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ACCESSION NBR:9308180096 DOC.DATE: 93/08/09 NOTARIZED: NO DOCKET #
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SUBJECT: Special rept:on 930630,valve packaging event occurred due to equipment failure.Leakage cleaned up,area decontaminated, studs on valve 2HP-64 replaced & valve vendor contacted for assessment of problem relative to 10CFR21 considerations.

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August 9, 1993

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Special Report Concerning Manual
Start of Engineered Safeguards Pump

Gentlemen:

This report is provided for information regarding a June 30, 1993 valve packing leak event. The NRC was notified of the event at 1253 hours because it was initially decided that starting the 2A HPI pump could conservatively be considered reportable under 10CFR50.72 (b)(2)(ii) as an event or condition that results in manual or automatic actuation of any Engineered Safety feature. However, upon further review, it was decided for reasons described in this report, that this event is not reportable.

If you have any questions, please contact S. G. Benesole at (803) 885-3518.

Very truly yours,

J. W. Hampton
Vice President

/ftr

Attachment

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BACKGROUND

The High Pressure Injection (HPI) System [EIIS:BQ] is a part of the Emergency Core Cooling System which mitigates the consequences of loss of coolant accidents. The HPI System prevents uncovering of the core for smaller break sizes, where high Reactor Coolant System (RCS) [EIIS:AB] pressure is maintained, and delays the uncovering of the core for intermediate break sizes. The HPI System, during emergency operation, supplies borated water to the RCS from the Borated Water Storage Tank (BWST). The HPI System has three parallel HPI pumps that have the capability to take suction from the BWST and to discharge through two redundant injection flow paths into the RCS. (See Attachment A)

The HPI System also has functions during normal plant operation to control the RCS inventory, provide the seal water for the Reactor Coolant Pumps (RCPs) [EIIS:P], and recirculate RCS letdown for water quality maintenance and reactor coolant boric acid concentration control. The HPI system takes water from the Letdown Storage Tank, pumps make-up water into the RCS via the normal injection line and seal supply water via seal supply filters into four lines going to the four RCPs' seals.

Valve 2HP-64 (see Attachment B) is a manual throttle valve used to regulate the seal supply flow to RCP 2A1. It is a 1/2 inch, stainless steel, packed y-globe throttle valve, manufactured by Kerotest and has been in service since March, 1988. The gland studs are 1/4 inch in diameter and are made of cadmium plated ASTM A193, Grade B7 material.

Technical Specification 3.1.6.1 states: "If the total reactor coolant leakage rate exceeds 10 gpm, the reactor shall be shutdown within 24 hours of detection."

Technical Specification 3.3.1 requires three HPI pumps and two HPI flow paths to be automatically operable when RCS temperature is greater than 350 degrees F. with fuel in the core. This is based on considerations of potential small breaks at the Reactor Coolant Pump discharge piping for which two HPI trains (two pumps and two flow paths) are required to assure adequate core cooling. A pump can be removed from service for test or maintenance for 72 hours.

EVENT DESCRIPTION

On April 29, 1993, Oconee Unit 2 shut down for a refueling outage. During the outage, all four Reactor Coolant Pump (RCP) Seal Supply throttle valves were repacked as part of normal preventive maintenance activities. Unit 2 returned to operation on June 24, 1993.

On June 28, 1993, a work request was issued due to a packing leak on 2HP-64. On June 30, 1993, Oconee Unit 2 was operating at 100% Full Power, when Maintenance Technicians A and B (MT-A and MT-B) began activities to tighten the packing.

Valve 2HP-64 is located in a pipe chase on the third level of the Auxiliary Building, across a corridor from a chemistry laboratory. The area had already been decontaminated following the refueling outage. A Radiation

Protection technician surveyed the area and determined that the only protective clothing required were rubber gloves over cotton glove liners.

The maintenance workers received clearance from Operations personnel to begin work. They were specifically cautioned not to change the valve position. (Normal procedure for tightening the packing on this type of valve is to tighten the packing, then manually operate the valve to assure that the stem is not binding. However, in this application, operating the valve would have affected the distribution of seal supply flow among the four RCPs.) MT-A prepared to perform the work while MT-B, using a telephone in the room, maintained communication with a Control Room Operator.

