07-200-01

NINE MILE POINT NUCLEAR STATION UNIT #2

OPERATING PROCEDURE

PROCEDURE NO. N2-OP-96

REACTOR MANUAL CONTROL AND ROD POSITION INDICATION SYSTEM

APPROVALS	SIGNATURES	DATE AND INITIALS REVISION 0	REVISION 1	REVISION 2
Superintendent Operations NMP Unit #2 M.D. Jones	M.D. Jones	6/3/86	8/7/86	8/18/86
Station Superintendent NMP Unit #2 R.B. Abbott	R.B. Abbott	6/6/86 RBA	8/8/86 RBA	8/18/86 RBA
General Superintendent Nuclear Generation T.J. Perkins	T.J. Perkins	6/6/86 TJP	8/8/86 TJP	8/18/86 TJP

FOR INFORMATION ONLY

Summary of Pages (Cont'd on Cover Sheet 2)

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This procedure supersedes N2-IOP-96, Rev. 1

NIAGARA MOHAWK POWER CORPORATION

THIS PROCEDURE NOT TO BE USED
AFTER AUGUST, 1992
SUBJECT TO PERIODIC REVIEW.

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OPERATING PROCEDURE

PROCEDURE NO. N2-OP-96

REACTOR MANUAL CONTROL AND ROD POSITION INDICATION SYSTEM

Cover Sheet Continuation (Page 2)

Summary of Pages (Cont'd)

Page	Date
26	May 1987 (TCN-3)
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REACTOR MANUAL CONTROL AND ROD POSITION INDICATION SYSTEM

A. TECHNICAL SPECIFICATIONS

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Control Rod Position Indication	Section 3/4.1.3.7
Control Rod Block Instrumentation	Section 3/4.3.6

B. SYSTEM DESCRIPTION

1.0 The Reactor Manual Control System (RMCS) is composed of four subsystems which allow the operator to select and move control rods as needed for efficient fuel management, and to control core power and flux distribution.

The Rod Drive Control System (RDCS) accomplishes all control rod movements except for a scram. The RDCS monitors a variety of conditions pertaining to the control rods and gives individual indications and summaries of those conditions. The RDCS receives inputs from various plant systems and will prevent rod withdrawals by enforcing rod blocks if selected plant parameters exceed their trip setpoints. See Table IV for a list of rod blocks.

The Rod Position Indication System (RPIS) provides information on the vertical position and temperature of the control rod drives.

Two other rod control subsystems, the Rod Worth Minimizer (RWM) and the Rod Sequence Control System (RSCS) function to limit control rod worths to minimize the effect of a control rod accident or rod withdrawal errors by enforcing adherence to specified control rod patterns through the use of control rod blocks. The operation of these systems is covered by N2-OP-95A (RWM) and N2-OP-95B (RSCS).

2.0 Rod Drive Control System (RDCS)

The RDCS consists of the controls indicators and circuitry necessary for normal insertion and withdrawal of control rods, one at a time. This system includes interlocks to prevent normal rod motion when rod block signals are present. The RDCS will not cause or prevent a scram, which is controlled by the Reactor Protection System (N2-OP-97).

The RDCS operates in three modes: 1) The operator control mode, 2) The scan mode, and 3) The self test mode. The Operator Control mode is used to move control rods. The Scan mode is used to gather status data for a rod. The Self Test mode is used to test the functions of the transponder cards and the related command circuitry. The system spends approximately 100 microseconds in a mode, and alternates between the Operator Control mode and the Scan mode until the status data is gathered for all rods. Each time the scan mode is entered, a different rod is scanned according to a prescribed sequence. When all rods have been scanned, the Self Test mode will replace the Scan mode for one alternation to test one transponder card. Each time the system enters the Self Test mode, the next rod in the sequence is scanned so that the circuitry for all rods is tested.

The RDCS is comprised of the following major components:

a. Rod Select Module (RSM)
b. Rod Drive Control Cabinet (RDCC)
c. Branch Junction Modules (BJMs)
d. HCU Transponders
e. Display Memory Module (DMM)
f. Rod and Detector Display (R&DD)

Rod Select Module. The Rod Select Module is located in the sloping portion of the Operator's console on panel P603. It contains a push button array for selecting: *

a. the control rod to be moved
b. stabilizer valve set (A or B)
c. Drift control (Test, Reset)
d. Rod movement commands
e. Accumulator Trouble Acknowledge

It also contains two identical transmitter cards, that independently sense which buttons have been pressed by the operator. The transmitter cards then generate duplicate binary REQUEST words which are transmitted to the activity control cards in the Rod Drive Control Cabinet. The RSM also receives inputs from the Rod Sequence Control System and the Rod Worth Minimizer.

Rod Drive Control Cabinet. The Rod Drive Control Cabinet is the heart of the system, and is located in panel P616. It contains four major sections. At the top of the cabinet are two identical Activity Control sections. Below this is an Analyzer section, and the Power Supply Section is in the bottom of the cabinet.

The two Activity Control sections are identical and independent. Each section consists of an Input Isolator card, an Activity Control card, and a Rod Motion Timer Card. Each Activity Control section receives a REQUEST word from the Rod Select Module. The REQUEST word, inputs from the rest of the system, plus the rod block signals from other systems enter the Activity Control section through the Input Isolator card, which electrically isolates the signals coming from outside the cabinet. The main function of the Activity Control Card is to monitor the status of the plant to determine if rod motion requested by the operator is permissible. If the request for rod movement is permitted (i.e.; no Rod Blocks), the Activity Control Cards each generate a COMMAND word and initiates operation of the respective Rod Motion Timer card. The Rod Motion Timer cards produce a 10 second timing signal to move a control rod one notch.

The Analyzer section contains an Analyzer card, a Fault Map card, and isolator cards. The Analyzer section is designed to detect errors in control signals that may occur due to electrical noise, equipment faults, etc.; and to prevent inadvertent rod motion due to these errors. The Analyzer section compares the COMMAND words from the Activity Control Sections for equivalency. If they are the same, one of the COMMAND words is transmitted to the transponders through the Branch Junction Modules, and the other is retained in the Analyzer as the REFERENCE word. The REFERENCE word is compared to the ACKNOWLEDGE word (returned to the cabinet from the Transponder of the selected rod) for errors. If a sufficient number of errors occur, the location of the fault (the BJM or the Transponder) will be indicated on the Fault Map card and system operation will be interrupted. The Analyzer section includes a number of controls and display registers which are used to verify proper system operation and to assist I&C personnel in troubleshooting the system. The Display registers hold all of the data available at the time the decision was made to stop system operation.

The Fault Map card contains an array of LEDs laid out in a mimic of the core, and is used to indicate faults with the Transponders. The Fault Map card also contains counters that are used to control the Scan mode and the Self Test mode.

