U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report Nos. 50-334/89-10
50-412/89-11

Docket Nos. 50-334
50-412

License Nos. DPR-66
NPF-73

Licensee: Duquesne Light Company
P.O. Box 4
Shippingport, Pennsylvania 15077

Facility Name: Beaver Valley Power Station, Units 1 and 2

Inspection At: Shippingport, Pennsylvania

Inspection Conducted: May 15-19, 1989

Inspectors: Roy K. Mathew
Roy K. Mathew, Reactor Engineer — 6-28-89 date

Approved by: C. J. Anderson
C. J. Anderson, Chief, Plant Systems Section — 6/28/89 date

Inspection Summary: Inspection on May 15-19, 1989 (Inspection Report Numbers 50-334/89-10 and 50-412/89-11)

Areas Inspected: Special announced inspection to review the corrective actions that resulted from IE Bulletin 85-03 that addressed improper limit switch and torque switch settings in motor operated valves. This inspection reviewed the engineering and maintenance activities to assure the operational readiness of the motor operated valves.

Results: The licensee has adequately addressed all of the significant aspects of the bulletin except for the unresolved items addressed in Sections 4.2 and 4.3.

DETAILS

1.0 Persons Contacted

1.1 Duquesne Light Company (DLC)

B. Bacher, Licensing Engineer
*D. Butor, Principal Engineer, Maintenance, Unit 2
*E. Coholich, Senior Licensing Supervisor
*J. O. Crockett, General Manager, Corporate Nuclear Services
*J. DiPerna, Valve Consultant
D. L. Feigley, Foreman, Electrical Maintenance
*R. L. Hansen, Director of General Engineering
S. Hovanec, Senior Engineer, Maintenance, Unit 1
*J. R. Kasunick, Site Maintenance Director
*C. Kirschner, Supervisor, Quality Assurance
*F. Lipchick, Senior Licensing Supervisor
*T. P. Noonan, General Manager, Nuclear Operations
*M. Pettigrew, Senior Engineer, Nuclear - Engineering Division
J. Proven, Licensing Engineer
*B. Sepelak, Licensing Engineer

1.2 U.S. Nuclear Regulatory Commission (NRC)

*J. Beall, Senior Resident Inspector
*P. Wilson, Resident Inspector

*Denotes those present at the exit meeting.

2.0 Purpose

The purpose of this inspection was to review the licensee's actions taken in response to IE Bulletin 85-03, motor operated valve (MOV) common mode failures during plant transients due to improper switch settings and to review the licensee's program to assure the operational readiness of the motor operated valves covered under this bulletin.

3.0 Background

On June 9, 1985, the Davis-Besse Plant experienced a complete loss of main and auxiliary feedwater which was caused, in part, by MOV failures. This event resulted in IE Bulletin 85-03 that promulgated NRC requirements to assure the operational readiness of MOVs in the high pressure coolant injection/core spray and emergency feedwater systems. The bulletin specified that licensees take the following actions.

(a) Review and document the design basis for the operation of each valve, including the maximum differential pressure expected during the normal and abnormal operation.

(b) Using the above data, establish the correct switch settings for torque, torque bypass, position limit and overload for each valve and perform the modifications as needed.

(c) Individual valves should be demonstrated to be operable by testing the valve at the maximum differential pressure based on the performance requirements. In the absence of differential pressure testing, a justification should be provided.

(d) Prepare and revise procedures to ensure that correct switch settings are determined and maintained throughout the life of the plant.

(e) Submit a schedule to accomplish the above program including a final submittal with the results of (b) through (d).

Item (a) was reviewed by the NRC Office of Nuclear Reactor Regulation (NRR). The scope of this inspection was to review items (b) through (d).

4.0 Duquesne Light Company Response to IE Bulletin 85-03

4.1 Status of Commitments

In a letter dated May 16, 1986 (Ref: 1 Attachment 1), the licensee completed the Unit 1 documentation of the maximum differential pressure expected across MOVs during normal and abnormal operation. The licensee completed bulletin items b through d on December 31, 1987. The final report was completed on April 18, 1988. Request for additional information by NRR in a letter dated September 9, 1987, (Ref: 1 attachment 1) concerning the response to the IE Bulletin for units 1 and 2 were completed on September 25, 1987.