According to MT-A, he tightened the gland nuts in 1/2 turn increments, alternating between the two nuts. At approximately 1015 hours, after approximately 1 and 1/2 turns, one of the studs broke. (Subsequent examination showed that it sheared at the surface of the valve bonnet.) The gland and gland follower were pushed up the stem by system pressure until the gland was cocked at an angle, held by the single remaining stud and nut. The packing leak increased from minor seepage to a more noticeable level.

MT-B informed the Control Room Operator, then both MT-A and MT-B left the room and went to the change room down the hall. There MT-B began contacting his supervision and Engineering. MT-C was substituting for the crew supervisor that day and was contacted. A conference line was established among MT-B, MT-C, the Operations Unit Supervisor, and Engineer A. They developed a plan to install a C-clamp on the valve stem such that it would prevent the gland follower from coming further out.

MT-A dressed out in paper anti-contamination clothing. He also went to the hot tool storage area to get additional tools and a 4 inch C-clamp. Upon his return to the valve, MT-A attempted to install the C-clamp on the valve stem. However, at approximately 1030 hours, while he was doing this, the second gland stud also broke, allowing the gland and gland follower to back out completely. System pressure ejected the packing, and High Pressure Injection (HPI) system water began spraying out of the valve.

MT-A was sprayed by the water from the leak. He came to the door of the room and told personnel in the Chemistry Lab to notify Radiation Protection (RP) and Operations of the increased leak. He was taken by RP personnel to the hot change room.

Operations Shift and Staff personnel consulted briefly as to the action to be taken, then entered Abnormal Procedures (AP) AP/2/A/1700/14, Loss of Normal HPI Make-up and Letdown, AP/2/A/1700/02, Excessive RCS Leakage, and the Limiting Condition for Operation (LCO) for Technical Specification (TS) 3.1.6.1. The operators monitored the drop in level in the Letdown Storage Tank and estimated that the leak was approximately 25 gpm.

At 1042 hours, Radiation Monitor RIA 32, Auxiliary Building Gas Monitor (a multipoint sampler) went into Alert. At 1047 hours, Radiation Monitor 2RIA 44, Unit 2 Vent Stack Iodine monitor, also went into Alert and the Operators consulted AP/2/A/1700/18, Abnormal Release of Radioactivity. The Auxiliary Building corridor and portions of the ventilation system are

shared between Unit 1 & Unit 2. Therefore, Radiation Monitor 1RIA 44, the Unit 1 Vent Stack Iodine monitor, also indicated increased activity.

The Operators took corrective action in accordance with AP/2/A/1700/14, Loss of Normal HPI Make-up and Letdown. At 1055 hours, the Operators started HPI pump 2A. At 1058 hours, valve 2HP-115, the HPI discharge header separation valve, was closed to isolate the seal injection header from the normal make-up line, which is also used for Emergency Core Cooling Flow. This made HPI pump 2B unavailable for Engineered Safeguards actuation and a 72 hour LCO was entered per TS 3.3.1. Then HPI pump 2B was secured at 1100 hours and 2HP-31, Seal Flow Control Valve, was closed. These actions isolated seal injection to all four RCPs and stopped the leak. (The effect on RCP seal operation is discussed below.) Operators also closed 2HP-138, Seal Flow Control Inlet Valve, and 2HP-283, Seal Supply to RCP 2A1 Outside Stop Check Valve, in order to further isolate 2HP-64 for maintenance. Operations personnel estimated that a total of approximately 550 gallons leaked from the HPI system to the Auxiliary Building during this event.

Engineer A and MT-B dressed out in anti-contamination clothing, and were issued respirators. They entered the room to determine the status of the leak, but it had been isolated. They examined the valve and the broken studs to determine the extent of necessary repairs. Then they exited the room and went to the hot change room.

