UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

JUN 20 1980

In Reply Refer To:
RII:JPO
50-338, 50-339
50-404, 50-405
50-280, 50-281

Virginia Electric and Power Company
ATTN: J. H. Ferguson
Executive Vice President-Power
P. O. Box 26666
Richmond, VA 23261

Gentlemen:

This Circular is forwarded for information. No written response to this IE Circular is required. If you have any questions related to this matter, please contact this office.

Sincerely,

for James P. O'Reilly
Director

Enclosures:
1. IE Circular No. 80-15
2. List of Recently Issued IE Circulars

cc w/encl:
W. R. Cartwright, Station Manager
P. G. Perry, Senior Resident Engineer
J. L. Wilson, Manager

8007020434

SSINS No.: 6835
Accession No.:
8005050073

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D. C. 20555

June 20, 1980

IE Circular No. 80-15

LOSS OF REACTOR COOLANT PUMP COOLING AND NATURAL CIRCULATION COOLDOWN

Description of Circumstances:

This Circular contains information on the St. Lucie Unit 1 response to a total loss of component cooling water (CCW) flow to reactor coolant pumps. Pressurizer level and primary system pressure response indicate that voids were formed in the reactor vessel during the ensuing natural circulation cooldown. The void was believed to have been steam in the area located directly under the reactor vessel head.

At time 0226 on June 11, 1980 with St. Lucie Unit 1 at full power, an electrical short across a solenoid valve terminal board caused one of two series containment isolation valves in the CCW return from all reactor coolant pumps (RCP) to fail shut. The terminal short resulted from environmental effects of a minor steam leak in the immediate vicinity of the solenoid valve. After unsuccessful attempts to restore CCW flow, the reactor was tripped manually at time 0233. Within two minutes, all four RCPs were also manually tripped. A natural circulation cooldown was initiated at approximately 0300.

Component cooling water flow to RCPs was restored at 0400. The solenoid operated air valve whose terminal board had shorted was bypassed with a temporary air line to reopen the CCW valve (HCV-14-6). Although variations in seal leakoff flowrates were observed, the seals on the four idle RCPs did not fail. St. Lucie has Byron Jackson reactor coolant pumps with three stage mechanical seals plus a vapor seal. Controlled reactor coolant bleedoff flow is used for seal cooling and lubrication. The pumps do not have a seal water injection system.

The natural circulation cooldown continued uneventfully until after time 0600. The highest cooldown rate achieved was approximately 65 to 70 F per hour. Between 0600 and 0630 RCS pressure was reduced from 1140 to 690 psi by charging water through the pressurizer auxiliary spray line. Pressurizer level increased rapidly around 0700 while charging via the auxiliary spray line. Pressurizer level continued variations for approximately five hours while the cooldown and depressurization continued. When charging was shifted to the RCS loops, pressurizer level decreased at rates lower than the rates of increase in level when charging through the auxiliary spray line. During a two minute interval while charging into the pressurizer auxiliary spray line at 88 gpm, pressurizer level rose at a rate approximately ten times greater than the charging flowrate.

The cause of pressurizer level variations appears to be formation of a steam void in the reactor head area due to a temperature lag with respect to bulk coolant temperature that developed because of insufficient cooling flow in that area during natural circulation cooldown. Gas concentration in a 0730 RCS sample was determined by the licensee to be 32 cc/kg hydrogen and 16 cc/kg nitrogen. These concentrations were not high enough to cause a significant volume of gas to come out of solution. The indicated subcooling margin (Tsat - Thot) ranged between 220 and 150 F when the reactor head steam void developed between 0600 and 0700. The minimum required subcooling of 50 F was not approached during the cooldown until around time 1219 at a pressurizer pressure of approximately 110 psig. An annotated record of pressurizer level is enclosed only to illustrate the high amplitudes and rates of pressurizer level variations. Insufficient information is contained in the enclosure to enable detailed evaluation of the RCS behavior.

Shutdown cooling using low pressure safety injection (LPSI) pump 1B was established at time 1051. At time 1227, LPSI pump 1A was started taking suction from the refueling water tank (RWT) and discharging into the low pressure safety injection header common to both LPSI pumps. The common recirculation line motor operated isolation valves to the RWT were opened at 1226. LPSI 1A was operating with its recirculation (miniflow) line open. The LPSI pump 1B recirculation line should have been closed. The pressurizer was filled to what was believed to be a water solid condition by charging at 88 gpm and using LPSI pump 1A to inject water and maintain near shutoff head pressure on the RCS. RCS pressure rose from the minimum 110 psig to 200 psig (time 1300 reading) during the time LPSI pump 1A was operating.

