GE Nuclear Energy

ABWR

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Subject Tech Specs

Message

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DRAFT PROPOSED ABWR TECHNICAL SPECIFICATIONS
SECTION 3.3.1.1/2 - RPS INSTRUMENTATION/LOGIC

Attached are proposed technical specifications for the ABWR Reactor Protection System (RPS). These specifications were developed from the BWR/6 Improved Technical Specifications (ITS) and adjusted for relevant design differences in the ABWR. It was intended to retain the look and feel of the BWR ITS to the maximum extent practical. When departures were necessary to reflect design or performance differences, the ITS products for the other vendor designs were utilized where appropriate. With regards to instrumentation systems, the ABWR uses input from many of the same variables as with past BWR designs. Thus, to a great extent, the basic technical specifications have remained the same. However, the logic and processing of input is done with digital technology that is a departure from past BWR practice. In that regard it is very similar to the technology used in other vendor designs. Thus, their ITS products were used as a basis for some of the modifications that were made to the ABWR specifications and are reflected in the example attached. Included with the attached specifications are very abbreviated bases intended to provide general insight into the proposed specifications, with particular emphasis on differences from recent past practice. These descriptions are in no way meant to be a substitute for the full blown bases which are to be provided in a future submittal. The intent of this submittal is to provide the NRC staff with an indication of the direction GE is headed in the instrumentation area of Tech Specs and to seek early feedback. Other ABWR instrumentation systems will resemble the RPS example and are currently in various stages of completion. As they are finalized in draft form they will be forwarded to the staff for review.

Abbreviated Discussion of ABWR Bases - RPS Instrumentation

The ABWR has a digitally multiplexed RPS that utilizes two out of four trip initiation logic. Four separate instrument divisions are used to monitor the required variables. Four separate divisions of trip logic are then used to perform the required trip determination. This occurs within the divisional Digital Trip Modules (DTMs). Each divisional DTM receives input from the instrumentation in that same division for each variable monitored. For analog variables the DTMs make the trip/no-trip decision by comparing a digitized analog value against a setpoint and initiating a trip condition for that variable if the setpoint is exceeded. For some variables trip determinations are made by the monitoring element itself (e.g. limit switch). In such cases the DTM simply passes on the signal in the form of a trip/no-trip output. The output of each divisional DTM (a trip/no-trip condition) for each variable is then routed to all four divisional Trip Logic Units (TLUs) such that each divisional TLU receives input from each of the four divisions of DTMs. Each DTM has a division-of-sensors bypass such that all instruments in that division will be bypassed in the RPS trip logic at the TLUs. Thus, each TLU will be making its trip decision on a two out of three logic basis for each variable. It is possible for only one division-of-sensors bypass condition to be in effect at any time.

The two out of four trip logic decision (or two out of three if a division-of-sensors bypass is in effect) is made by each TLU on a per variable basis such that setpoint exceedence in two instrument divisions *for the same variable* is required to initiate a trip output at the TLU. Since each TLU sees the outputs from all four DTMs, all four divisions of logic should sense and initiate a required trip simultaneously. A two out of four trip in a TLU causes a trip in its corresponding Output Logic Unit (OLU). It is this trip that then initiates a reactor scram by tripping load drivers in the power circuits that energize the CRD scram pilot valve solenoids. Each OLU sends output signals to a total of eight load drivers, four each associated with the 'A' and 'B' scram pilot valve solenoids, respectively. The total set of 32 load drivers are grouped in a series-parallel arrangement such that each load driver group energizes either the 'A' or the 'B' scram pilot valve solenoids for the control rods in one of four distinct groups of control rods. The overall arrangement of OLU outputs and load driver groupings is such that a trip of any two of four TLUs (and associated OLUs) will cause the de-energization of both the 'A' and 'B' scram pilot valve solenoids for all four groups of control rods, affecting a full reactor scram. Each of the four TLUs has a bypass switch so that they can be bypassed, one at a time, such that the RPS output logic reverts to two out of three, i.e. the tripping of any two of the three remaining TLUs will still result in a full scram. Each OLU has test and trip switches such that the load drivers can be tested both with and without causing a half scram condition (i.e. tripping of either the 'A' or 'B' scram pilot valve solenoids).

