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ILLINOIS POWER

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Docket No. 50-461

Document Control Desk
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Clinton Power Station - Unit 1
Licensee Event Report No. 92-002-01

Dear Sir:

Please find enclosed Licensee Event Report No. 92-002-01: Manufacturing Deficiencies and Inadequate Maintenance Procedures Result in Reactor Feed Pump Control Valve Lockup, Feedwater Level Transient, and Low Reactor Water Level SCRAM. The LER has been revised to address the cause of and corrective actions for the turbine driven reactor feed pump lockup, an additional feed pump lockup, previous similar events, and equipment failures. This report is being submitted in accordance with the requirements of 10CFR50.73.

Sincerely yours,

F. A. Spangenberg, III
Manager, Licensing and Safety

RSF/alh

Enclosure

cc: NRC Clinton Licensing Project Manager
NRC Resident Office, V-690
NRC Region III, Regional Administrator
Illinois Department of Nuclear Safety
INPO Records Center

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NRC FORM 366
(6-89)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Clinton Power Station	0 5 0 0 0 4 6 1	1 OF 0 9

TITLE (4) Manufacturing Deficiencies and Inadequate Maintenance Procedures Result in Reactor Feed Pump Control Valve Lockup, Feedwater Level Transient, and Low Reactor Water Level SCRAM

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 2	2 7	9 2	9 2	0 0 2	0 1	0 3	1 9	9 2	None	0 5 0 0 0
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OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)					
POWER LEVEL (10)	0 7 2	20.402(b)	20.405(c)	X	50.73(a)(2)(iv)	73.71(b)	
		20.405(a)(1)(i)	50.36(c)(1)		50.73(a)(2)(v)	73.71(c)	
		20.405(a)(1)(ii)	50.36(c)(2)	X	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)	
		20.405(a)(1)(iii)	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		
		20.405(a)(1)(iv)	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
		20.405(a)(1)(v)	50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
O. Villarreal, System Engineer, Extension 3098	AREA CODE 2 1 7 9 3 5 - 2 8 8 1

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
D	S J	F C V	G 0 8 4	Y							

SUPPLEMENTAL REPORT EXPECTED (14)		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

With the plant at 72 percent reactor power, an automatic reactor scram occurred due to low reactor water level when the "B" Turbine Driven Reactor Feed Pump (TDRFP) control valve (CV) failed to properly control TDRFP speed and, consequently, feedwater flow. During a transfer of reactor feedwater level control from the "A" channel to the "B" channel, the "B" TDRFP controller signaled the "B" TDRFP CV to open. The TDRFP CV locked up causing the "B" TDRFP to pick up more of the controller demand to the vessel than the "A" TDRFP. After the TDRFP CV locked up, the controller demand went to a minimum, giving the TDRFP CV a full-close signal. While reducing reactor power and attempting to manually remove the "B" TDRFP from service, the TDRFP CV closed causing the TDRFP speed to decrease and creating a low reactor water level condition which resulted in an automatic reactor scram. The cause of this event is attributed to manufacturing deficiencies compounded by inadequate procedural guidance for maintaining the TDRFP turbine actuating linkages. Corrective actions include replacing worn or damaged components; revising procedures to include more detailed instructions; initiating a preventive maintenance task to periodically inspect the linkages; training maintenance personnel on lessons learned; and monitoring TDRFP performance.

DESCRIPTION OF EVENT

On February 27, 1992, at approximately 1726 hours, with the plant in Mode 1 (POWER OPERATION) at approximately seventy-two percent reactor [RCT] power, an automatic reactor scram occurred due to low reactor pressure vessel [RPV] water level (Level 3). The scram occurred during a feedwater transient when the "B" turbine [TRB] driven reactor feed pump (TDRFP) [P] control valve [FCV] failed to properly control TDRFP speed and, consequently, feedwater [SJ] flow.

On February 27, Temporary Modification 92-26 was installed because of previous failures of the "B" TDRFP to properly control reactor water level. Because the General Electric Transient Analysis Recording System (GETARS) information for evaluation of the previous failures had not been sufficient to establish whether the failures were caused by problems in electrical controls or mechanical components, a decision was made to initiate and install Temporary Modification 92-26. The purpose of the temporary modification was to allow monitoring of additional components in the TDRFP control valve's hydraulic control mechanism during the power reduction activity that was scheduled to begin later that night for the plant's third refueling outage (RF-3). Temporary Modification 92-26 allowed monitoring of the "B" TDRFP pilot valve [V] position and servo valve control signal response. The monitoring was to be accomplished with the GETARS.

