	
Planning for Replacing Missing/Defective Valve Parts			
1. Complete safety review/ for replacement of valve parts.	B. A. Hannaford	Complete	See item 6 above
2. Prepare or update procedure and conduct training for replacing valve parts.	J. L. Guthrie	7-9-90	Complete
3. Replace missing valve parts and/or cracked packing nuts and port caps (parts availability will be based on 3-site priority evaluation).	J. K. Keith	TBD	

Corrective Actions	Responsibilities	Comp. Date	Status
Other Cylinder Related Actions			
1. Assess the need for moving all cylinders currently in direct contact with ground to paved surface and store on chocks.	C. R. Barlow	9-30-90	Underway
2. If cylinder corrosion visually appears excessive, inspect cylinders for pitting and make ultrasonic thickness measurements.	J. L. Frazier	9-30-90	Underway
3. Develop plans to handle cylinders with excessive corrosion.	R. L. Faulkner	TBD	

APPENDIX C

BRIEFING TO DOE ON CYLINDER YARD INSPECTIONS

BRIEFING ON

UF_6

CYLINDER VALVE

INSPECTIONS

INTRODUCTION

<u>Outline</u>

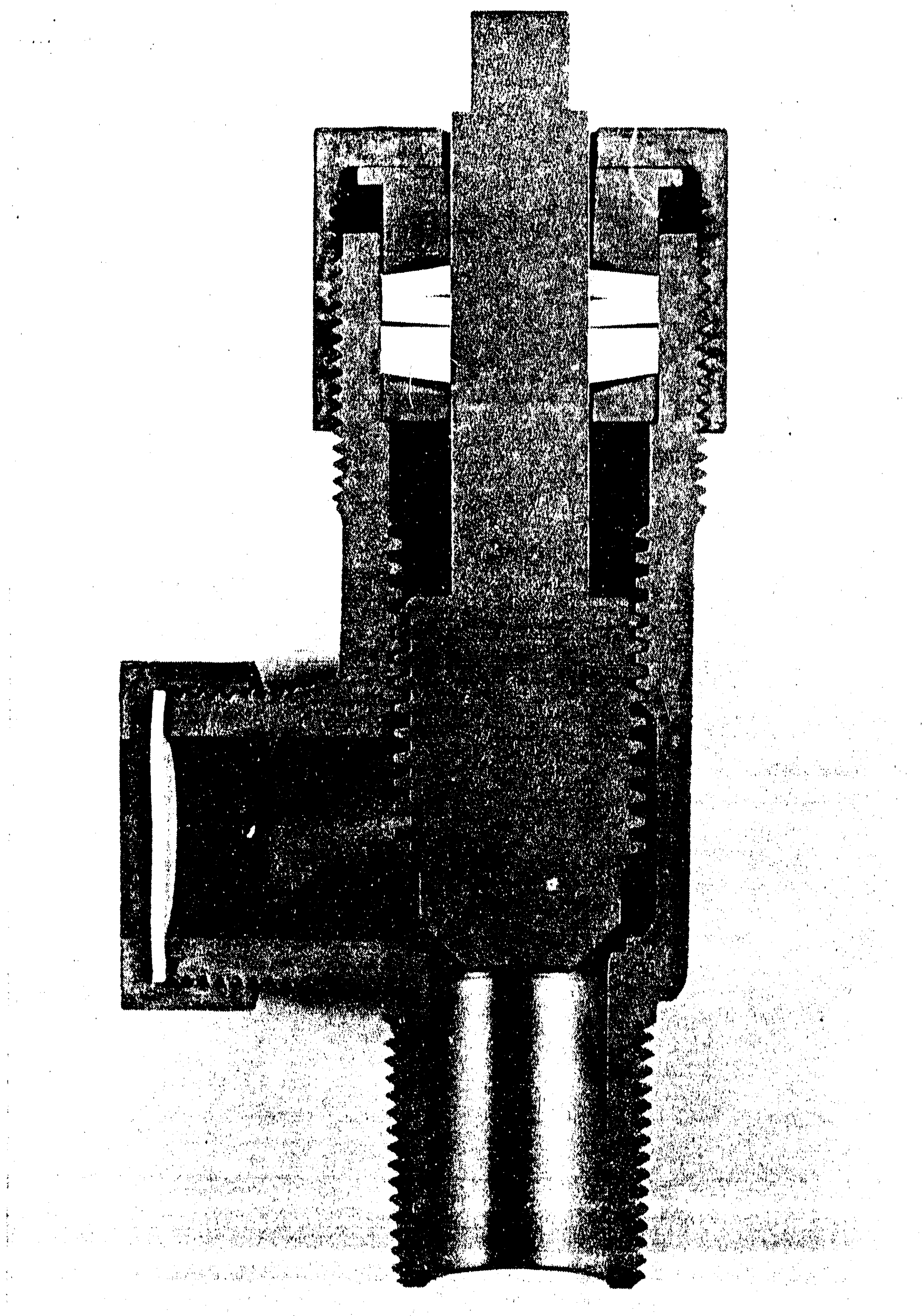
- o UF_6 Cylinder Storage Overview (3 - Site)
- o UF_6 Cylinder Monitoring Program
- o UF_6 Cylinder Storage Concerns
- o Follow on Inspection Plan
- o Current Findings (3 - Site)
- o Future Plans