The licensee was a participant in the PWR owners group study to respond to the bulletin for Unit 2. The NRC granted the 90 day delay in a letter dated May 13, 1986 (Ref. 5 Attachment 1), to allow the licensee time to factor in the owners group recommendations. With a letter dated August 15, 1986 (Reference 6, Attachment 1), the licensee submitted the completed documentation of the maximum differential pressure expected across MOVs during normal and abnormal operation. The licensee's final response was completed by letters dated May 29, 1987 and July 31, 1987 (Ref. 7 and 8 of Attachment 1). The licensee actions required by the bulletin were within the two-year completion date of November 15, 1987 for Unit 2.

4.2 Switch Settings

Item (b) of the bulletin requires that the correct switch settings for torque, torque bypass, position limit and overload for each valve be established. These items are addressed below:

Open Torque Switch & Open Bypass Limit Switch

This switch is normally used to limit the mechanical thrust applied to the valve in the open direction. This switch is usually bypassed during the initial valve unseating which is the most challenging portion of the open stroke. Failure to set this switch to the required value or not bypassing this switch in the initial opening stroke, can prevent the valve from opening.

For Unit 1, the torque switch is bypassed for approximately 20% to 25% of the valve stroke past the unseating of the valve. This setting assures that the maximum operator "pull out" thrust is available to open a valve during the period when the maximum design basis differential pressure occurs across the valve. Then the MOV will "ride on" the torque switch until the open limit switch contact opens. The torque switch is set at the design thrust value plus 10 percent tolerance.

For Unit 2, the torque switch is bypassed for approximately 5% to 20% of the valve stroke past the unseating of the valve. During an accident condition, the torque switch would be bypassed to provide the maximum thrust to open the valve. The MOV will ride on the open limit switch until the limit switch contact opens.

As the valve is not backseated, the valve is not subjected to undue strain. The torque switch setting for both units is sufficient to prevent the actuation of the opening torque switch during design bases operations. The open torque switch setpoints and open bypass limit switch positions are verified by a MOVATS signature trace system.

Close Torque Switch/Close Torque Switch Bypass

The close torque switch bypass acts in the same manner as the open torque switch bypass. However the close bypass, contrary to the open torque switch bypass normally bypasses the torque switch during the lightest duty portion of the stroke, the beginning of the closing stroke. The use of this switch should be set to operate during the initial part of the stroke, to assure that valve closure is not prevented by the torque switch.

The Unit 1 & 2 close torque bypass switches are set such that at the starting of the motor, the torque switches are bypassed for approximately 5% of the stroke. For the remainder of the valve stroke, the torque switches are used in the control circuit during the normal operations for most of the valves.

However, in Unit 2, the torque switches are bypassed during accident conditions to assure full motor torque to close the valves. For Unit 2 type D valves, the close torque switches are jumpered to facilitate full closure of the valve in both normal and accident conditions.

The close torque switch is used to stop motor rotation on the completion of valve travel in the close direction. Since this switch provides a normal control function and is exercised on every closure stroke, this switch setting needs careful consideration. The limiting requirement of the close torque switch is at the end of the closure stroke when thrust requirements are the highest. The thrust at the point the torque switch trips should equal the most limiting closure thrust including the thrust needed to overcome the differential pressure across the valve. Differential pressure testing using process system pumps with appropriate data gathering and diagnostic evaluation provides a positive means of assuring the adequacy of the torque switch setpoint. Other approaches based on similarity and analysis may also be acceptable with sufficient bases. A further discussion of differential pressure testing is provided in Section 4.3.

For Units 1 and 2, the licensee set the torque switches to the required design thrust value plus 10% margin to account for instrument error and line losses. The thrust values are verified by the MOVAT system. The inspector reviewed the thrust values and torque settings in the MOVATS data sheet and found agreement with the design torque/thrust requirements.

Open Limit Switch/Close Limit Switch

The normal industry practice is to seat valves on action of the torque switch and to backseat valves on action of the electrical limit switch. The rationale for this approach is provide tight seating during closure and a positive stop of the operator during valve opening to prevent backseating. At Beaver Valley Unit 1, the licensee uses limit switch control to open valves and torque switch control to close valves. Unit 2 type C valves open on limit switch and closes on torque switch during normal operation. The Unit 2 torque switches are bypassed during accident conditions. Valve opening and closure are controlled by the limit switch set at almost 95% to 98% of the valve travel. Motor inertia is used to fully close or open the valve. For Unit 2 type D valves, the open limit and close limit switches are used to open and close these valves, respectively.