Manual scram is accomplished either via two manual scram push buttons or by placing the reactor mode switch in the shutdown position. Both manual scram functions directly interrupt power in the circuits that energize the scram pilot valve solenoids such that a full scram results. This occurs upstream of the load driver groups and is completely separate from the associated automatic scram logic. They are also hardwired and therefore not reliant on the plant multiplexing system. The two manual scram pushbuttons each de-energize a separate path such that when individually actuated a half-scram condition results, and when actuated together a full scram results. Placing the mode switch in shutdown immediately results in full scram by coincidentally interrupting power to the circuits affected by each manual scram pushbutton.

The RPS instrumentation for ABWR is very similar to that in recent BWR designs with many of the same variables providing trip input. The biggest difference in the variables utilized is due to the elimination of the scram discharge volume (SDV). Replacing the various SDV trips is a trip on low CRD charging water header pressure. This trip is added because the scram discharge in ABWR is into the reactor, and thus against full reactor pressure and not normal atmospheric pressure. Therefore, fully charged HCUs are essential for assuring reactor scram. Additionally, a trip on high suppression pool temperature has been added to automate the ABWR response to a stuck open SRV event. This signal will be supplied by the suppression pool temperature monitoring system (and will likely be in the form of a trip/no-trip signal based on an algorithm and/or setpoint comparison done within that system).

Other RPS variables that differ slightly are those generated within the Neutron Monitoring System (NMS). The APRM supplied inputs remain the same with the addition of a trip on rapid core flow coastdown to terminate postulated multiple RIP trip events that may have unacceptable transient analyses results. The Startup Range Neutron Monitoring (SRNM) system replaces the IRMs of old. There is still a high flux trip in this range, but because the range switches have been deleted, a direct trip on fast period has been added. A significant difference from the past is that all APRM and SRNM trip decisions are made within the NMS. This is done on a divisional basis and the results then sent directly to the RPS TLUs (i.e. the DTM function is done within the NMS). Thus, each NMS division sends only two inputs to the RPS divisional TLUs, one for APRM trip/no-trip and one for SRNM trip/no-trip. A divisional APRM or SRNM may be tripped due to any of the monitored variables exceeding its trip setpoint. The RPS two out of four trip decision is then made, not on a per variable basis, but on an APRM tripped or SRNM tripped basis, by looking at the four divisions of APRM and four divisions of SRNM. All bypasses of the SRNMs and APRMs are performed within and by the NMS.

Another variable treated strictly on a divisional basis is the MSIV closure status. Each divisional DTM monitors the status of the inboard and outboard MSIV in one (of four) steamline and establishes a trip condition if either valve is sensed as not full open. Therefore, a scram on MSIV closure will occur if the valve position limit switches for one or both valves in a given steamline indicate an MSIV not full open in two or more steamlines.

The scram trips on turbine stop valve closure and turbine control valve fast closure are also handled in a unique way by the RPS in that the automatic bypass on turbine first stage pressure is handled on a divisional basis only. As in the past these scram trips are bypassed when reactor power is below approximately 40 % RTP, as sensed by turbine first stage pressure. The actual scram trips on valve closure are determined on a two out of four basis, by the DTMs and TLUs as described previously. However, the four turbine first stage pressure instrument inputs remain divisional, each providing input only to the logic in that division and affecting a bypass, if appropriate, only in that division. Like other RPS variables the instrument output goes to its respective divisional DTM where a trip/no-trip (i.e. bypass/no-bypass) condition is generated. Each divisional DTM output, however, is routed only to the TLU in that same division. Therefore, three bypass channels are needed to prevent scram as the trip of any two unbypassed TLUs would still cause a reactor scram.