Because of the previous problems with the control valve, the operations crew discussed the risks of installing Temporary Modification 92-26 and the possibility that this could result in a control system disturbance. This was also discussed with management before the temporary modification was installed. The installation of the temporary modification was completed without incident.

Routine monthly surveillance CPS 9538.03, "Feedwater Reactor Vessel Water Level C34-N004A(B,C) Channel Functional," was scheduled for water level transmitter [LT] 1C34-N004A on February 27. In order to perform this surveillance, feedwater RPV level control had to be transferred from the "A" reactor water level control channel [LC] to the "B" reactor water level control channel of the Feedwater Control System [JB].

The "B" reactor water level transmitter 1C34-N004B normally reads level about 3.5 inches lower than the "A" or "C" reactor water level transmitters. Therefore, transferring to the "B" reactor water level control channel will automatically cause a minor demand signal change to the TDRFPs to compensate for the lower level that the control system will see as soon as the "B" channel is selected. The demand will cause the TDRFP control valve to momentarily open more, resulting in increased feed pump speed and more water being pumped into the RPV for a brief time

until a new equilibrium level is reached to match the level setpoint on the Master Level Automatic Controller.

Before transferring level control from channel "A" to channel "B", the operations crew held a briefing to discuss the evolution and decided to leave the feedwater controller in Master Level Automatic while shifting reactor water level control channels.

At 1655 hours, with the plant at about ninety-six percent reactor power, the "A" Control Room Operator (CRO) selected the "B" reactor water level control channel and immediately adjusted the Master Level Controller level setpoint to match the level indicated by the "B" reactor water level transmitter. The "A" CRO adjusted the setpoint from about thirty-five inches (level the "A" reactor water level transmitter was reading) to about thirty-two inches (level the "B" reactor water level transmitter was reading). The transfer of the reactor water level control channels appeared to be successful.

After the transfer of channels, the "B" TDRFP control valve operated erratically; the speed of the "B" TDRFP increased and the "B" TDRFP assumed more of the feedwater flow load than the "A" TDRFP. Then the speed of the "B" TDRFP stabilized. Reactor water level was stable at thirty-three inches.

The "B" TDRFP controller demand signal then went to minimum over several minutes, giving the "B" TDRFP control valve a signal to close to reduce turbine speed to the Low Speed Stop (LSS). The controller remained in the minimum demand position waiting for a response from the "B" TDRFP control valve to balance flow between both reactor feed pumps.

At 1700 hours, Operators notified the Load Dispatcher of the feedwater problems and began reducing reactor power over the next fifteen minutes in preparation for removing the "B" TDRFP from service.

At 1705 hours, operators shut high pressure steam supply valve 1B21-F303B. The area operator slowly shut off low pressure steam to the "B" TDRFP using the local manual handwheel of isolation valve [ISV] 1B21-F310B. The area operator coordinated this evolution with the "A" CRO in the Main Control Room who was reducing reactor power by reducing reactor recirculation [AD] flow.

By 1716 hours, reactor power had been reduced to eighty-three percent and operators began a further reduction in power toward seventy-five percent. Valve 1B21-F310B was approximately eighty percent closed when flow through the "B" TDRFP started to decrease and the "A" TDRFP started to pick up more of the feedwater flow load.

At 1726 hours, with reactor power at seventy-two percent and valve 1B21-F310B approximately ninety percent closed, the "B" TDRFP control valve closed. Reactor water level quickly dropped from 32.5 inches to about 12 inches and then slowly dropped to about 10.7 inches. Level then appeared to be on the verge of recovering. The TDRFP controller demand went to thirty percent. The area operator noted that the "B" TDRFP control valve opened briefly and then closed.

The Shift Supervisor directed that a manual scram be initiated, but before the scram could be initiated, an automatic scram occurred because of low reactor water level (Level 3).

No other automatic or manually initiated safety system responses were necessary to place the plant in a safe and stable condition. No other equipment or components were inoperable at the start of this event such that their inoperable condition contributed to this event.