After the leak was stopped, the airborne contamination levels dropped and returned to normal. Vent Stack monitors trended back to normal after isolation of the leak. The Alert on 2RIA-44 reset at 1211 hours. During the event, there was a small contribution to releases of gasses and particulate through the ventilation system via the Unit Vent Stack. Effluent counts on 2RIA-44 increased from 23 cpm to a peak of 232 cpm. The counts on 2RIA-43, Unit Vent Stack Particulate Radiation Monitor, increased from approximately 1110 cpm to a peak of 3747 cpm. Total releases to the public were well within normal operating limits.

MT-A was found to be contaminated, with readings of 800 corrected counts per minute (ccpm) on his skin and clothing and 2400 ccpm on his shoes. After showering with soap and water, his skin count was reduced to zero ccpm. At approximately 1215 hours he was given a body burden analysis, which indicated zero body burden detected and no DAC-hours were assigned.

MT-B and Engineer A were also frisked, and found to be contaminated, apparently by gaseous activity, with readings of 800 ccpm. They showered and had body burden analyses performed at approximately 1315 hours. They also showed zero body burden.

Subsequently, MT-C and MT-D removed one of the broken studs but were unable to remove the other stud. Therefore, they removed the bonnet assembly from 2HP-64 and took it to the machine shop. At the machine shop the remaining broken stud was drilled out. During the process, threads on the hole were damaged to the extent that the new stud did not tighten adequately. A design change was initiated, the bonnet hole was retapped, and an oversize stud was installed. The valve was reassembled.

Operations personnel prepared a restricted change to the RCP operating procedure to document steps to slowly restore seal injection flow. At 2050 hours, 2HP-115 was reopened in accordance with this change, which allowed Unit 2 to exit the TS 3.3.1 LCO. At 2238 hours, the seal supply flows were restored to normal, ending the event.

The leakage was cleaned up and the area decontaminated. None of the leaking water was released offsite.

The broken studs were sent to the Duke Power Applied Science Center laboratory for analysis. The laboratory examination confirmed that the studs composition and structure was consistent with ASTM A193, Grade B7 material with cadmium plating. The stud which broke first had a rust deposit indicating that failure had occurred in at least two steps. The laboratory examination found evidence of ductile failure at both the initiation and final fracture points, with propagation by mixed intergranular and ductile fracture. The second stud showed mixed microvoid and intergranular fracture. The laboratory report concluded that hydrogen had been absorbed into the metal, possibly during the cadmium plating process, causing hydrogen embrittlement.

As a result of the laboratory findings, the seal supply throttle valves on all three units were visually inspected. The inspection indicated that all of the Unit 2 valves (2HP-64, 65, 66, 67) have cocked (i.e. bent slightly outwards at the top) packing studs. On Unit 1, 1HP-64, 65, and 66 have cocked studs. The Unit 3 valves were not cocked. A qualitative evaluation by Component Engineering concluded that the studs are not expected to fail under the existing loads and continued operation with the cocked studs is acceptable. A decision was made to restrict future tightening of the packing on these valves, pending either replacement of the 1/4 inch studs with larger diameter studs or replacement of the entire valve with another model valve. These replacements will be performed during the next appropriate outage on each unit. In addition, a "generic" contingency plan package will be developed in order to facilitate replacement should studs on a valve fail while under pressure.

Oconee Unit 2 RCPs are Bingham pumps, equipped with a three seal package that is designed to operate indefinitely without seal injection flow. This mode of operation is documented in the vendor manuals and has been incorporated into station procedures. During this event, the RCP operating parameters, such as seal temperatures, seal leakoff flow, seal return flow, pump vibration, etc., were monitored closely by both Operations and Engineering personnel. All parameters remained within the nominal values expected for this mode. No alarm limits or shutdown criteria were approached.

Because the HPI pumps also perform an Engineered Safeguards (ES) function, it was initially decided that starting the 2A HPI pump could conservatively be considered reportable under 10CFR50.72(b)(2)ii as an event or condition that results in manual or automatic actuation of any Engineered Safety Feature. Therefore, the NRC was notified of the event at 1253 hours. However, upon further review, it was decided that this event should not be considered reportable and the notification was retracted on July 20, 1993, at 1608 hours. Although the 2A HPI pump can receive an ES signal, and does perform an ES function in an emergency, it also performs a normal function.