The cold calibrated pressurizer level instrument indication rose to 64 percent and remained constant while hot calibrated channels rose to 100% level. Temperature correction data for the cold calibrated level instrument didn't extend to 360 F, which was the approximate pressurizer temperature when the pressurizer indicated full. Constant level on the cold calibrated channel indicated the pressurizer was solid, but continued charging flow at 88 gpm was not causing pressure to rise above 200 psig, as it should have had the RCS been solid. Letdown had been secured while filling the pressurizer. The indications of a steam void in the reactor vessel head were no longer evident after RCS pressure increased although the exact time when the void disappeared has not been established.

During the time LPSI pump 1A was operating with miniflow recirculation to the RWT, the absence of rising pressure in response to charging flow was investigated. RWT level increased 0.3 feet (approximately 4500 gal.) during this period. Miniflow from LPSI pump 1B operating in the shutdown cooling mode is believed to have been the discharge path from the RCS to the RWT. After shutdown cooling system warmup, the LPSI pump 1B miniflow manual isolation valve had been shut. After RWT level increased, this valve was found one turn open, which would have allowed miniflow back to the RWT from LPSI pump 1B. At time 1357, LPSI pump 1A operating in the injection mode was secured and miniflow was isolated. Continued charging with two pumps at 88 gpm total flowrate caused a slight rise in both pressurizer pressure (to 260 psig) and cold calibrated pressurizer level. Letdown in excess of charging flowrate was established at 1430, and by 1500 a steam bubble was drawn in the pressurizer with level in the indicating range.

The RCS was degasified over the next day, then depressurized and drained to inspect and replace all RCP seals. All seals have been removed and visual inspection showed no signs of degradation of these seals.

This event is significant for several reasons. It is an example of a natural circulation cooldown during which a steam void formed under seemingly normal conditions that was large enough to cause large, rapid variations in pressurizer level. The possibility of a total loss of component cooling water to reactor coolant pumps due to the single failure of any one of four CCW containment isolation valves was highlighted. Inadequate control of LPSI system alignment allowed an unanticipated discharge of reactor coolant directly to the refueling water tank apparently through a pump recirculation line.

Recommended Action for Power Reactor Licensee Consideration:

1. Disseminate this information to all licensed operating personnel working at power reactor facilities. These personnel should become aware of the possibility of steam void formation in the reactor vessel head during natural circulation cooldown even when a high subcooling margin exists in the reactor coolant loops.

2. Review and revise natural circulation cooldown and shutdown cooling procedures to caution operators against the anomalous conditions that occurred and to include appropriate recovery action if they do occur.

3. Establish a natural circulation cooldown and depressurization rate envelop that will both preclude steam void formation and assure adequate core cooling. Incorporate this envelop in cooldown procedures.