The power section of the RDCC contains the main circuit breakers for the system, the Power Gate and the Contact Power Supply. The Power Gate consists of two large silicon-controlled rectifiers (SCRs) and controls the 120 VAC power to the transponders. If the Analyzer section encounters a problem in the system, it interrupts the control signal to the SCRs, turning them off. This will disconnect all power to the HCUs and will prevent a failure in the system from causing inadvertent rod motion. The Contact Power supply furnishes power to all external contacts for the system.

Branch Junction Module. The Branch Junction Module is a enclosure mounted at the end of a cluster of HCUs. A BJM serves as a termination point for cables from the control room, adjoining BJMs, and for the Transponders on it's group of HCUs. The BJM receives the COMMAND word, amplifies and shapes the signal, and transmits it to it's associated cluster of transponders, and to the downstream BJM (if applicable). It also receives the ACKNOWLEDGE words from transponders within it's cluster and downstream BJMs, and transmits it upstream to the next BJM or the RDCC.

Transponder. The Transponders compare the rod address within the COMMAND word (transmitted from the RDCC) to their own. The Transponder that matches (i.e.; that rod has been selected for movement), will process the COMMAND sequence generated by the RDCC. The selected Transponder immediately returns an ACKNOWLEDGE word back to the Analyzer Card in the RDCC. The ACKNOWLEDGE word includes information on the present status of: the solenoid valves, scram valve position, accumulator pressure and liquid level, and the scram test switches. The selected Transponder continues to process the COMMAND work to open and close the Directional control Valves in the specified sequence to move the control rod. The Transponders also provide amplification to signals being passed through it to and from other Transponders.

Display Memory Module (DMM). The Display Memory Module receives information from the RPIS and RDCS, stores the information from the RPIS and the RDCS, stores the information in it's memory, and prepares the information for display on the Rod and Detector Display (R&DD) and the Four Rod display.

Rod and Detector Display (R&DD). The Rod and Detector Display, or "full core display", is mounted in the vertical section on panel P603. It is an array of back-lit indicator elements arranged in a mimic of the core. Six parameters are displayed for every control rod:

FULL IN: Lit when the rod is fully inserted.
FULL OUT: Lit when the rod is fully withdrawn.
DRIFT: Lit if the rod is moving and should not be.
SELECTED: Specific rod's push button is lit when the rod is selected on the RSM. *
ACCUM: Lit if the accumulator pressure or water level is abnormal in the HCU.
SCRAM: Lit if both scram valves on the HCU have opened.

The display also provides indication of Upscale and Downscale alarms for the LPRMs in each location (from the Neutron Monitoring System).

In addition to information given by the full core display, the 4-rod display presents the vertical position of a selected rod and the other rods in it's group, and LPRM readings for the LPRMs located next to the group. The rod positions displayed will be in the form of a two-digit number with an illuminated background. Even notch positions are indicated by numbers and Odd notch positions are indicated by dashes. If RPIS is receiving abnormal data (e.g.; a reed switch stuck open), it will be indicated by a double X in the display. If the selected group has less than four rods, the display window(s) will be blank for the locations that do not have rods.

Operator Control Mode. In the operator control mode, the operator initiates movement of a control rod by momentarily depressing the rod select push button on the RSM to select the rod to be moved. Then the operator pushes the INSERT or WITHDRAW push button as desired. If there are no rod blocks present, the RDCC initiates the sequence to move the rod in the desired direction. *

To insert the selected rod, the RDCC sends a signal to the selected rod's HCU to open the insert supply and exhaust valves to drive the rod inward. After about 3 seconds, during which the rod moves in slightly more than one notch (6 inches), the insert valves close, and the settle valve opens for about 5 seconds to allow the rod to settle back down to the next notch position. Depressing the INSERT push button continuously causes a continuous insertion of the selected control rod. A control rod can also be continuously inserted by depressing and holding the continuous insert push button. This bypasses the rod motion timer cycle and the rod settle feature does not operate in this mode. *

To withdraw the selected rod, the RDCC sends a signal to the selected rod's HCU to open the insert supply and exhaust valves for 0.6 seconds to insert the rod far enough to free the collet fingers from the detent and hold them open. After the insert valves shut, the withdraw valves open to drive the rod out. The withdraw supply valve closes after 1.5 seconds and the withdraw exhaust (settle) valve remains open for an additional 6 seconds to allow the rod to "settle" down to the next notch. Continuous withdrawal of a control rod is achieved by simultaneously depressing the CONTINUOUS WITHDRAW and the WITHDRAW push buttons. The dual push button requirement prevents an inadvertent continuous withdrawal of control rods. During a startup RSCS imposes the following restrictions: 1) continuous rod withdrawal is allowed for notches 00-48 up to a 75% rod density; 2) between 75% rod density and the Low Power Set Point (LPSP) continuous rod withdrawal is not only allowed between notches 12 to 48. The RMCS does not impose any restricts above the LPSP. *

Scan Mode. In the scan mode, the Analyzer card initiates commands to gather status data from a single HCU. Accumulator pressure and water level, scram valve position, and scram test switch position are checked. The Fault Map card generates a rod I.D. and sends it via the Analyzer card to each of the Activity Control cards. Each Activity Control card forms a COMMAND word (although in this case, no rod motion is called for) which is transmitted in the same manner as in the Operator Control mode. The selected Transponder transmits the HCU status data back to the RDCC. The system does not verify correctness of the reply because the ability of the Transponders to reply correctly is checked in the Self Test mode and, besides there is no reference available for the status data. At the next alternation with the Operator Control mode, a counter advances and causes the Fault Map card to generate the next rod I.D., which is processed as above. | *

Self Test Mode. This mode is used for diagnosis and evaluation. As in the Scan Mode, the Fault Map card generates the rod I.D., but this time it also generates a specific valve control signal determined by a built-in program in the Analyzer. It sends this information to each Activity Control, where a COMMAND word is formed and processed exactly as in the other modes. The Analyzer program briefly exercises the valve driver circuit on the HCU; not long enough for mechanical valve motion, but long enough to verify electrical operation by means of a drive monitoring circuit located on the Transponder. The ACKNOWLEDGE word returned to the Analyzer is checked for correct response; both that the correct Transponder replies as indicated by the I.D. and that the valve driver circuit response is correct. In the Self Test evaluation, a comparison failure of more than a prescribed number of words results in an automatic shutdown of the RDCS and a ROD DRIVE CONTROL SYSTEM INOPERABLE (603303) annunciator.

Interlocks. The Reactor Manual Control System (RMCS) inhibits movement or selection of control rods under various conditions. The rod blocks caused by inputs from other systems are listed in Table IV.

Rod select blocks are initiated by the RDCC to prevent the selection of a control rod under the following conditions.

a. A control rod has already been selected for movement and the movement cycle is not complete.

b. The rod selected key-lock switch on the Rod Select Module is not rotated fully clockwise.

c. One rod is selected and withdrawn while in the Refuel mode.