In this event, the 2A HPI pump was started manually, using its normal controls, to perform its normal function. If the 2A HPI pump had already been in operation (2A and 2B are routinely swapped in order to equalize run time), it would not have been necessary to start another pump in response to the event. The make-up flows were not excessive during this event. No RCS pressure, temperature, volume, or power transients occurred, therefore, no Reactor Protective System or ES actuation setpoints were approached.

CONCLUSIONS

The initiating cause of this event is equipment failure. Both gland studs broke during the attempt to tighten the valve packing. The Root Cause of the event is Design/Manufacturing Deficiency, (Material Deficiency, apparently resulting from the manufacturing process). Laboratory tests indicate that hydrogen, presumed to be introduced during the cadmium plating process, induced embrittlement which weakened the gland studs.

Although there have been previous cases of deficient materials discovered at Oconee, none have involved hydrogen embrittlement. Nor have there been any similar events involving stud failures. Therefore, this event is not considered to be a recurring event.

The failure of 2HP-64 is NPRDS reportable. It is a 1/2 inch, stainless steel packed y-globe throttle valve, manufactured by Kerotest.

Although three employees were mildly contaminated during this event, no personnel injuries, over-exposures, or releases to the public in excess of normal operating limits occurred.

CORRECTIVE ACTIONS

Immediate

1. Operations isolated the leak in accordance with AP/2/A/1700/14, Loss of Normal HPI Make-up and Letdown.

Subsequent

1. The studs on 2HP-64 were replaced, the valve repacked, and the system was returned to service.

2. Component Engineering inspected the packing gland studs on the other seal supply throttle valves for all three Oconee Units.

Planned

1. During the next appropriate outage of sufficient duration on each unit, the valve packing gland studs (or the entire valves) on all seal supply throttle valves will be replaced.

2. Site Engineering will contact the valve vendor for assessment of the defective stud problem relative to 10CFR21 considerations.

SAFETY ANALYSIS

The failure of the packing on 2HP-64 due to the broken packing studs resulted in an isolatable leak of approximately 25 gpm into the Auxiliary Building. This is well within the normal make-up capacity of a single High Pressure Injection (HPI) pump. Therefore, the leak is not considered significant from a nuclear safety aspect. Had the leak been in a location such that it could not have been isolated, Technical Specification 3.1.6.1 would have applied and Unit 2 would have been shutdown within 24 hours.

The leak was reported to Operations and was promptly isolated. If the stems and/or the packing had failed under different circumstances without personnel in the room, the leak could have continued for a longer period prior to isolation. However, the leak would still have been identified by one of the following methods:

1) Operator investigation of Radiation Monitor Alerts,

2) Control Room Operator observing the excessive rate of change in Letdown Storage Tank level,

3) Non-Licensed Operator inspection of the room during rounds,

4) Personnel passing through corridor noting water coming out of room under the door,

5) Reactor Coolant Leakage calculation, performed once per shift.

In order to isolate the leak, it was necessary to isolate seal supply flow to all four Reactor Coolant Pumps (RCPs). Unit 2 and 3 have Bingham pumps. The seal package on these Bingham pumps is designed with a shaft driven impeller which recirculates approximately 40 gpm of seal injection water, of which only approximately 10 gpm normally comes from the HPI seal supply flow. The recirculated seal injection water is cooled by a heat exchanger which functions to control seal temperatures within design limits. On loss of seal supply flow, additional water enters from the Reactor Coolant System, therefore seal temperatures rise slightly (approximately 25 degrees F), but remain within operational limits. This design permits continued operation in this mode without any anticipated adverse affect on the seals.

Unit 1 is equipped with Westinghouse pumps. Although the design of the seal package is different, they are also designed to operate indefinitely with a loss of seal supply flow. (Westinghouse does recommend a 24 hour limit due to contamination control considerations.) Therefore, RCP seal failure is not an expected result on any Oconee Unit following isolation of the seal supply flow.