The LCO for RPS instrumentation has been separated into two separate LCOs, borrowing from how digital systems are treated in the CE and B&W ITS products. LCO 3.3.1.1 deals with the actual instrumentation providing RPS input, including that which performs automatic bypass functions, as well as the associated setpoint trip determination done at either the DTM level. This LCO then is essentially limited to issues concerning instrumentation and the verification that RPS trips (and bypasses) occur at the proper variable setpoints. LCO 3.3.1.2 deals with the automatic output trip logic performed at the TLU/OLU level and also covers the manual scram function. This LCO covers the output logic and trip devices that actually affect reactor scram, including load drivers and solenoids of the scram pilot valves.

LCO 3.3.1.1 RPS Instrumentation

This LCO deals with the OPERABILITY of instruments and instrument trip channels, including setpoints. The LCO uses the familiar instrument table, arranged by variable, where setpoint values, Applicability requirements and Required Surveillances are specified. All RPS variables are monitored by four instrument channels, all of which are required to be OPERABLE. However, with one instrument trip channel out of service, that channel can be bypassed in all four divisions of logic, such that the logic automatically reverts to two out of 3. This is done via the division-of-sensors bypass function at the DTM. Alternately, the channel could be tripped, which would effectively result in a one out of three logic being in place for that variable in all four logic divisions. Either is an acceptable long term condition at the instrument trip channel level as there would still be four channels of RPS trip output logic.

The intent of the Required . tion is to not force an unneeded shutdown to repair equipment that might not be readily accessible during operation. Of course, most repairs are likely to be simple card or other electronic subassembly replacements that can be done on-line with the affected division of sensors in bypass. In such cases, restoration should be done as soon as practicable. With two channels out, one is bypassed and the other tripped, resulting effectively in an one out of two logic configuration. This situation would only be acceptable for a shorter duration. Failure to meet Required Actions would necessitate placing the plant in an operating mode, or conditions, where the particular variable involved is no longer required. Such actions mimic very closely those specified in the ITS.

The Surveillance Requirements for RPS instrumentation are virtually identical to those in the BWR/6 ITS. Minor modifications were made to reflect design differences such as having SRNMs instead of IRMs. However, the intent, with regards to the scope and depth of surveillance testing to be performed, is the same for ABWR as with current plants. This testing will not include tripping of the final trip actuation devices except for the combined testing that is done as part of the LOGIC SYSTEM FUNCTIONAL TESTs.

LOC 3.3.1.2 RPS Trip Logic

This LCO covers the bulk of the RPS aside from the actual instrumentation and associated setpoint comparison and digital trip signal initiation. Although the equipment differs from past BWR designs, other than being two out of four logic the system is effectively the same in how it functions and with regards to technical specifications.

If one automatic output logic channel is out of service it can be placed in bypass, such that the RPS is operating in two out of three logic, and must then be restored within the next seven days. However, most repairs are expected to be simple replacements and then restoration would be expected to be made in a much shorter time interval. Should restoration not be made within the allowable time interval, continuation with the channel in bypass (i.e. the RPS in two out of three logic) is allowed only if the three remaining OPERABLE RPS logic channels are surveilled more frequently to assure their continued operability. Alternatively, the inoperable channel could be taken out of bypass and tripped, placing the RPS in a one out of three logic. This would effectively increase the reliability of the scram function, if demanded, such that continued operation is then justified. In either case, the inoperable RPS channel would have to be restored to OPERABLE status within the following 31 days.

With two automatic output logic channels, or one manual scram channel, inoperable redundancy is significantly reduced and restoration to OPERABLE status is required much more expeditiously. Individual scram actuation devices, such as load drivers and [illegible] pilot valve solenoids, are an integral part of the RPS and are specifically covered by the required surveillance testing. However, their operability was not singled out within the proposed Conditions as they are fail-safe, de-energize to operate devices whose failure would cause a trip, or partial trip, in their respective channel(s). Failures of these devices would be treated by declaring the associated logic division inoperable and proceeding accordingly. Required surveillance testing is equivalent to current BWRs for this portion of the RPS, consisting of CHANNEL FUNCTIONAL and LOGIC SYSTEM FUNCTIONAL TESTs. On-line testing of the automatic and manual scram output logic, including testing of the final actuators, is required on a monthly basis. The exception is the Reactor Mode Switch--Shutdown Position manual scram function which can only be tested during shutdown conditions. LOGIC SYSTEM FUNCTIONAL TESTing of the RPS will combined testing of both instrumentation input trip logic and scram output logic.