The open limit switch provides the control function for determining the upper limit of the valve stem travel in the open direction. Opening this switch stops motor rotation by opening the circuit. The setting of this switch must assure adequate valve opening and should

prevent backseating. Valve backseats are normally used to provide a seal that is redundant to valve packing. Using the motor power to backseat can and has caused valve stem shearing and stem thread twisting. Therefore, it is important to set the open limit switch away from the backseat with adequate margin to allow for motor deenergization and inertia. The licensee set the open limit switch such that the valve does not backseat by inertia. This was verified by the MOVATS current trace. No problem was identified with this arrangement.

The close limit switch is usually used with the close torque switch in series for over-torque protection. For high speed operators, where torque switches cannot react in sufficient time, the close limit switch deenergizes the motor. The remaining inertia forces seat the valve.

Beaver Valley Unit 1 does not utilize the close limit switch to deenergize motors for valves covered under this bulletin. Unit 2 type C valves use the close limit switch in parallel with the close torque switch (when bypassed) during an accident condition to close the valve. For the type D valve, the close limit switch is used to deenergize the motor during the closing stroke for normal and accident conditions.

The inspector raised the following concern about Unit 2 valves that are closed under limit switch control. The concern regards the determination of the influence of seat wear on valve seating. During a valve closing sequence, the motor gets a signal to shut-off the limit switch at a specified point during the closing stroke based on the limit switch setpoint. If the valve seat suffers erosion or other wear, the inertia force available after the motor shuts off may not be sufficient to adequately seat the valve. Subsequent to the inspection, the licensee explained that the valves in question are either tested for leakage under the IST program or the valves are boundary valves where the upstream valves are tested under the IST program.

Open/Close Indication

A red light provides a valve open signal. This light is taken from the close rotor limit switch which is set to actuate close to the end of valve closure. A green light provides a valve closed signal and is taken from the open rotor limit switch actuation. The green light will turn off when the MOV is in the full open position, and the red light will turn off when the MOV is in the full closed position. When both lights are on, the valve is in an intermediate position.

Beaver Valley Unit 2 MOV's have four rotors and therefore have indication lights from two different rotors. This allows

independent adjustment of the two rotors and can be set very close to the actual full open and closed status. For two rotor MOV configurations at Unit 1, this is not practical due to the torque switch bypass function needed from the same rotor. For two rotor MOV configurations, changes in limit switch settings can influence MOV stroke time testing as well as valve position dependent interlocks and permissives.

In Unit 1 most of the torque bypass switch and indicating lights are from different rotors except for valves MOV-1FW-151A to F which utilize a two rotor MOV configuration. Any adjustment to the bypass switch for these valves will affect indication. The licensee is performing a modification, DCP No. 1296 during the 7R refueling outage to utilize different rotors for these valves for the red indicating lamp and for 'open' torque switch bypass. This will eliminate the potential for these MOV indicating closed when they may actually be partially (5 to 10%) open.

Thermal Overload Relay

Thermal overload relays are used to protect motor winding insulation from breakdown during overload conditions. Devices used consist of heaters at the motor control center which trip a heat sensitive relay, the contacts of which either interrupt current to the contactor closure or open the coil (which stops the motor) or initiates an overload alarm, or both. Where thermal overload relays stop operator motor rotation on tripping, the heaters must either be sized to prevent inadvertently stopping the motor or the overload relays must be bypassed when motor operation is important to safety. The heaters should also be sized to protect the motor windings from thermal damage. Regulatory Guide 1.106 and limitorque Bulletin LM-77 thermal overload protection for electric motors on motor operated valves provides guidelines on the design criteria for thermal overloads.

Designs generally in use to eliminate inadvertent motor trips include: (1) removing the heaters or relay contacts from use; (2) using the relay contacts for alarm only; (3) bypassing the relay contacts during all operating modes except when a valve is being exercised for testing; (4) bypassing the relay contacts only during the presence of an automatic safety actuation signal; and, (5) oversizing the thermal overloads.

The Beaver Valley Unit 1 design utilizes thermal overload relays during normal and accident operation. For Unit 2, thermal overload relays are bypassed during accident conditions to perform a safety function.