RMCS system failures (i.e.; disagreement between the Activity Control sections, or an error detected by the Analyzer section) and performance of manual testing will impose rod blocks.

The following is a brief summary of the rod blocks imposed by the Rod Worth Minimizer (RWM) and the Rod Sequence Control System (RSCS). For more information, refer to the respective operating procedure (N2-OP-95 A&B).

the Rod Worth Minimizer (RWM) applies rod block and permissive signals to the RDCS which generate the rod block or permissive output signals. Rod blocks are applied when the RWM permissive requirements are not met and power is below the LPSP. A control rod in a group is in the permissive state when there are two or less insert errors and no withdraw errors.

Another RWM system interlock involves the Rod Test sequence. The Rod Test mode may only be entered if no more than one control rod is withdrawn from the fully inserted position. If a rod is being tested and is in any position other than notch 00, a rod withdrawal block will be initiated if a second rod is selected on the RSM. If more than one rod is withdrawn beyond the 00 position, and the Rod Test push button is depressed, both insert and withdraw blocks are immediately applied. The Rod Test push button must be depressed a second time to return the system to normal. |*

Once power is raised above the LPSP, no rod blocks are applied, but alarm indications and insert error displays are still provided. At power levels above the Low Power Alarm Point (LPAP), the monitoring functions of the RWM are automatically bypassed. System hardware failures will initiate rod blocks at any power level. Whenever a RWM program abort occurs, the RWM is automatically taken off-line, withdraw and insert blocks are applied, and the RWM must be reinitialized before the program can be executed again.

RSCS will cause rod blocks for the following special conditions:

a. If substitute position data has already been entered from the RSCS operator panel, that rod is moved another notch, and the position data for the new position is also bad, then rod motion insert and withdraw blocks are inserted. This block can be bypassed for the <u>insert</u> direction only to the last good position by using the bypass switch in the Bypass File card.

b. From the 75% rod density to the LPSP, only notch movement is allowed between notches 00 and 12.

c. Rod blocks are used to enforce bank withdrawal and insertion limits.

3.0 Rod Position Indication System (RPIS)

The RPIS continuously monitors the vertical position and temperature of the control rod drives. The position information is transmitted to the Rod Drive Control System (RDCC) for display on the Rod and Detector Display (R&DD) and the 4-Rod Display, and to the process computer.

A thermocouple is attached to each control rod drive. The thermocouple sends a temperature signal to a chart recorder on panel 2CES*RAK007 (Rx Bldg. elev. 261', North) and energizes an annunciator on panel P603 if a high temperature condition is sensed.

The Position Indication Probes are the primary source of information for the system. Each control rod drive contains a Position Indicator Probe, which contains 53 reed switches connected in an eleven wire array. A closed reed switch will connect two of the eleven wires together and provides a unique output corresponding to the position of the rod. The drive piston in the CRD contains a magnet that closes the reed switch located nearest to the magnet. Forty-nine (49) switches are used to detect the position of the control rod. They are spaced at 3 inch intervals and are numbered from notch (position) 00 to 48. Notch 00 indicates that the rod is fully inserted into the core and notch 48 indicates that the rod is fully withdrawn. The even numbered switches correspond to the latch positions of the drive. The odd numbered switches correspond to intermediate positions between the notches on the drive. A second switch is located at the same location as the 00 position and is used to light the green FULL-IN indication on the full core display (R&DD). Another switch is located 1 1/4 inches further in than the notch 00 switch and keeps the green FULL-IN light energized when the rod is driven in past position 00 (e.g.; during a scram). Another switch is located at the same location as the notch 48 switch and is used to light the red FULL-OUT indication on the full core display. The last switch is located two inches further out than notch 48 and is used to detect an uncoupled rod. During normal rod motion, the rod is prevented from traveling past notch 48 by the control rod backseating on the stub tube. However, if the control rod drive is uncoupled from the blade, the drive is free to move out past notch 48 and will close the "overtravel" reed switch. This switch is used to initiate an annunciator or panel P603.

All of the wires from the probes terminate in the Rod Position Indication Cabinet (RPIC) located in panel P615 in the control room. The RPIC is the heart of the RPIS. It contains three modules, a Control module and two Multiplex modules. The Control module contains all of the electronics for controlling the system.

There are no operator controls or displays directly associated with the RPIS. RPIS supplies the information to the Display Memory Module, which drives the Rod and Detector Display and the 4-Rod Display.

Typical signal flow through the system is as follows: A counter in the RPI Cabinet advances automatically through all of the rod addresses. A multiplexed word, the IDENT word, is distributed to all of the Probe Multiplexer (MUX) cards in the system. These cards (each of which services a 4 rod group) compare the address contained in the IDENT word with their identity as defined by their Row and Column IDENT cards.

The card whose identity matches the address will respond with the position data from the corresponding control rod probe. This data is analyzed by the Probe Data Processor III Card in the RPIC.

The processor first determines if the data is acceptable. That is, the data must represent a realistic state for the control rod (e.g.; the rod cannot be in both positions 12 and 14 at the same time). If the data is not realistic, then some defect exists in the system.

If the data is acceptable, the processor will translate it from a pure binary format into a binary coded decimal format that is used to drive the position displays. This code and other data is appended to the IDENT code and transmitted to the Display Memory Module as the POSITION word. The position data is also loaded into a local memory which can be accessed by the plant computer. If the data is not acceptable, it is discarded and a fault code is generated. The fault code is transmitted instead, as part of the POSITION word.

After transmitting a POSITION word, the counter will advance to the next address and the process will be repeated. This cycle is repeated continuously, checking the status of all the rods. It takes about 40 milliseconds to cycle through all of the rods. The system does not stop if a fault is detected.

Operator inputs into the system are multiplexed into REQUEST words by the Rod Select Module in the RDCS. A REQUEST word is transmitted to the RPI Cabinet. From this word, the RPIC extracts:

The IDENT of the selected rod.
The Drift Test command (if applicable).
The Drift Reset request (if applicable).

One of the bits in the POSITION word is used to identify the selected rod. When, in the process of scanning the probes, the processor comes across the rod whose IDENT is the same as the REQUEST word, it will set this bit into the POSITION word prior to transmitting it.

Unless a control rod is being moved, it should only be located at an even-numbered notch position. If a rod is located at an odd-numbered position, it is defined as Drifting (unless the operator is moving that rod). One bit in the POSITION word carries the drift information for that rod, and once set, remains even if the rod stops drifting (i.e.; latches into an even-numbered notch). A "Drift Reset" signal originated by the operator and carried by the REQUEST word, will cause all drift signals to reset unless the rod is still drifting. The "Drift Test" is used to check the drift detection function by temporarily overriding the "rod driving" signal (coming from RDCS) while the operator moves a rod through an odd-numbered position.