CAUSE OF EVENT

The lockup of the "B" TDRFP control valve caused the feedwater transient and the low reactor water level scram. The cause of the "B" TDRFP lockup is attributed to manufacturing deficiencies compounded by inadequate procedural guidance for maintenance of the TDRFP turbine actuating linkages. Factors which contributed to the cause of the lockup were application of improper lubrication which was specified by the TDRFP vendor, General Electric; misalignment of pillow blocks; out-of-round torque arm journals; inadequate surface finish on torque arm journals; high spots on the bores of the pillow blocks; reduction of bearing-to-journal clearance when the pillow blocks were tightened to specifications; and lack of periodic maintenance tasks to verify actuator assembly condition. (Reference figure for sketch of TDRFP turbine torque arm assembly components.)

The system engineer performed a preliminary assessment of the "B" TDRFP control valve lockup based on data from a GETARS trace (via Temporary Modification 92-26). The preliminary assessment determined that the feedwater control signal functioned properly during the event, and the pilot valve response to the servo valve action was consistent with the feedwater control signal. However, the GETARS data indicated that the lockup of the "B" TDRFP control valve was caused by a mechanical restriction which prevented the TDRFP control valve from properly modulating in response to the feedwater control signal.

The sudden closure of the "B" TDRFP control valve was caused by the freeing of the control valve from its locked-up position when the control signal was at a minimum. The reactor water level transient caused the low water level scram.

The preliminary assessment identified that the main operating cylinder and/or torque arm assembly of the TDRFP control valve did not respond as expected but instead locked up while trying to respond to the level transient.

Three previous events have occurred involving a lockup of the "B" TDRFP control valve. None of the events were reportable under the provisions of 10CFR50.73. Investigation of an event which occurred on May 1, 1991 provided strong indication that the TDRFP control valve lockup was caused by the servo valve in the operating cylinder assembly of the TDRFP control valve. Following replacement of the servo valve, the pump operated properly. Investigation of an event which occurred on September 24, 1991 involved the mechanical components that operate the TDRFP control valve. Severe wear was found in three bearings of the mechanical linkage assembly. Two bronze sleeve bearings (pillow block bearings) for the torque arm assembly were cleaned, lubricated and rotated to make contact with the unused surface. A third bearing (spherical), on the actuating lever, was also cleaned and lubricated. Following completion of these actions, the unit operated properly. The third bearing was scheduled for replacement in RF-3 pending parts availability. On January 30, 1992, the unit locked up for only a few minutes and then restored to normal.

During the May 1 and September 24 events, the "B" TDRFP was successfully isolated in the manner similar to that pursued during this event. The successful isolation of the pump prevented a reactor water level transient that would have caused a reactor scram. Following the January 30 event, the decision was made to install Temporary Modification 92-26.

A detailed investigation of the cause of the repeated "B" TDRFP control valve actuating mechanism failures was performed during RF-3. The investigation traced the failures to the pillow block bearings. As discussed above, these bearings were found worn in September, 1991 and were replaced in November, 1991. The investigation determined that the pillow block bearings failed because of insufficient clearance between the bearing and journal and the bearing and pillow block. The clearance problem was exacerbated by a crush or distortion produced when the pillow block upper cap was tightened to specifications.

While replacing the "A" TDRFP control valve pillow block bearings during RF-3 (as part of a "lessons learned"), the outer diameter of the bearings was found somewhat oversized and was being distorted when the pillow blocks were tightened to specifications. This condition was preventing free movement of the torque arm assembly. That condition was corrected by sanding the bearing outer surface.

Vendor and Clinton Power Station procedures did not provide guidance for specifying the clearances between the bearing and the torque arm journal

and the bearing and pillow block. Vendor manual K2806-0001, "Steam Turbine Feed Pump Drive," and maintenance procedure CPS 8211.03, "Reactor Feed Pump Turbine Low Pressure Control Valve," contain drawings indicating that the bearing blocks are to be machined during assembly to fit the bearing. The "machine to fit" note would imply that bearing-to-journal and bearing-to-pillow-block clearances are required to be custom set by measuring the respective diameters and machining as required. However, no procedural or vendor manual specifications are provided for the fitting. For this reason, bearing fit ups were not checked at assembly during the September and November, 1991 maintenance. During the November 1991 maintenance, the bearings were noted to fit tightly on the torque arm journals.

During the replacement of the bearings in November, 1991, grease lubrication was added to the bearings to supplement the bearings' graphite lubrication as directed by the vendor representative in the previous visit in September 1991. However, the bearings are designed for dry lubricant. After the February 27, 1992 incident, a different vendor representative advised that grease is not recommended for use on graphite lubricated bearings. Using grease causes the graphite to ball and become displaced out of the bearing, thereby allowing the journal to come into direct contact with the bronze bearing material, resulting in galling.