Licensee documents specify that overload protection shall be selected for 120% - 130% of the motor full load current rating. The licensee stated that in the existing thermal overload sizing design, they did not consider locked rotor conditions of the motor. For Unit 1, if the thermal overload relays utilized are undersized, they would result in premature tripping of the motor before the required torque develops to support the operation of the MOV. No thermal overload relay sizing calculations were available for review during the time of the inspection. This is an unresolved item pending NRC review of the licensee action to assure the adequacy of the thermal overload relay settings for Unit 1. (50-334/89-10-02)

During the field walkdown, the inspector verified that the thermal overload relays installed in the plant agreed with the licensee's documents. No discrepancies were noticed.

The inspector noted that the existing design of Unit 1 MOV control circuitry is such that, control room indication is not provided to identify tripped overload relays. The licensee stated they will review the indication circuitry to determine the need for control room indication of tripped overload relays.

4.3 Demonstration of Operability

This involves demonstrating the valve to be operable by testing the valve under maximum differential pressure after changing the individual valve settings as appropriate based on the design bases. In the absence of testing with full differential pressure across the valve, a justification is to be provided. The use of a MOVATS data base to set the torque switches for a particular type of valve is considered an acceptable approach to eliminate the need for differential pressure testing, provided this type of valve has a sufficient test data base to establish similarity. However, a suitable test is needed to establish that the desired force is available at the valve seat for closure.

DLC utilized manufacturer testing supplemented by MOVATS static testing for demonstrating the operability of the Unit 1 valves. They have followed the following acceptance criteria for the operability of IEB 85-03 MOVs.

1. MOVATS verified "as left" thrust levels are within or exceed the maximum differential pressure calculated thrust range.

2. MOVATS verified "as left" thrust levels exceed the MOVATS thrust data base level.

3. The valves are normally closed and can be opened with the maximum available operator pull out thrust verified by the torque switch bypass limit settings, set and confirmed by MOVATS test data.

The inspector noted that the as left thrust values are within or exceed the calculated maximum differential pressure seating thrust except for MOV-CH-310. The anomaly for MOV-CH-310 was due a to low torque limitorque plate setting of 2.0 suggested by the manufacturer. The correct limiter setting was subsequently verified as 3.0. The licensee has scheduled to reset the torque switch to the required thrust range during the 7R refueling outage. The licensee's justification for continued operation of this valve was confirmed by the last SI actuation signal during the past BVPS #1 operation. The valve received an automatic signal to close during an SI actuation and closed in the safety direction.

Unit 1 MOV's CH-289, CH-115C, E and CH-373 are set at thrust levels within or exceeding the calculated thrust range, but below the MOVATS data base thrust range. These valves are normally open and their safety function is to close. Motor Operated Valves require more thrust during the closure cycle especially when subjected to maximum differential pressure across the valve. The licensee is planning to review the torque set points for these valves (including valve CH-310) in accordance with the MOVATS database closing thrust levels to provide additional confidence for MOV operation.

For BVPS-2, the licensee had tested all Bulletin related valves to the maximum differential pressure conditions to the extent practical during the preoperational and functional testing. However, no tests results were available for review during the inspection. All Bulletin valves except valves 2CHSLCV115, B, C, D, and E were tested at 94%-95% of design differential pressure. Valves 2CHSLCV115B, C, D and E were tested at 10% of the design differential pressure. The licensee tested all of these valves using MOVATS equipment and established that the 'as left' thrust is more than the desired target thrust. The licensee has not provided any justification for the valves that were tested below the maximum differential pressure. This justification should include the alternative to maximum differential pressure testing which will be used to verify the correct settings for the operability of the MOVS. During the Unit 2 differential pressure test, no MOVATS equipment was used to establish the thrust levels for seating and unseating valves. The licensee also has not shown the actual torque and thrust values the motor and the actuator is designed to develop.

This is an unresolved item pending NRC review of the licensee action to set the torque switches for the above Unit 1 valves to meet the MOVAT data base thrust level and to give sufficient justification for Unit 2 MOVS to operate under maximum differential pressure conditions. (50-334/89-10-01; 50-412/89-11-01).

4.4 Maintenance and Procedures

The bulletin requires that licensees prepare or revise procedures to ensure that correct switch settings are maintained throughout the life of the plant and also to ensure that applicable industry recommendations are considered in the preparation of the procedure.

The inspector reviewed the procedures and documents listed in Attachment 2. The licensee had revised these procedures for maintaining the limit and torque switch settings. The procedures specified the acceptable lubrication type, quality and quantity of grease for stem lubrication, main gear assembly and limit switch assembly lubrication. The references in the procedure addressed IE notices, service information letter, IE bulletins, INPO SOERS. The procedures contained sufficient details, with illustrations to perform the job.