The 4-rod display presents the vertical position of a selected rod and the other rods in it's group. The rod positions are displayed in the form of a two digit number. Even notch positions are indicated by numbers and Odd notch positions are indicated by dashes. If RPIS is receiving abnormal data (e.g.; a reed switch stuck open), it will be indicated by a double X in the display. If the selected group has less than four rods, the display window(s) will be blank for the locations that do not have rods.

C. OPERATING REQUIREMENTS

1.0 the following systems should be in operation:

1.1 Control Rod Drive Hydraulic System N2-OP-30.

1.2 Rod Worth Minimizer N2-OP-95A.

1.3 Rod Sequence Control System N2-OP-95B.

1.4 Neutron Monitoring System N2-OP-92.

1.5 Reactor Protection System N2-OP-97.

2.0 Normal AC Distribution N2-OP-70 & -71.

D. PRECAUTIONS/LIMITATIONS

1.0 Use CAUTION when using Continuous Rod Withdrawal in order to avoid large reactivity transients. Continuous Rod Withdrawal should not be used when approaching criticality.

2.0 Monitor the appropriate nuclear instrumentation response closely during any rod movement.

3.0 During reactor startup and shutdown, the selected control rod sequence must be strictly adhered to, in order to prevent local fuel damage. If the sequence cannot be adhered to, the Reactor Analyst shall be contacted for instructions.

4.0 Whenever a rod is withdrawn to the full-out position, a coupling check must be performed. |*2

5.0 Use CAUTION when using the Continuous Insert push button for rod movement, because the rod motion timer is bypassed and there no settle function. Fully inserting a rod in this manner could cause damage to the CRD seals.

6.0 Extreme care must be exercised when moving a bypassed (from RSCS) control rod, the control rod is transparent to the Rod Pattern Controller and a high rod worth condition could result with no rod block protection.

7.0 Under certain conditions, operation may continue with the Rod Worth Minimizer inoperable. However, additional restrictions must be applied. Refer to section H. of N2-OP-95A (RWM).

8.0 Unless specifically directed by the Emergency Operating Procedures, bypassing RSCS OR using the individual scram test switches to insert control rods to rapidly reduce power is prohibited. These methods of power reduction can result in high rod worths, which could result in fuel damage.

E. STARTUP PROCEDURE

1.0 Verify the required support systems listed in section C are in operation.

2.0 Complete the system electrical lineup per Table II.

3.0 Turn the power switch for the Rod Select Module to ON (fully clockwise).

4.0 Verify that all alarms and rod blocks are clear, except for those expected for the given plant conditions.

5.0 Verify all required surveillance tests have been performed.

6.0 Select the sequence (A or B) to be used for startup (determined by the Reactor Analyst) on RSCS.

F. NORMAL OPERATION

NOTE: All control rod motion shall be in accordance with the Reactor Analyst's instructions and shall be in agreement with the sequence allowed by the Rod Worth Minimizer and the Rod Sequence Control System.

1.0 Control Rod Selection

a. Select the rod to be moved by momentarily depressing the push button for that rod on the Rod Select Module on panel P603.

b. Observe the following:

CAUTION:

DO NOT REPLACE A LIGHT BULB ON THE ROD SELECT MODULE FOR A SELECTED ROD. WITH THE LENS COVER REMOVED ON THE SELECT MODULE AND THAT ROD SELECTED, DAMAGE COULD OCCUR TO THE REACTOR MANUAL CONTROL SYSTEM SHOULD AN OBJECT FALL ONTO THE EXPOSED CONTACTS. A DIFFERENT ROD SHOULD BE SELECTED PRIOR TO REMOVING THE LENS COVER FOR A ROD ON THE SELECT MATRIX. 16452

1. The selected push button for the rod lights up.

2. The white "select" light on the full core display is lit for that control rod.

3. The rod's position is indicated on the 4-Rod Display.

4. The amber LED for the rod selected is flashing on the RSCS panel.

2.0 Control Rod Withdrawal

2.1 Notch Withdrawal

a. Verify that the Reactor mode switch is not in SHUTDOWN and there are no rod withdrawal blocks.

b. Verify that the correct rod has been selected in accordance with the sequence being used.

c. Momentarily depress the WITHDRAW push button. Observe that the IN, OUT, and SETTLE lights cycle correctly.

d. Observe that the selected rod moves out one notch to the next even-numbered position on the 4-Rod Display.

e. Monitor the appropriate nuclear instruments for proper response.

2.2 Continuous Withdrawal

a. Verify that the Reactor mode switch is not in SHUTDOWN and there are no rod withdrawal blocks.

b. Verify that the correct rod has been selected in accordance with the sequence being used AND that continuous rod withdrawal is allowed for the given conditions.

c. Simultaneously depress the WITHDRAW and the CONTINUOUS WITHDRAW push buttons. Observe that the WITHDRAW and CONTINUOUS WITHDRAW lights are on.

d. Observe that the selected rod moves continuously outward on the 4-Rod Display.

e. Monitor the appropriate nuclear instruments closely for proper response.

f. Just prior to the rod reaching the desired position (or notch 48), release both push buttons and allow the rod to settle into the desired notch. Observe the proper cycling of the IN, OUT, and SETTLE lights.

3.0 Control Rod Insertion

3.1 Notch Insertion

a. Verify that there are no rod insert blocks.

b. Verify that the correct rod has been selected in accordance with the sequence being used.

c. Momentarily depress the INSERT push button. Observe that the IN and SETTLE lights cycle correctly. *

d. Observe that the selected rod moves in one notch to the next even-numbered position on the 4-Rod Display.

e. Monitor the appropriate nuclear instruments for proper response.

3.2 Continuous Insertion

CAUTION

Do not use the Continuous Insert push button for normal rod movement. The rod motion timer is bypassed and there is no settle function, fully inserting a rod in this manner could cause damage to the CRD seals. *

a. Verify that there are no rod insert blocks.

b. Verify that the correct rod has been selected in accordance with the sequence being used.

c. Depress and hold the INSERT push button. Observe that the INSERT light remains on as long as the push button is held down. *

d. Observe that the selected rod moves continuously inward on the 4-Rod Display.

e. When the rod reaches the desired position (or notch 00), release the push button and allow the rod to settle into the desired notch. Observe the proper cycling of the IN and SETTLE lights. *

f. Monitor the appropriate nuclear instruments for proper response.

G. SHUTDOWN

The system will normally remain in continuous operation. If shutdown of the system is required, de-energize the power supplies listed in Table II.

H. OFF NORMAL PROCEDURES

1.0 Mispositioned Control Rod

1.1 In the event a single control rod is mispositioned, the SSS and the Reactor Analyst will be contacted immediately for instructions. Recovery from an inadvertent or intentional control rod insertion (i.e. single rod scram or rod drift in) shall be performed in accordance with N2-REP-16.