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3.3 INSTRUMENTATION

3.3.1.1 Reactor Protection System (RPS) Instrumentation

LCO 3.3.1.1 Four RPS instrumentation trip channels for the functions in Table 3.3.1.1-1 shall be OPERABLE.

APPLICABILITY: According to Table 3.3.1.1-1.

ACTIONS

--------------------------------NOTE--------------------------------
Seperate Condition entry is allowed for each RPS trip function
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CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One RPS instrumentation trip channel inoperable.	A.1	-------NOTE------- LCO 3.0.4 is not applicable. ------------------ Place channel in bypass or trip.	1 hour
	AND		
	A.2	Restore channel to OPERABLE status.	Prior to entering MODE 2 following next MODE 5 entry.
B. Two RPS instrumentation trip channels inoperable.	B.1	Place one channel in bypass and the other in trip.	1 hour
	AND		
	B.2	Restore one channel to OPERABLE status.	Prior to completion of the next CHANNEL FUNCTIONAL TEST

C. Required Actions and associated Completion Times of Condition A or B not met.	C.1	Enter the Condition(s) referenced in Table 3.3.1.1-1 for the function.	Immediately
D. As required by Required Action C.1 and referenced in Table 3.3.1.1-1.	D.1	Reduce THERMAL POWER to < [80]% RTP.	4 hours
E. As required by Required Action C.1 and referenced in Table 3.3.1.1-1.	E.1	Reduce THERMAL POWER to < [40]% RTP.	4 hours
F. As required by Required Action C.1 and referenced in Table 3.3.1.1-1.	F.1	Be in MODE 2.	6 hours
G. As required by Required Action C.1 and referenced in Table 3.3.1.1-1.	G.1	Be in MODE 3.	12 hours
H. As required by Required Action C.1 and referenced in Table 3.3.1.1-1.	H.1	Initiate action to insert all insertable control rods in core cells containing one or more fuel assemblies.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
---NOTE--- Refer to Table 3.3.1.1-1 to determine which SRs apply for each RPS function.		
SR 3.3.1.1.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.1.1.2	---NOTE--- Only required with THERMAL POWER ≥ 25% RTP. --- Verify the absolute difference between the APRM channels and the calculated power ≤ 2% [plus any gain adjustment required by LCO3.2.4] RTP.	7 days
SR 3.3.1.1.3	Adjust the channel to conform to a calibrated flow signal.	7 days
SR 3.3.1.1.4	---NOTE--- Not required to be performed when entering MODE 2 from MODE 1 until 12 hours after entering MODE 2. --- Perform CHANNEL FUNCTIONAL TEST.	7 days
SR 3.3.1.1.5	Perform CHANNEL FUNCTIONAL TEST.	7 days
SR 3.3.1.1.6	---NOTE--- Only required to be met during entry into MODE 2 from MODE 1. --- Verify the SRNMs indicate within [2]% RTP of actual reactor power at a reactor power level between [5]% and [40]% RTP.	7 days

SR 3.3.1.1.7	Calibrate the lo[illegible] power range monitors.	1000 MWD/T average core exposure
SR 3.3.1.1.8	Perform CHANNEL FUNCTIONAL TEST.	31 days
SR 3.3.1.1.9	Perform CHANNEL FUNCTIONAL TEST.	[92] days
SR 3.3.1.1.10	------------------NOTE------------------ Neutron detectors may be excluded. -- Perform CHANNEL CALIBRATION.	 184 days
SR 3.3.1.1.11	Perform CHANNEL FUNCTIONAL TEST.	[18] months
SR 3.3.1.1.12	------------------NOTE------------------ Neutron detectors may be excluded. -- Perform CHANNEL CALIBRATION.	 [18] months
SR 3.3.1.1.13	Verify the APRM Flow Biased Simulated Thermal Power--High time constant is ≤ [7] seconds.	[18] months
SR 3.3.1.1.14	Perform LOGIC SYSTEM FUNCTIONAL TEST.	[1[illegible]] months
SR 3.3.1.1.15	Verify Turbine Stop Valve (TSV) Closure and Turbine Control Valve (TCV) Fast Closure functions are not bypassed when ≥ [40] % RTP.	[18] months
SR 3.3.1.1.16	------------------NOTE------------------ Neutron detectors may be excluded. -- Verify the RPS RESPONSE TIME is within limits.	 [18] months on a STAGGERED TEST BASIS