A walkdown was conducted to assess MOV maintenance effectiveness and to verify the torque and the limit switch settings. As Unit 1 was operating at full power and Unit 2 was at Mode 3 operation after refueling; access to these valves was limited. However, the Limitorque compartments and grease levels were checked in Unit 1 valves MOV FW-151A, C and E and Unit 2 Valves 2CHS* MOV275B and C. The inspector verified the grease adequacy in the main gear case, limit switch gear and valve stems. These were found to be sufficiently lubricated. The inspector also observed that there were no signs of moisture or rust inside operator housings and the limit switch and torque switch contacts were free of corrosion, oxidation and pitting. The licensee technicians and the staff were knowledgeable in the operation and maintenance of the valves. No discrepancies were identified.

During the walkdown of the valves in Unit 1, the torque settings for valve MOV-FW-151A was verified as 1 3/4/1.5 instead of 1.0/1.0 as shown on the MOVATS test data sheet and maintenance manual set point procedure. However, the settings were in the conservative direction. The existing "as left" thrust value is above the MOVATS data base level.

No discrepancies were noted between the calculated target thrust value and the as left thrust value shown on the MOVATS test data sheet. The licensee set the torque switches according to the thrust values using the MOVATS system. The torque set readings serve as a

secondary source of information to maintain the proper thrust values. The licensee is planning to determine the cause of the one anomaly noted above. Subsequent discussions with the licensee concluded that the error was caused by an individual who recorded the torque switch readings onto the data sheet. The licensee reviewed other MOVATS data sheets and confirmed that this an isolated case. No deficiencies were identified in Unit 2.

During the procedure review, the inspector noted that maintenance procedure BVPS 1/2 maintenance manual, section 14, attachment E and F documents the set points utilized during the performance of the MOVATS. Units 1 and 2 torque values shown in the manual did not match the MOVATS test data sheet. The licensee stated that the procedure (Attachment E and F of maintenance manual) is updated quarterly and the next revision will correct all of the discrepancies. Subsequent discussions confirmed that the Unit 1 set points were revised and the Unit 2 setpoints are to be completed within 2 weeks. The update is done by a computer program tracking system. The licensee is also in process of transferring all the data into the MEL data base. The inspector noted that in accordance with the existing procedure, the maintenance department has to clarify the set points through engineering memorandums until the MEL data base update is completed. The inspector also observed that the MOVATS test data is recorded on data sheet as well as stored on MOVATS software bubble memory per procedure 1/2-75-MOVATS-IE.

The inspector had no further questions.

Maintenance department personnel have attended the in-house training program consisting of operation, disassembly and assembly of MOVS, torque switch and limit switch settings and hands on training. In addition to the on the job training, responsible maintenance staff were trained by the MOVATS staff to use the signature tracing techniques by MOVATS system. During the inspection, the licensee presented a demonstration of the MOVATS system using a sample valve. The inspector noted that the maintenance staff were knowledgeable in the use of the MOVATS system.

The inspector reviewed the MOVATS test data, maintenance work requests, LER's and NPRDS records and confirmed that there were no MOV failures during the last two years.

5.0 Licensee Program for Switch Settings

The inspector reviewed the licensee's program to establish the correct switch settings for motor operated valves covered under the bulletin. The licensee utilized the MOVATS system to develop and set torque and limit switches. The licensee uses the limit switch to open and the torque switch to close MOV's in Unit 1. The overloads relays are used in Unit 1 during normal and accident operations. For Unit 2, the licensee uses both

the limit switches and torque switches to open and close the valves. Also, in Unit 2 overload relays and torque switches are bypassed during the accident operation of the valves.

The engineering and maintenance groups are well trained and are capable of addressing MOV concerns. Based on a review of NPRDS failure data, Beaver Valley Units 1 and 2 did not have any MOV failures in last two years. However, the licensee has not established the adequacy of thermal overload relays for Unit 1. The differential pressure testing for Unit 1 and 2 were not performed to the full satisfaction of the bulletin requirements.

Based on the review of the licensee activities, it was concluded that there is reasonable assurance that the valves covered under the bulletin can perform their safety function during normal and abnormal operation.

6.0 Unresolved Items

Unresolved items are matters for which more information is required in order to ascertain whether they are acceptable, violations, or deviations. Two unresolved items are discussed in sections 4.2 and 4.3 of this report.