1.2 In the event multiple control rods are mispositioned, such as following a one-quarter scram condition, the reactor operator shall immediately notify the SSS and initiate a manual reactor scram. Recovery from other mispositioned control rod events (such as one rod group pulled past its limit) shall be in accordance with SSS and Reactor Analyst instructions.

1.3 If the control rod is mispositioned because of rod drift out, refer to N2-OP-30 Section H.5.0 for corrective action.

2.0 Loss Of Rod Position Indication Or Control Rod Display.

NOTE: Corrective action must be accomplished within 1 hour per T.S. 3.1.3.7.

Defective control rod position data from RPIS can be indicated by:

a. The DATA FAULT light being energized on the Rod Select Module.
b. ROD POSITION INDICATING SYS INOPERABLE annunciator (603304) on panel P603.
c. Loss of position indication on the Rod and Detector Display (i.e.; loss of Full-in or Full-out indication) or the 4-Rod Display.
d. A double XX displayed on the 4-rod display for the rod(s).

2.1 Suspend all control rod motion. If only one rod is affected, move rod in one notch to attempt to restore position indication.

2.2 Attempt to determine the position of the control rod(s) by checking:

a. The Full-In (or Full-out) indication on the R&DD, if the rod is fully inserted (or fully withdrawn).
b. If a single rod is affected and below the LPSP, refer to the RSCS procedure (N2-OP-95B, section H) for instructions on entering substitute position data or bypassing the control rod.
c. Demand an OD-7 printout from the process computer.

2.3 Refer to Tech Specs, Section 3.1.3.7. Verify and enter in CSO log that no control rod drift alarm occurs at least once per 12 hours.

2.4 If all attempts to restore Rod Position Indication have failed, notify the Reactor Analyst and Contact the I&C Department to troubleshoot and repair. A TIP trace can be performed to determine the position of the rod(s).

3.0 Rod Drift Alarm Test

a. Select a rod to be tested on the Rod Select Module.

b. Initiate rod movement (either INSERT or WITHDRAW).

c. While the rod is in motion, depress the ROD DRIFT TEST push button.

d. As the rod moves through an odd-numbered position, verify the following indications:

1. The ROD DRIFT annunciator (603443) alarms.

2. The ROD DRIFT light energizes for the rod selected on the full core display.

e. Release the ROD DRIFT TEST push button.

f. After the rod has settled into it's next even notch position, depress the ROD DRIFT RESET push button. Observe that the ROD DRIFT annunciator clears and the lights on the full core display and the Rod Select Module de-energize.

4.0 Uncoupled Control Rod

NOTE: Any rod which becomes uncoupled from it's drive mechanism will energize the CONTROL ROD OVERTRAVEL annunciator (603444), while performing the rod coupling check. Rod uncoupling could also be indicated by the lack of a noticeable change in neutron monitoring indication while the drive is being moved. The exact location of the rod (vertically) may be determined by a TIP trace. *2

If a control rod is found uncoupled, within 2 hours perform the following:

4.1 If permitted by the rod worth minimizer (RWM) and rod sequence control system (RSCS).

a. Insert the control rod two notches in an attempt to recouple the rod.

b. Consult with the Reactor Analyst before rod withdrawal.

c. Withdraw the control rod to position 48 with the Reactor Analysts concurrence, and observe nuclear instrumentation response during rod movement.

d. Apply a continuous withdraw signal at position 48 and verify the CONTROL ROD OVERTRAVEL alarm (603444) stays clear.

e. If the control rod is successfully recoupled on the first attempt, reposition the control rod with the Reactor Analysts concurrence.

f. If recouple is not accomplished on first attempt, refer to Tech. Spec. 3.1.3.6.

4.2 If not permitted by RWM or RSCS, declare the control rod inoperable, insert the control rod, and disarm the control rod per H.5.0 of this procedure.

5.0 Disarming a Control Rod at the HCU.

5.1 When required by Tech Specs, a control rod drive may be hydraulically disarmed as follows: TCN-9

a. Shut the drive water isolation valve (103)

b. Shut the exhaust water isolation valve (105)

5.2 When required by Tech Specs, a control rod drive may be electrically disarmed as follows:

a. Verify that the rod to be disarmed is in the required position.

b. Remove the clip holding the solenoid on top of the following valves for the HCU to be disarmed.

2RDS-SOV-120
2RDS-SOV-121
2RDS-SOV-122
2RDS-SOV-123

c. Remove the solenoid from the valve stem for each of the valves. Support the solenoids so that they are not hanging by the electrical cables.

d. Replace the clip on the valve stem to prevent losing it.

6.0 BYPASSING A ROD WITH A BAD TRANSPONDER CARD

NOTE: This will be indicated on PNL 616 (Rod Drive Control Cabinet Analyzer) by having "RDCS STATUS" Inoperative Led Lit and having the associated Rod Location LED Lit on the fault map.

6.1 Enter Binary X & Y Coordinates into Bypassed Rod Identity Switches (Down = 0; Up = 1).

6.2 Place Bypass Switch in Bypass (Up) Position.

6.3 Depress RDCS Reset Push Button.

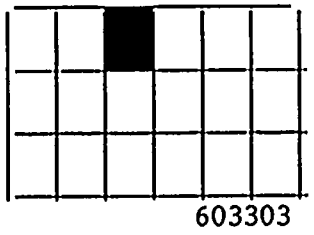
6.4 To Return the Bypassed Rod to Service place the Bypass Switch in Normal (Down) Position.

I. PROCEDURE FOR CORRECTING ALARM CONDITIONS

1.0 603303 Rod Drive Control System Inoperable

Reflash: No

ROD DRIVE CONTROL SYSTEM INOPERABLE 603303



1.1	Computer Point	Computer Printout	Source	
	RDSBC 13	RDCS SYS INOP	Relay 26-K1:	*1

1. Low Voltage
2. Computer Failure
3. Master Test Push-button depressed
4. Loss of permissive signal from (fcn. of Rx Mode Switch):
   a. RPIS (INOP)
   b. NMS
   c. RSCS
   d. RWM
   e. Scram Discharge Volume
   f. Scram Discharge Volume Bypass
   g. Refuel Platform
   h. Service Platform
5. Clock Failure

1.2 Automatic Response

a. Rod Out Block

1.3 Corrective Action

a. Suspend all attempts to move control rods.

b. Attempt to determine the cause (check the system indications on panel P616), and correct.

c. Reset the Rod Drive Control System on panel P616.

d. If the problem cannot be corrected, record which LEDs are energized on panel P616 and contact the I&C Department to troubleshoot and repair.