The investigation also identified some vertical and some apparent horizontal misalignment of the two pillow blocks. However, the misalignment condition alone would not have caused a bearing seizure.

In addition, the vendor manual did not provide specific recommendations for periodic preventive maintenance on TDRFP control valve linkages.

On June 13, 1992, following completion of RF-3 and remedial actions to repair the "B" TDRFP linkages, with the plant operating at 100 percent reactor power, the "B" TDRFP locked up again. Operators were able to control reactor water level and avoid a reactor trip. This occurrence was not reportable under the provisions of 10CFR50.73.

An immediate investigation identified that the cause of the June 13, 1992 occurrence was the lockup or physical binding of the torque arm assembly between the pillow block bearings and the torque arm journal. A detailed plan was developed to investigate the cause of the premature failure of the "B" TDRFP. The investigation found severe galling on both pillow block bearings and significant scoring of the torque arm journals. Further investigation identified the torque arm journals were slightly out-of-round; the pillow block bearings had high spots on the inside wall when the pillow block was in the tightened position; the pillow block bores had high spots; and the pillow block alignment was inaccurate.

An evaluation concluded that these surface imperfections decreased the established clearances of 0.003 to 0.004 inches to virtually zero clearance with the pillow block tightened to specifications. The resulting clearances allowed metal to metal contact between the journal and the bearing causing the surfaces to rub without lubrication and thereby creating metal fragments, increased friction and, finally, bearing failure.

Illinois Power further determined that the alignment of the pillow blocks performed during RF-3 was inaccurate. The RF-3 alignment was performed using a precision level and an aluminum try-bar made from stock on site. The alignment performed following the June 13, 1992 occurrence was performed using a new, more accurate, laser alignment instrument that indicated the previous alignment was inaccurate.

CORRECTIVE ACTION

During RF-3, the "B" TDRFP low pressure valve operating cylinder assembly and torque arm assembly were disassembled and inspected. Several components exhibiting wear or damage were replaced. The unit was reassembled and aligned. The torque arm assembly was exercised manually to verify free movement prior to connecting it to the operating cylinder and the steam control valve.

Prior to returning the "B" TDRFP to service following RF-3, the "B" TDRFP control valve was stroked to ensure the operating cylinder was properly purged of air and the response was uniform and consistent with design.

Following the June 13, 1992 occurrence and determination of its cause, the "B" TDRFP actuating linkage was reworked and reassembled. The torque arm journals were machined and ground to a fine surface finish (16 RMS). New pillow block bearings were measured and machined to fit, and the high spots in the pillow block bores were removed. The pillow blocks were aligned using the laser alignment instrument.

Also following the June 13, 1992 occurrence, the "A" TDRFP was disassembled and inspected; problems similar to the "B" TDRFP were identified. The "A" TDRFP components were reworked and aligned similarly to the "B" TDRFP components.

The vendor manual will be revised to include clear instructions for performing maintenance activities on the feed pump turbine torque arm assembly. These instructions will address the following items as a minimum: dimensions and tolerances for pillow block bearings; method for verifying free movement of the torque arm; alignment of the torque arm; and lubrication of pillow block bearings and other bearings.

Maintenance procedures CPS 8211.03, and CPS 8211.05, "Reactor Feed Pump Turbine Maintenance," will be revised to include more detailed instructions for performing maintenance activities on the feed pump turbine torque arm assembly.

A preventive maintenance task will be initiated to perform periodic inspections of the torque arm assembly and to replace components as necessary.

Mechanical maintenance personnel will be trained on the lessons learned about bearing clearances and lubrication of graphite impregnated bearings.

Engineering will perform periodic monitoring of GETARS traces to compare relevant performance parameters of the "A" and "B" TDRFPs. A review of previous traces indicates that the "B" TDRFP appeared to be hesitating prior to the actual failure. Monitoring future traces is expected to provide timely identification of future TDRFP degradation. Results of the monitoring will also be used to determine future increases and decreases in the frequency of monitoring.

ANALYSIS OF EVENT

This event is reportable under the provisions of 10CFR50.73(a)(2)(iv) due to the automatic actuation of the Reactor Protection System [JC].

Assessment of the safety consequences and implications of this event indicates that this event was not nuclear safety significant. This event is bounded by the Loss of Feedwater Flow transient discussed in Chapter 15 of the Updated Safety Analysis Report. This event was within the design basis of the plant. The capability of the plant to perform its intended safety functions and achieve and maintain a safe shutdown was not affected by this event.