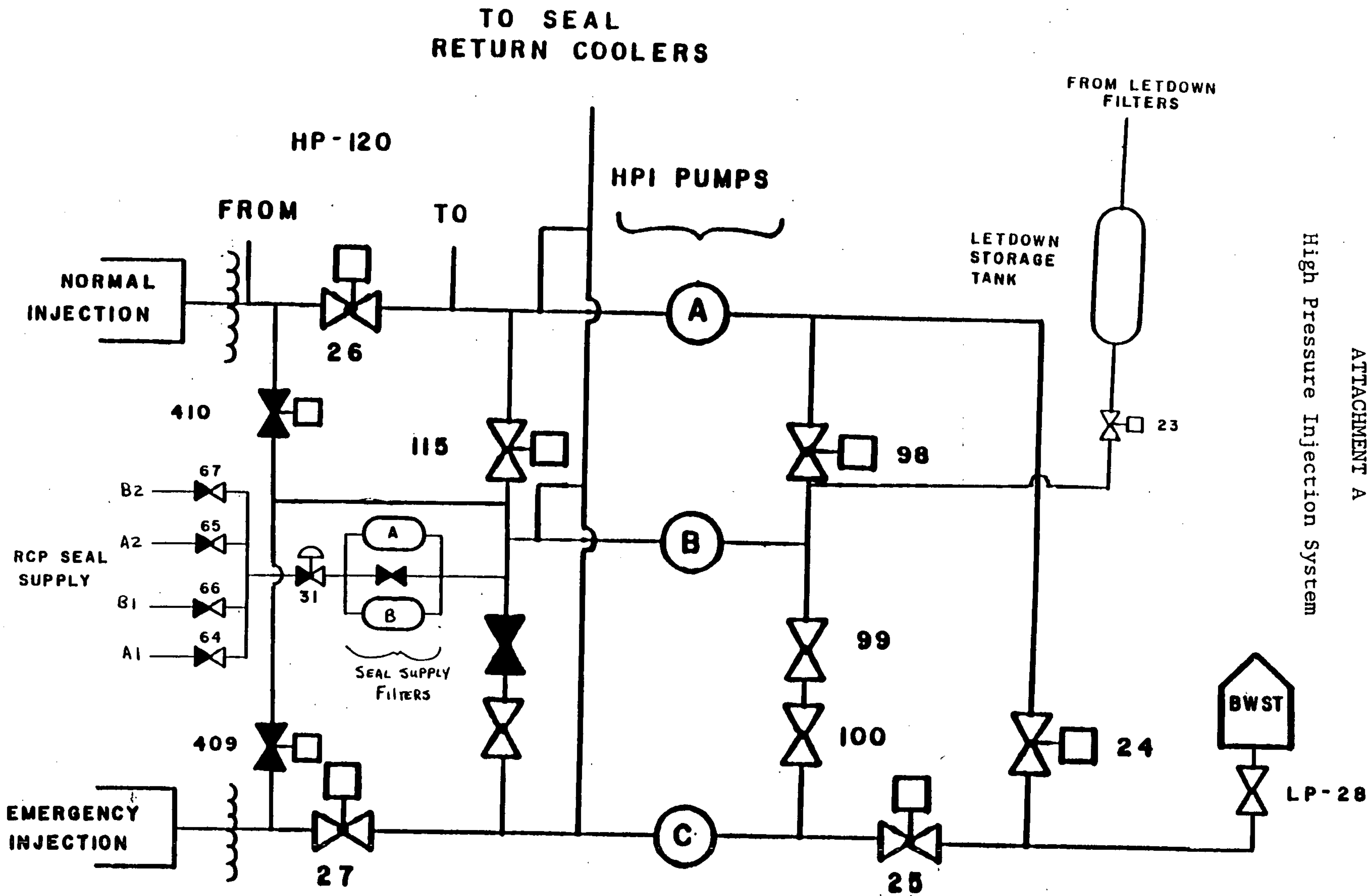
The principle safety impact of this event was the closure of 2HP-115, which removed the 2B HPI pump from line up for Engineered Safeguards (ES). This placed Unit 2 under a 72 hour Limiting Condition for Operation. If an event which requires HPI operation in ES mode, such as a small break Loss Of Coolant Accident, had occurred while operating in this mode, HPI pumps 2A and 2C would still have been available for ES operation. These two pumps could fully meet the functional requirements for scenarios defined in the Final Safety Analysis Report unless an additional single failure