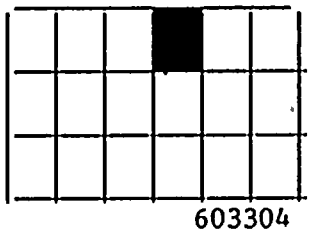
e. If Rod Drive Control System cannot be immediately restored, continuously monitor Control Rod Drive accumulators to verify operability, due to loss of normal scan function. TCN-12

I. PROCEDURE FOR CORRECTING ALARM CONDITIONS (cont.)

2.0 603304 Rod Position Indicating System Inoperable

Reflash: No

ROD POSITION INDICATING SYS INOPERABLE 603304



2.1	Computer Point	Computer Printout	Source	
	RDSBC 08	RPIS INOP	Relay K3: 1. Loss of power 2. Clock Failure 3. Response Failure	*1

2.2 Automatic Response

a. Rod out block

2.3 Corrective Action

a. Suspend all attempts to move control rods.

b. Refer to section H of this procedure.

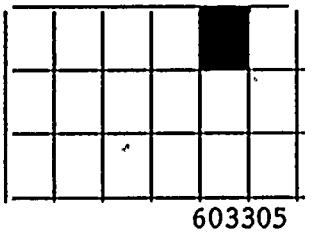
I. PROCEDURE FOR CORRECTING ALARM CONDITIONS (cont.)

3.0 603305 Control Rod Display Inoperable

Reflash: No

TCN-10

CONTROL ROD DISPLAY INOPERABLE 603305



3.1 Computer Point	Computer Printout	Source
RDSBC 14	CONTROL ROD DISPLAY INOP	Relay K2: 1. Loss of power 2. High Temperature on Rod & Detector Display

3.2 Automatic Response

a. Possible loss of indications on the Rod and Detector Display (P603).

3.3 Corrective Action

a. Suspend all attempts to move control rods.

b. Refer to section H of this procedure.

c. Verify the Rod Display fans are operating in P603 panel, depress "Test High Temp" and "Test Low Temp" orange push button to verify fan operation.

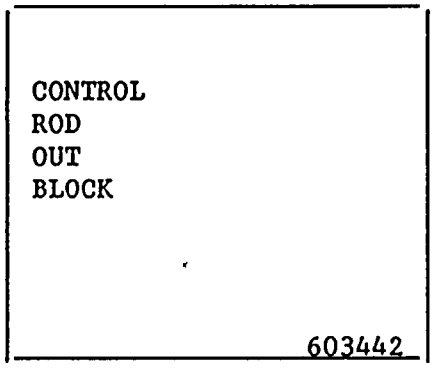
d. Provide temporary cooling fan as required.

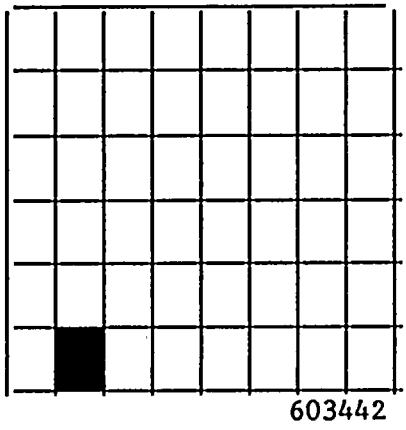
I. PROCEDURE FOR CORRECTING ALARM CONDITIONS (cont.)

4.0 603442 Control Rod Out Block

TCN-10

Reflash: No





4.1

Computer Point	Computer Printout	Source
RDSBC 12	CONTROL ROD OUT BLOCK	See below

4.2 Automatic Response

NONE

4.3 Corrective Action

a. Determine cause of rod block (See Table below).

b. If the rod block was a wrong rod position or rod select error, return the rod to its required position.

c. If RSCS block and need to bypass the control rod, consult the Reactor Analyst.

d. Follow the corrective action per Table below.

Source	Trip Setpoint	Corrective Action
a. SRM		
1. SRM Downscale	3 CPS	1. Insert the detector if count rate is less than 100 CPS and IRM is below Range 3.
2. SRM Upscale	1×10^5 CPS	2. Bypass the affected SRM if downscale and IRM below Range 3.
3. Detector wrong position	less than 100 CPS and detector not full in	3. Withdraw the detector if SRM upscale.
4. SRM INOP	High voltage low module unplugged SRM select switch not in "OPERATE".	4. Check the SRM drawer switch is in normal lineup.
b. IRM		
1. IRM Downscale	less than 5/125%	1. Fully insert the detector if not fully inserted.
2. IRM Upscale	greater than 108/125%	2. Range down the IRM if downscale occurs.
3. Detector wrong	detector not fully inserted	3. Range up the IRM if upscale.
4. IRM INOP	High voltage low module unplugged IRM select switch not in "OPERATE".	4. Bypass the affected IRM if required.
		5. Check the IRM drawer switch is in normal lineup.
c. APRM		
1. APRM Downscale	less than 4%	1. Bypass the affected APRM if required.
2. APRM Upscale	greater than 12% in "STARTUP", greater than .66w + 42%	2. Place mode switch to "STARTUP" if downscale occurs in "RUN" during reactor shutdown.
3. APRM INOP	Module unplugged APRM select switch not in "OPERATE" less than 14 LPRM input.	3. Reduce power if upscale occurs in "RUN" mode.
		4. Place the mode switch to "RUN" if upscale occurs in "STARTUP" as directed by N2-OP-101.

Source	Trip Setpoint	Corrective Action
d. Flow Units		
1. Upscale	greater than 108%	1. Bypass the affected unit.
2. Flow Comparator	greater than 10%	
3. Flow Unit INOP	Module unplugged Flow Unit Select Switch not in "OPERATE".	2. Check the flow unit switch is in normal lineup.
e. Miscellaneous		
1. Scram Discharge Volume	greater than 16.5"	1. Verify any HCU scram discharge valve leakage by reference of control rod drive temperature.
2. Scram Dis-Volume High Level Bypassed	SDV BYPASS switch is in Bypass.	2. Return the SDV Bypass switch to "NORMAL" when SDV high level alarm clears.
3. Mode switch is shut down		3. Information alarm when Mode switch in "SHUTDOWN"
4. Mode switch in "REFUEL".	*Any rod not full in and other rod selected. *Refuel bridge/ service platform over the vessel and hoisted loaded.	
f. Rod Block Monitor		
1. Downscale	less than 5%	1. Setup the reference RDM if required.
2. Upscale	.66w + 54% .66w + 40% .66w + 33% .66w + 25%	2. Bypass the affected RBM if required.
		3. Check the RBM drawer switch is in normal lineup.
3. RBM INOP	Nulling in progress fail to null less than 50% LPRM inputs card pulled switch not in "OPERATE" no rod or more than one rod selected.	