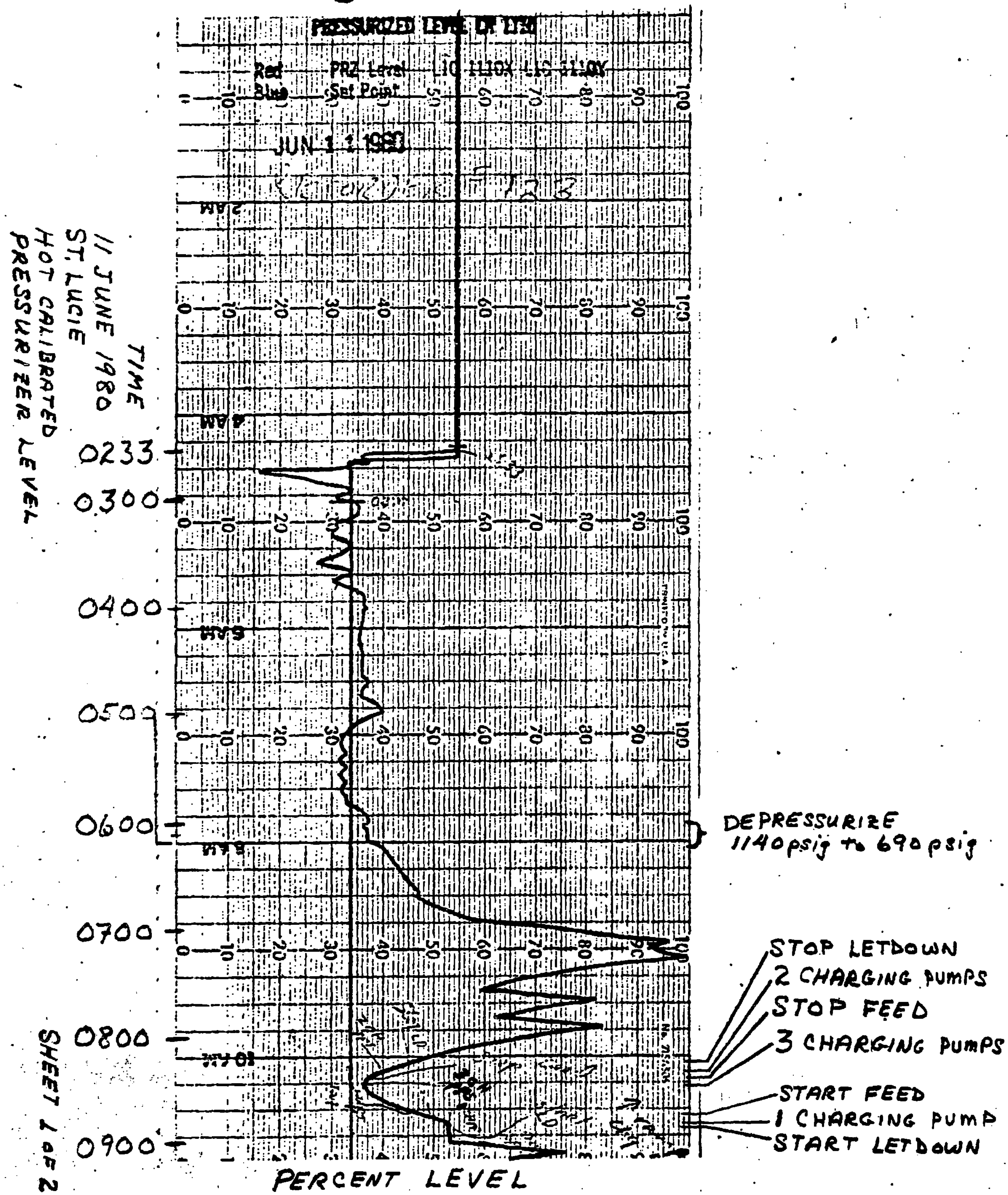
4. Evaluate the design of component cooling water systems to determine vulnerability to single failures that could cause loss of RCP cooling, common cause failures of RCP seals and reactor coolant system leaks through failed seals at multiple locations.

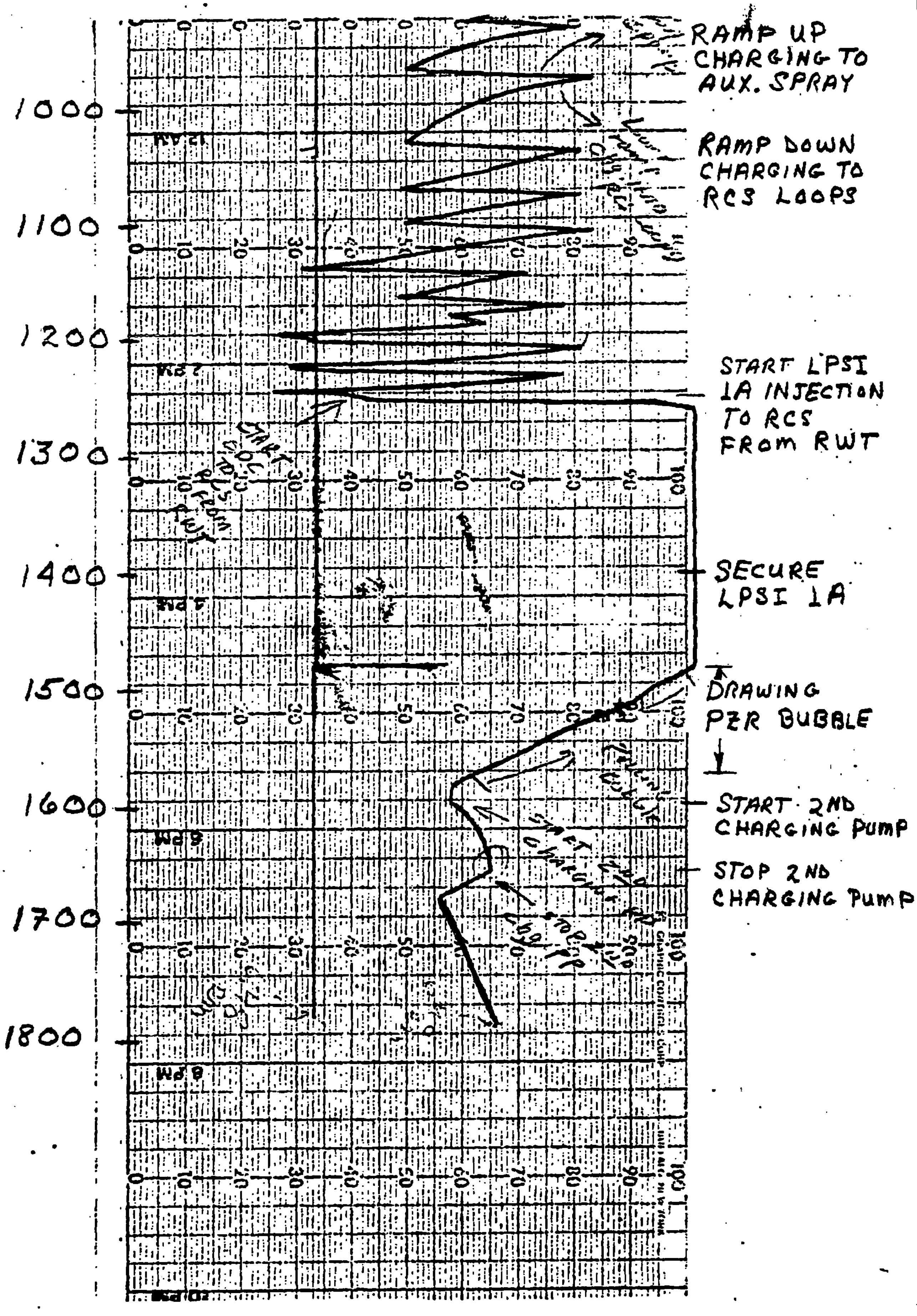
5. Consider installation of a reactor vessel head metal temperature monitoring system, if not already installed. It should aid the operator in preventing a reactor head to bulk coolant temperature differential large enough to form a steam void during natural circulation cooldown.