UF_6 CYLINDER IN STORAGE

Three-Site Summary

	Tails	Normal	Product	Misc.*	Total
ORGDP	4,846	938	347 (heels)	905	7,036
PGDP	26,358	6,500	900		33,758
PORTS	10,400	1,358	1,718	1,440	14,916
Total	41,604	8,796	2,965	2,345	55,710

* MD Cylinders (8" & 12" OD) or 2-1/2 Ton Cylinders.



Sectional View of One-Inch Cylinder Valve

UF_6 CYLINDER MONITORING PROGRAM

(Current Initiatives)

- Cylinder Corrosion Studies (Ongoing)
- UF_6 Handling Committee (Oversite)
- Long-Range Planning Support for UF_6 Cylinders (1st Planning Document Scheduled for Issuance by October 1, 1990)
- Cylinder Integrity Assessments (Ongoing)
- Cylinder Testing (Ongoing)

CYLINDER INTEGRITY ASSESSMENTS

- Random Cylinder Inspections

- Visual Inspection of ~200 Cylinders in K-1066-E Cylinder Yard.

- Findings: 1 Cylinder Valve Stem Showed Evidence of Significant Corrosion.

  1 Valve Port-Cap Contained Water

  Several Valves Showed Evidence of Visible Material

  Several Areas Indicated Potential Concrete Contamination

  7 Cracked Packing Nuts

Cylinder Integrity Assessments (contd)

- Immediate Actions
  - No Visual Signs of Continuing Outleakage.
  - Decontaminated Valves and Concrete.
  - Plastic Bag Installed Over Valve With Stem Corrosion. (No Evidence of Visible Leakage Into Plastic Bag After Two Week Period)

CYLINDER INSPECTION PLAN

- o Prepare Procedures and Inspection Forms
- o Conduct Training
- o Initiated Inspection June 8, 1990
- o Personnel Health & Safety Evaluations
  - Determined the Radiation Levels. The Radiation Level Maximum Was 3 mR/hr.
  - Air Monitoring For Hydrogen Fluoride Was Below Levels of Detection.
  - Precautions Were Identified for Bees and Wasps.
- o Complete Cylinder Inspection: ORGDP - June 25, 1990
PGDP - TBD
PORTS - TBD

CYLINDER INSPECTION INFORMATION

Summary Data	ORGDP	PGDP	PORTS
Total Cylinders	7,036	33,758	14,916
Total Number of Cylinders Checked	6,836	19,165	13,772
Percent Complete	97%	57%	92%
DEFECTS			
Missing Packing Nuts	0	0	853
Cracked Packing Nuts	24	60	0
Bent Valves	1	7	2

Cylinder Inspection Information (contd)

Summary Data	ORGDP	PGDP	PORTS
Port-Cap Missing	30	3	7
Visible Material	29*	10	92
Cracked Port-Caps	2	0	
Total Defects	86	80	954
Total Defects/Total Cylinders Checked	.013	.004	.069

* An additional 293 valves identified by inspection have not been checked by Health Physics.

PRELIMINARY EVALUATION OF THE OBSERVATIONS

- There is no Visible Leakage.

- High Volume Air Sampling (5 Samples) Indicate Less Than Detectable Quantities of Uranium on Selected Cylinder Valves.

CURRENT PLANNING

Install Plastic Bags Over Suspect Valves.

Decontaminate Valves, Concrete, etc., As Appropriate.

Safety Evaluation to Change Out the Corroded Value Which Includes Procedures, Training and Equipment Inspections.

Assure Port Caps are in Place.

Change the Cracked packing Nuts.

Investigate the Valve Stem Corrosion.

Investigate Cracking of Packing Nuts and Port Caps.

Investigate the Value Discoloration.

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