7.0 Exit Interview

At the conclusion of the inspection on May 19, 1989, the inspector met with the licensee representatives, denoted in section 1.0. The inspector summarized the scope and findings of the inspection at that time.

IEB 85-03 REFERENCE DOCUMENTS

ATTACHMENT 1

1. Licensee letter from J. J. Carey to USNRC Region I to the attention of Thomas E. Murley dated May 16, 1986

2. NRC letter from W. F. Kane to the attention of J. J. Carey, DLC dated September 9, 1987.

3. Licensee letter from J. D. Sieber to USNRC to the attention of document control desk dated September 25, 1987

4. Licensee letter from J. D. Sieber to USNRC to the attention of document control desk dated April 18, 1988.

5. Licensee letter from J. J. Carey to USNRC Region I to the attention of Thomas E. Murley dated May 13, 1986

6. Licensee letter from J. J. Carey to USNRC Region I to the attention of Thomas E. Murley dated August 15, 1986.

7. Licensee letter from J. J. Carey to USNRC Region I to the attention of W. T. Russell dated May 29, 1987.

8. Licensee letter from J. J. Carey to USNRC Region I to the attention of W. T. Russell dated July 31, 1987.

BV 1&2 MOTOR OPERATED VALVE
MAINTENANCE PROCEDURES AND DOCUMENTS REVIEWED

ATTACHMENT 2

PMP No. 1-75-MOV-IE, Revison 0 - Environmentally qualified MOV - motor operator inspection.

CMP No. 1/2 CMP-75-Limit Switch-1E, Revision 0 - Limitorque geared limit switch installation and maintenance.

Site Administrative Procedures Chapter 3D, Revision 5 - The maintenance work request.

MAP #2BV067, Revision 6 - EQ Maintenance Assessment.

CMP No. 1/2-75-MOV Overhaul-1E, Revision 1 - Limitorque motor operator SB/SBD/SMB 0 through 4 overhaul.

CMP No. 1/2-75-MOV-1E, Revision 0 - Limitorque motor operator removal and installation.

CMP No. 1/2-75-MOV Overhaul-6E, Revision 0 - Limitorque motor operator type SB/SBD/SMB-00 overhaul.

CMP No. 1/2-75-MOV Overhaul-5E, Revision 0 - Limitorque motor operator type SB/SBD/SMB-000 overhaul.

CMP No. 1/2-75-Torque Switch-1E, Revision 2 - installation on and maintenance of torque switch in Limitorque operators.

PMP No. 2-75-MOV-2E, Revision 6 - Limitorque MOV maintenance.

CMP No. 1/2-75-MOVATS-1E, Revision 1, - Testing of motor operated valves using MOVATS.

BVPS 1/2 Maintenance Manual, Section 14, Revision 0 - Conduct of Maintenance.

EM-No. 62144 - Nuclear Engineering Memorandum.

DCP No. 1296 - Add two limit switch rotors to MOV-1FW-151A to F.

Drawing No. 8700-RE-21HF, Revision 7 - Elementary diagram, feedwater sheet 7 of 7.

Drawing No. 8700-RE-21KM, Revision 5 - Elementary diagram, safety injection (SI).

Drawing No. 12241-E-6JG Revision 11 - Elementary diagram - 480VMCC circuits, charging pump minimum flow line isolation valves.

Drawing No. 12241-E-6JK, Revision 15, Sht 1 - Elementary diagram - 480VMCC circuits charging pump suction valves.

Drawing No. 12241-E-6JL, Revision 17 - Elementary diagram - 480V MCC circuits, charging system valves.

Drawing No. 12241-E-JG, Revision 11 - Elementary diagram - 480V MCC circuits, charging pump minimum flow line isolation valves.

Drawing No. 12241-E-6HT, Revision 10 - Elementary diagram - 480V MCC circuits, Boron injection isolation valves.

12241-6QN Sht 1, Revision 12 - Elementary diagram - 480V MCC circuit, alternate mini flow isolation valves.

12241-E-6HS, Revision 11 - Elementary diagram - 480V MCC circuit, boron injection isolation valves.

11700-ESK-132-FA, MCC 480V device settings.

DCP 714 - MOV Limitorque sizing Calc #8700-631.

25.06300-001-004D - Westinghouse - EMD motor instrument manual gate and check valve.