If you have questions regarding this matter, please contact the Director of the appropriate NRC Regional Office.

No written response to this Circular is required.

Enclosure:
Annotated record of
pressurizer level


PRESSURIZED LEVEL OF LT-30
Red PRZ Level LIC 1110X LIC 1110Y
Blue Set Point
0 10 20 30 40 50 60 70 80 90 100
JUN 1 1 1980
TIME
11 JUNE 1980
ST. LUCIE
HOT CALIBRATED
PRESSURIZER LEVEL
0233
0300
0400
0500
0600
0700
0800
0900
DEPRESSURIZE
1140psig to 690psig
STOP LETDOWN
2 CHARGING PUMPS
STOP FEED
3 CHARGING PUMPS
START FEED
1 CHARGING PUMP
START LETDOWN
PERCENT LEVEL
SHEET 1 of 2


RAMP UP CHARGING TO AUX. SPRAY
RAMP DOWN CHARGING TO RCS LOOPS
START LPSI 1A INJECTION TO RCS FROM RWT
SECURE LPSI 1A
DRAWING PZR BUBBLE
START 2ND CHARGING PUMP
STOP 2ND CHARGING PUMP
1000
1100
1200
1300
1400
1500
1600
1700
1800
12 PM
2 PM
4 PM
6 PM
8 PM
10 PM
0
10
20
30
40
50
60
70
80
90
100

SHEET 2 OF 2

IE Circular No. 80-15
June 20, 1980

Enclosure

RECENTLY ISSUED
IE CIRCULARS

Circular No.	Subject	Date of Issue	Issued to
80-15	Loss of Reactor Coolant Pump Cooling and Natural Circulation Cooldown	6/20/80	All holders of OLs and CPs
80-14	Radioactive Contamination of Plant Demineralized Water System and Resultant Internal Contamination of Personnel	6/24/80	All holders of Power and Research Reactor licensees (Operating and Construction Permits), and Fuel Cycle licensees
80-13	Grid Strap Damage in Westinghouse Fuel Assemblies	5/18/80	All holders of Reactor OLs and CPs
80-12	Valve-Shaft-To-Actuator Key May Fall Out of Place When Mounted Below Horizontal Axis	5/14/80	All holders of Reactor OLs and CPs
80-11	Emergency Diesel Generator Lube Oil Cooler Failures	5/13/80	All holders of a power reactor OL or CP
80-10	Failure to Maintain Environmental Qualification of Equipment	4/29/80	All holders of Reactor OLs and CPs
80-09	Problems With Plant Internal Communications Systems	4/28/80	All holders of a power reactor OL or CP
80-08	BWR Technical Specification Inconsistency - RPS Response Time	4/18/80	All General Electric BWR's holding a power reactor OL
80-07	Problems with HPCI Turbine Oil System	4/3/80	All holders of a power reactor OL or CP
80-06	Control and Accountability Systems for Implant Therapy Sources	4/14/80	Medical licensees in Categories G and G1
80-05	Emergency Diesel-Generator Lubricating Oil Addition and Onsite Supply	4/1/80	All holders of a power reactor OL or CP
80-04	Securing of Threaded Locking Devices on Safety-Related Equipment	3/14/80	All holders of a power reactor OL or CP