Table 3.3.1.1-1 Reactor Protection System Instrumentation

FUNCTION	APPLICABLE MODES	CONDITION REFERENCED FROM REQUIRED ACTION C.1	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
1. Startup Range Neutron Monitors				
a. Neutron Flux--High	2		SR 3.3.1.1.1 SR 3.3.1.1.4 SR 3.3.1.1.6 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [48] % RTP
	$5^{(a)}$	H	SR 3.3.1.1.1 SR 3.3.1.1.5 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [48] % RTP
b. Neutron Flux--Short Period	$2^{(b)}$	G	SR 3.3.1.1.1 SR 3.3.1.1.4 SR 3.3.1.1.6 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [10.7] second period
	$5^{(a)(b)}$	H	SR 3.3.1.1.1 SR 3.3.1.1.5 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [10.7] second period
c. Inop	2	G	SR 3.3.1.1.4 SR 3.3.1.1.14	N/A
	$5^{(a)}$	H	SR 3.3.1.1.5 SR 3.3.1.1.14	N/A

2. Average Power Range Monitors				
a. Neutron Flux--High, Setdown	2	G	SR 3.3.1.1.1 SR 3.3.1.1.4 SR 3.3.1.1.6 SR 3.3.1.1.10 SR 3.3.1.1.14	≤ [13.6]% RTP
	5(a)	H	SR 3.3.1.1.1 SR 3.3.1.1.5 SR 3.3.1.1.10 SR 3.3.1.1.14	≤ [13.6]% RTP
b. Flow Biased Simulated Thermal Power--High	1	F	SR 3.3.1.1.1 SR 3.3.1.1.3 SR 3.3.1.1.8 SR 3.3.1.1.10 SR 3.3.1.1.13 SR 3.3.1.1.14 SR 3.3.1.1.16	≤ [0.66W + 52]% RTP, and ≤ [113.5]% RTP
c. Fixed Neutron Flux--High	1	F	SR 3.3.1.1.1 SR 3.3.1.1.2 SR 3.3.1.1.7 SR 3.3.1.1.8 SR 3.3.1.1.10 SR 3.3.1.1.14 SR 3.3.1.1.16	≤ [119]% RTP
d. Core Flow Rapid Decrease	≥ [80] % RTP(c)	D	SR 3.3.1.1.1 SR 3.3.1.1.3 SR 3.3.1.1.8 SR 3.3.1.1.10 SR 3.3.1.1.14 SR 3.3.1.1.16	Value of Z(d) ≤[1.5]% Flow
e. Inop	1, 2	G	SR 3.3.1.1.9 SR 3.3.1.1.14	N/A
	5(a)	H	SR 3.3.1.1.5 SR 3.3.1.1.14	N/A

3. Control Rod Drive Accumulator Charging Water Header Pressure--Low	1,2	G	SR 3.3.1.1.1 SR 3.3.1.1.8 SR 3.3.1.1.12 SR 3.3.1.1.14	≥ [1870] psig
	5(a)	E	SR 3.3.1.1.1 SR 3.3.1.1.5 SR 3.3.1.1.12 SR 3.3.1.1.14	≥ [1870] psig
4. Reactor Vessel Steam Dome Pressure--High	1,2	G	SR 3.3.1.1.1 SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14 SR 3.3.1.1.16	≤ [1090] psig
5. Reactor Vessel Water Level--Low, Level 3	1,2	G	SR 3.3.1.1.1 SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14 SR 3.3.1.1.16	≥ [23] inches
6. Drywell Pressure--High	1,2	G	SR 3.3.1.1.1 SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [1.85] psig
7. Main Steam Isolation Valve--Closure	1	F	SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14 SR 3.3.1.1.16	≤ [8]% closed
8. Main Steamline Radiation Monitors				
a. Main Steamline Radiation--High	1,2	G	SR 3.3.1.1.1 SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [3.6 X Background]
b. Inop	1,2	G	SR 3.3.1.1.9 SR 3.3.1.1.14	N/A