1

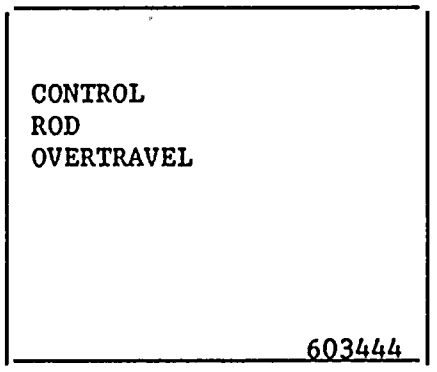
Source	Trip Setpoint	Corrective Action
g. Rod Worth Minimizer (Below Low Power setpoint)	Any withdraw error more than two insert error. During rod testing, one rod not fully inserted and second rod selected. Program abort.	1. Verify the RWM error display and correct the rod position. 2. Bypass RWM as required, refer to N2-OP-95A, Section H.1.
h. Rod Sequence Control System (Below Low Power setpoint)	Any rod position error	1. Correct the mispositioned rod. 2. If rod position failed, insert the substitute rod position. 3. Consult Reactor Analyst if the rod needs to be bypassed. Refer to N2-OP-95B for bypassing the control rod.

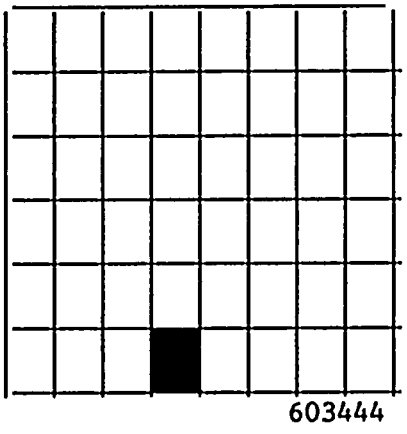
I. PROCEDURE FOR CORRECTING ALARM CONDITIONS (cont.)

5.0 603444 Control Rod Overtravel

Reflash: No

TCN-10





5.1	Computer Point	Computer Printout	Source
	RDSBC 10	CONTROL ROD OVERTRAVEL	Relay K1: Overtravel reed switch closed.

5.2 Automatic Response

NONE

5.3 Corrective Action

a. Monitor the LPRM indications next to the affected rod on the 4-Rod display, for indications of a control rod drop.

b. Refer to section H of this procedure.

TABLE II

SYSTEM POWER SUPPLY LINEUP

COMPONENT NO.	COMPONENT DESCRIPTION	POWER SUPPLY Bus Number - Cubicle/ Breaker	NORMAL POSITION	ACTUAL POSITION	INITIALS/ DATE	REMARKS
2RDSN06	Rod Drive Control System AC Junction Box	2VBS-PNLA101 - #36	ON			TCN -3
2RDSN07	CRD Temperature Recorder	2VBS-PNLA101 #12	ON			
2RDSN05	Rod Select Logic	2VBS-PNLA101 - #37	ON			
2RDSN11	RSCS Operator Display and Core Display Fans	2VBS-PNLB101 - #12	ON			
	24 Power Supply	2CEC*PNL616 PS-281	ON			
	Remote Display Pwr Brkr	2CEC*PNL603 C12A-S1	ON			
	Branch Junction Module Power Breaker	2CEC*PNL616 C12A-CB1	ON			
	Branch Junction Module Power Breaker	2CEC*PNL616 C12A-CB2	ON			
	5 Volt Display Logic Power Supply	2CEC*PNL603 C12A-PS01	ON			
	Rod Select Power Switch	2CEC*PNL603 C12A-S2	ON			
	RPIS Power Switch	2CEC*PNL615 C12A-S1	ON			
2RDSN08	RPIS Power Supply	2VBS-PNLA101 #7	ON			
CKT # 2RDSN05	Display and Select Logic, Select Lamps and Display Fan Control (P603)	2VBS-PNLA101 #4	ON			
2RDSN09	Scram Timing Circuits	2VBS-PNLA101 #6	ON			

TABLE IV

ROD BLOCKS

WITHDRAWAL BLOCKS:

Block	Setpoint	Bypassed
SRM Downscale Alarm	3 cps	1. IRMs Range 3 or above (or bypassed) or 2. Mode switch in RUN or 3. SRM bypassed
SRM Upscale	1×10^5 cps	1. Associated IRM on Range 8 or above (or bypassed) or 2. Mode switch in RUN or 3. SRM bypassed
SRM INOP	1. Module unplugged 2. High Voltage Low 3. SRM Select Switch not in Operate*.	1. Associated IRM on Range 8 or above (or bypassed) or 2. Mode switch in RUN or 3. SRM bypassed * INOP Inhibit push button pressed
SRM Detector Not Full In	< 100 cps and Detectors not fully inserted	1. IRMS Range 3 or above (or bypassed) or 2. Mode switch in RUN or 3. SRM Bypassed
IRM Downscale Alarm	5/125 of scale	1. IRM on Range 1 or 2. Mode switch in RUN or 3. IRM bypassed
IRM Upscale Alarm	108/125 of scale	1. Mode switch in RUN or 2. IRM bypassed
IRM Detector Not Full In	IRM Detector not fully inserted	1. Mode switch in RUN or 2. IRM bypassed
IRM INOP	1. Module unplugged 2. High Voltage Low 3. IRM Drawer Selector Switch not in Operate*	1. Mode switch in RUN or 2. IRM bypassed *INOP Inhibit Push Button depressed

TABLE IV (cont.)

ROD BLOCKS

WITHDRAWAL BLOCKS:

Block	Setpoint	Bypassed
APRM Downscale Alarm	< 4 percent	1. Mode switch not in RUN or 2. APRM bypassed
APRM Upscale Alarm	> 12 percent	1. Mode switch in RUN or 2. APRM bypassed
	> 0.66 (W-ΔW) + 42 percent	1. Mode switch not in RUN or 2. APRM bypassed
APRM INOP	1. Module unplugged 2. < 14 LPRMs per APRM 3. APRM calibrate/ operate switch not in Operate*.	1. APRM bypassed *INOP Inhibit Push Button depressed
Flow Unit Upscale Alarm	> 108 percent	Flow Unit Bypassed
Flow Unit Comparator	> 10 percent difference	Flow Unit Bypassed
Flow Unit INOP	1. Flow Upscale alarm 2. Flow Unit mode switch not in Operate 3. Flow module unplugged.	Flow Unit Bypassed
Scram Discharge Volume High Water level	> 16.5 inches	N/A
Scram Discharge Volume High Water Level Bypass	Switch in Bypass Position	Switch in Normal Position

TABLE IV (cont.)