ADDITIONAL INFORMATION

The "B" TDRFP control valve that locked up during this event is part of the "B" reactor feed pump turbine, 1FW01KB. The turbine is a model DEV731, seven-stage dual inlet turbine manufactured by General Electric Co.

Illinois Power has not reported events similar to the event described in LER 92-002.

For further information regarding this event, contact O. Villarreal, System Engineer, at (217)935-8881, extension 3098.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

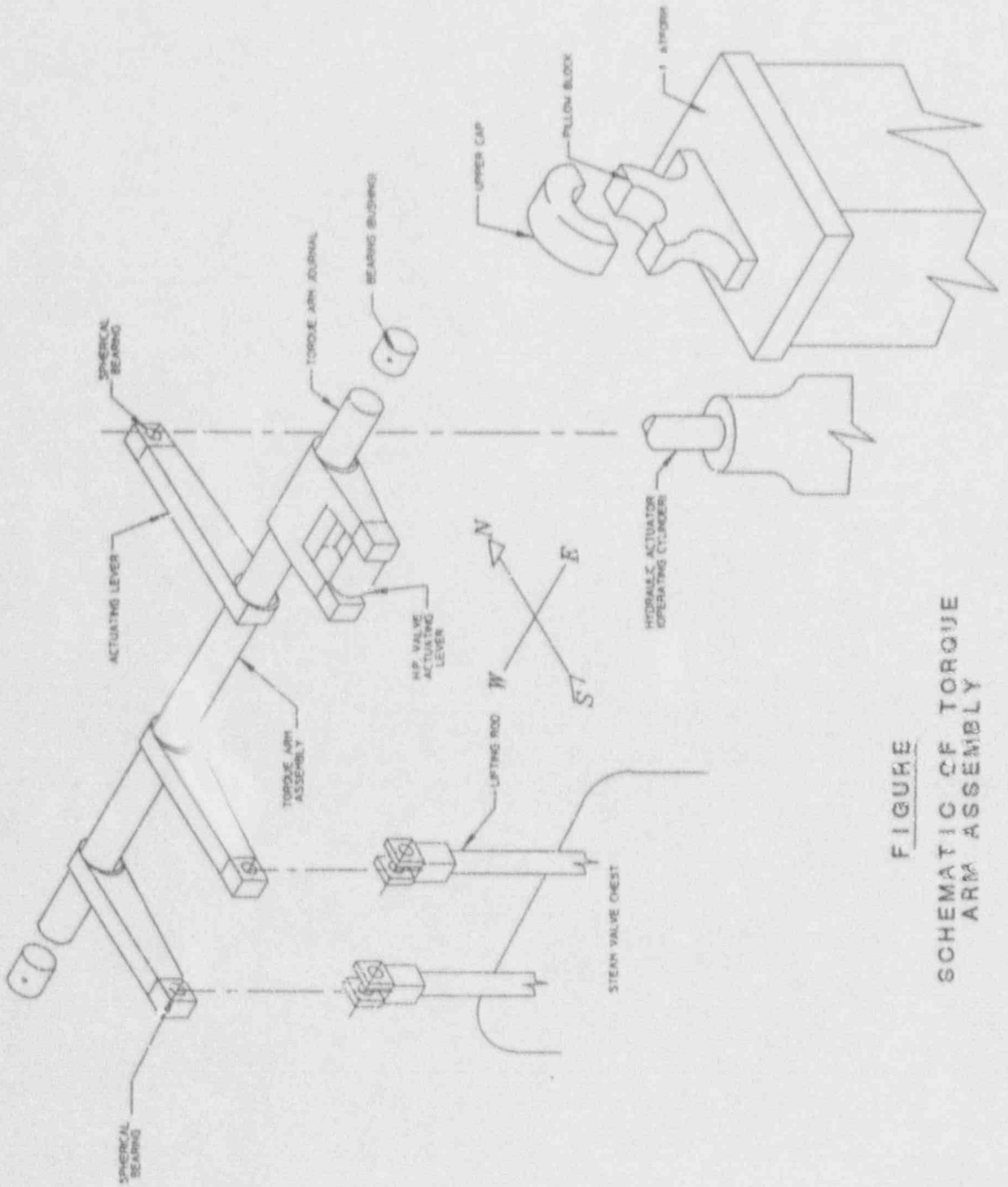

FIGURE
SCHEMATIC OF TORQUE ARM ASSEMBLY