9. Turbine Stop Valve Closure	≥ [40]% RTP(e)	E	SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14 SR 3.3.1.1.15 SR 3.3.1.1.16	≤ [5] % closed
10. Turbine Control Valve Fast Closure, Emergency Trip System Oil Pressure--Low	≥ [40]% RTP(e)	E	SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14 SR 3.3.1.1.15 SR 3.3.1.1.16	≥ [500] psig
11. Suppression Pool Temperature--High	1, 2	F	SR 3.3.1.1.1 SR 3.3.1.1.9 SR 3.3.1.1.12 SR 3.3.1.1.14	≤ [ ] °F

(a) With any control rod withdrawn from a core cell containing one or more fuel assemblies

(b) Trip automatically bypassed within each SRNM (and not required to be OPERABLE) at reactor power levels ≤ [10^{-4}]% RTP

(c) Trip automatically bypassed within each APRM (and not required to be OPERABLE) at reactor power levels ≤ [80]% RTP

(d) 2*(Flow(t) - A X Flow(t-3 seconds) - B) % Flow; A = [ ], B = [ ]

(e) Trip automatically bypassed within each divisional RPS TLU at reactor power levels ≤ [40]% RTP, as approximated by a single turbine first stage pressure instrument channel in each division

3.3 INSTRUMENTATION

3.3.1.2 Reactor Protection System (RPS) Trip Actuation

LCO 3.3.1.2 Four RPS automatic trip channels and ? RPS manual trip channels shall be OPERABLE.

APPLICABILITY: MODE 1 and 2,
MODE 5 with any control rod withdrawn from a core cell containing one or more fuel assemblies

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One RPS automatic trip channel inoperable.	A.1.1 Place channel in bypass.	1 hour
	AND	
	A.1.2 Restore channel to OPERABLE status.	7 days
B. Required Actions and associated Completion Times of Condition A not met.	B.1.1 Place inoperable RPS automatic trip channel in trip.	8 hours
	OR	
	B.1.2 Perform SR 3.3.1.2.1 on OPERABLE RPS automatic trip channels.	8 hours AND Once per 7 days thereafter
	AND	
	B.2 Restore inoperable channel to OPERABLE status.	31 days

C. Two RPS automatic trip channels inoperable.	C.1	Place one channel in bypass and the other in trip.	1 hour
	AND		
	C.2	Restore one channel to OPERABLE status.	24 hours
D. One RPS manual trip channel inoperable.	D.1	Place channel in trip by disconnecting power to the associated scram pilot valve solenoids	1 hour
	AND		
	D.2	Restore channel to OPERABLE status.	24 hours
E. Required Action and associated Completion Time of Condition B, C or D not met in MODE 1 or 2.	E.1	Be in MODE 3.	12 hours
F. Required Action and associated Completion Time of Condition B, C or D not met in MODE 5 with any control rod withdrawn from a core cell containing one or more fuel assemblies.	F.1	Initiate action to insert all insertable control rods in core cells containing one or more fuel assemblies.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.3.1.2.1	Perform CHANNEL FUNCTIONAL TEST for automatic and manual scram channels.	31 days
SR 3.3.1.2.2	Perform CHANNEL FUNCTIONAL TEST for Reactor Mode Switch--Shutdown Position scram function.	[illegible] months
SR 3.3.1.2.3	Perform LOGIC SYSTEM FUNCTIONAL TEST.	[18] month[illegible]