ROD BLOCKS

WITHDRAWAL BLOCKS:

Block	Setpoint	Bypassed
RBM Downscale Alarm	< 5% power	1. Mode switch not in RUN or 2. RBM bypassed (< 30% power)
RBM Upscale Alarm		
1. Low	1. 0.66 (W-ΔW) + 24%	RBM Bypassed (< 30% power)
2. Intermediate	2. 0.66 (W-ΔW) + 32%	RBM Bypassed (< 30% power)
3. Normal	3. 0.66 (W-ΔW) + 40%	RBM Bypassed (< 30% power)
4. Backup	4. 0.66 (W-ΔW) + 54% W = Rx Recirc Flow	RBM Bypassed (< 30% power)
RBM INOP Alarm	1. RBM mode switch not in operate* 2. RBM module unplugged 3. < 1/2 required LPRM inputs 4. Failure to null 5. Select matrix self check unsuccessful (> 1 rod selected)	RBM Bypassed (< 30% power) *Inop Inhibit pushbutton depressed
Reactor Mode Switch	Rx. Mode switch in SHUTDOWN	N/A

REFUELING ROD BLOCKS

The following conditions will cause a Rod Block:

Mode Switch Position	Condition Causing Block
STARTUP	1. Refuel Platform over Core or 2. Service Platform hoist loaded
REFUEL	1. Any rod not full in AND another rod selected or 2. Service Platform hoist loaded or 3. Refuel Platform over Core and a. Fuel Grapple loaded or b. Frame mounted hoist loaded or c. Monorail hoist loaded

*

TABLE IV (cont.)

ROD BLOCKS

ROD WORTH MINIMIZER ROD BLOCKS

The following conditions will cause a Withdrawal Rod Block:

Condition Causing Block	Bypassed
1. Any Withdraw Error	1. Reactor Power above the LPSP (as sensed by steam flow)
2. 3 Existing Insert errors and an Insert Block applied- causes a block for any rod selected other than one causing an Insert error	2. RWM Bypassed
3. Rod Test a. One rod withdrawn 00 AND another rod selected b. 1 rod withdrawn 00 AND the Rod Test push button is depressed.	*
4. RWM program abort.	

The following conditions will cause an Insert Rod Block:

Condition Causing Block	Bypassed
1. Two Insert Errors existing AND a third Insert Error is made	1. Reactor Power above the LPSP (as sensed by steam flow)
2. A Withdraw error existing AND a Withdraw Block applied- causes a block for any rod selected other than one causing the Withdraw error.	2. RWM Bypassed
3. When power reaches the LPSP during Rx Power decreases AND a. A Withdraw error exists OR b. The Operating Sequence is not latched.	
4. 1 rod withdrawn 00 AND the Rod Test push button is depressed	*
5. RWM program abort.	

ROD SEQUENCE CONTROL SYSTEM ROD BLOCKS

The following condition will cause Withdrawal or Insert Rod Blocks:

Condition Causing Block	Bypassed
Rod Sequence violated	Rx Power above the LPSP (as sensed by turbine 1st stage pressure)

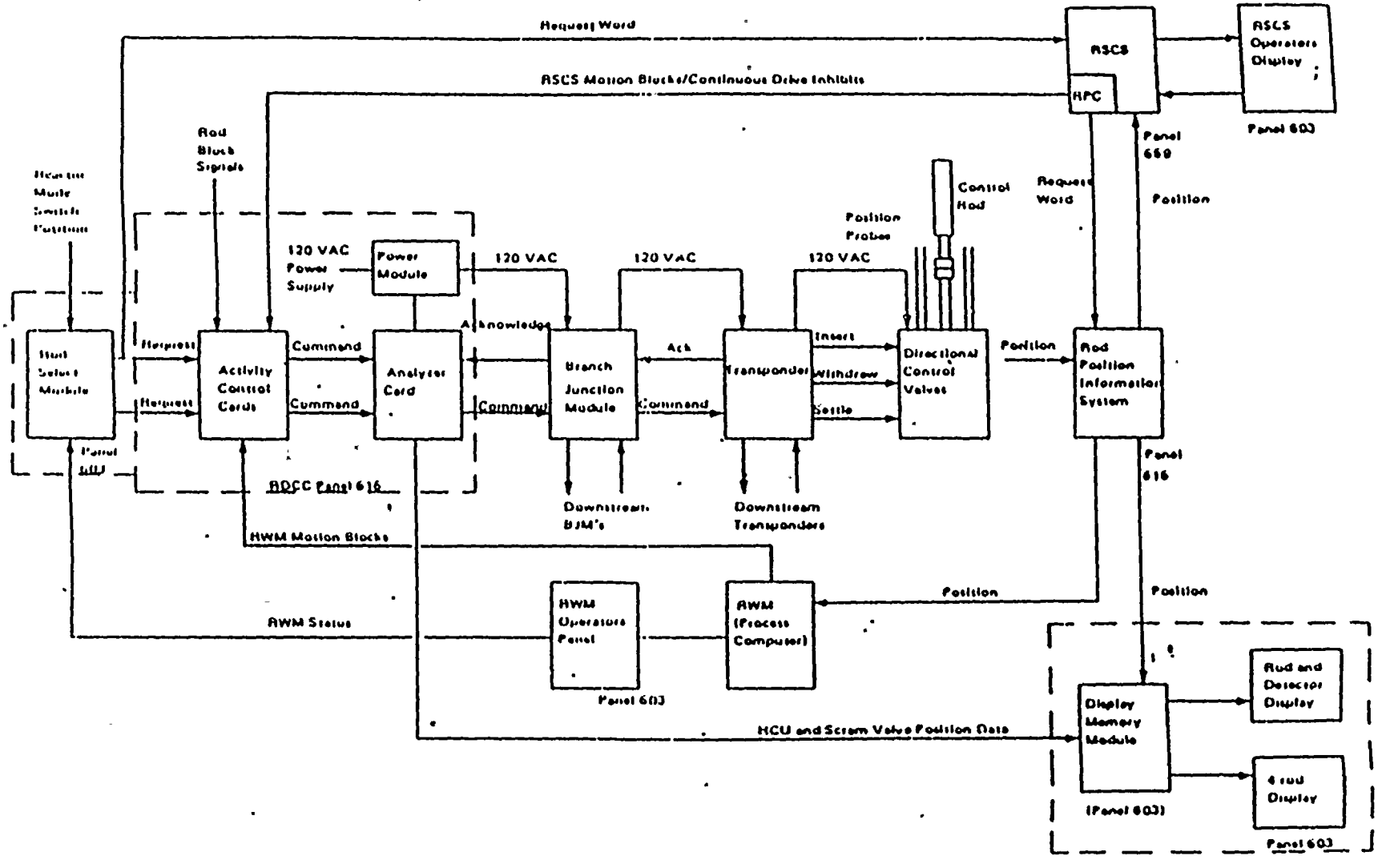


Figure 1	Rev. 0
Title: REACTOR MANUAL CONTROL SYSTEM	