occurred. However, 2B HPI pump would still have started on ES signal and could have been realigned to provide ES flow to either injection header by Operator action to open 2HP-115, 2HP-409, and/or 2HP-410, all of which are operable from the control room.

Therefore, the health and safety of the public was not affected by this event.

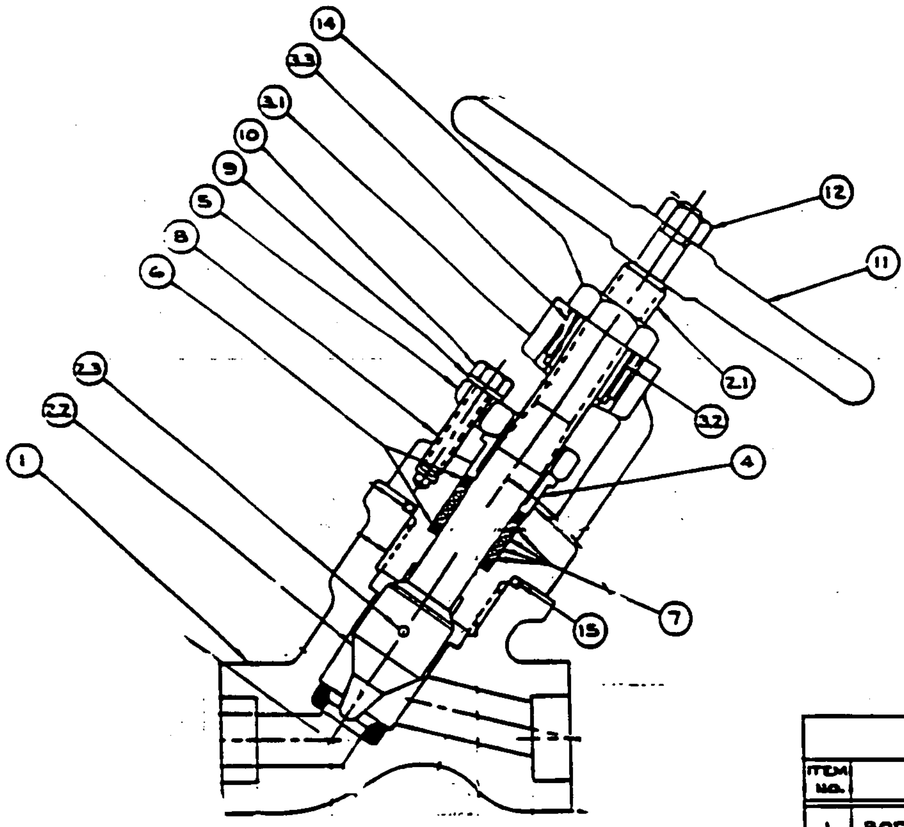
ATTACHMENT A

High Pressure Injection System



ATTACHMENT B

KEROTEST 1/2 Inch Throttle Valve



ITEM NO.	NAME OF PART	NO. REQ'D.
1	BODY	1
2	STEM & DISC ASS'Y.	1
2.1	STEM	1
2.2	DISC	1
2.3	PIN	1
3	BONNET ASSEMBLY	1
3.1	BONNET	1
3.2	BUSHING	1
3.3	PIN	2
4	GLAND FOLLOWER	1
5	GLAND	1
6	PACKING RING	2
7	PACKING RING	MIN. 4
8	GLAND STUD	2
9	GLAND WASHER	2
10	GLAND NUT	2
11	HANDLE	1
12	HANDLE LOCKNUT	1
13	NAMEPLATE	1
14	STEM LOCKNUT	1
15	GASKET RING	1
16	TAG	1

PARTS LIST