December 3, 1977

DISTRIBUTION:
Docket
NRC PDR
L PDR
ORB#4 Reading
EGCase
WMcDonald, MIPC
KRGoller
RIngram
MFairtile
OELD
OI&E(3)
BJones (2)
BScharf (10)
DEisenhut
ACRS(16)
OPA, Clare Miles
JBuchanan
TAbernathy
Gray file
4 XTRA
TCarter

Docket No. 50-280

Virginia Electric & Power Company
ATTN: Mr. W. L. Proffitt
Senior Vice President - Power
P. O. Box 26666
Richmond, Virginia 23261

Gentlemen:

Enclosed is a signed original of an Order for Modification of License, dated December 3, 1977, issued by the Commission for the Surry Power Station Unit No. 1. This Order amends Facility Operating License No. DPR-32 permitting continued operation of Surry Unit No. 1 for six equivalent months of operation, beyond midnight December 3, 1977, and relates to the steam generator repair program license provisions of the NRC Order of May 6, 1977. Appendix A-1 to the license, issued May 6, 1977, is being continued in order to implement the restrictions of Ordered License Condition 3.E.(4) regarding reactor coolant activity.

A copy of the related Safety Evaluation is also enclosed. The Order is being filed with the Office of the Federal Register for publication.

Sincerely,

Original signed by

Robert W. Reid, Chief
Operating Reactors Branch #4
Division of Operating Reactors

Enclosures:
1. Order for Modification of License
2. Safety Evaluation

cc w/enclosures: See next page

ORB#4:DOR
RIngram
12/2/77

for RWR
AD-OT:DOR
DEisenhut
12/2/77

cont 3

OFFICE	ORB#4:DOR	C-ORB#4:DOR	AD-OR:DOR	D:DOR	A-DXNRR	OELD
SURNAME	MFairtile:dn	RWReid	KRGoller	VStello	EGCase	
DATE	12/2 /77	12/2/77	12/2/77	12/3/77	12/ /77	12/ /77

NRC FORM 318 (9-76) NRCM 0240 ☆ U. S. GOVERNMENT PRINTING OFFICE: 1976 — 626-624

cc w/enclosure(s):

Michael W. Maupin, Esq.
Hunton, Williams, Gay & Gibson
P. O. Box 1535
Richmond, Virginia 23213

Mr. Sherlock Holmes, Chairman
Board of Supervisors of Surry County
Surry County Courthouse
Surry, Virginia 23683

Mr. James C. Dunstan
State Corporation Commission
Commonwealth of Virginia
Blandon Building
Richmond, Virginia 23209

Chief, Energy Systems
Analyses Branch (AW-459)
Office of Radiation Programs
U. S. Environmental Protection Agency
Room 645, East Tower
401 M Street, S.W.
Washington, D.C. 20460

U. S. Environmental Protection Agency
Region III Office
ATTN: EIS COORDINATOR
Curtis Building (Sixth Floor)
6th and Walnut Streets
Philadelphia, Pennsylvania 19106

Swem Library
College of William & Mary
Williamsburg, Virginia 23185

Commonwealth of Virginia
Council on the Environment
903 9th Street Office Building
Richmond, Virginia 23219

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
VIRGINIA ELECTRIC AND POWER COMPANY	)	Docket No. 50-280
	)	
Surry Power Station, Unit No. 1	)	

ORDER FOR MODIFICATION OF LICENSE

I.

Virginia Electric and Power Company (the licensee), is the holder of Facility Operating License No. DPR-32 which authorizes the operation of the nuclear power reactor known as Surry Power Station, Unit No. 1 (the facility) at steady state reactor power levels not in excess of 2441 thermal megawatts (rated power). The reactor is a pressurized water reactor (PWR) located at the licensee's site in Surry County, Virginia.

II.

On February 8, 1977, the NRC staff issued an Order for Modification of License No. DPR-32 which addressed operation of Surry Power Station Unit No. 1 under conditions in which steam generator tubes have been plugged as a result of the tube denting caused by corrosion of the tube support plate in the annular spaces between tube and the tube support plate. Subsequently on February 11, 1977, the NRC staff issued a Safety Evaluation supporting the Order. In order to perform an inspection of the steam generators, the February 8, 1977 Order limited operation to 60 equivalent days of operation.* On May 6, 1977, a sub-

*Equivalent operation is defined as operation with the reactor coolant at or above 350°F.

sequent Order was issued with an accompanying Safety Evaluation providing for an additional six months of equivalent operation, after the staff evaluated the results of an inspection and repair program. On November 30, 1977, the licensee submitted the results of the inspection and repair program required by the May 6, 1977 Order. The NRC staff has evaluated the results of the inspection and repair program and has assessed whether continued operation of the facility would be safe. This evaluation is set forth in the staff's concurrently issued Safety Evaluation relating to steam generator tube integrity.

We have reviewed the licensee's November 30, 1977 inspection program submittal. The plugging pattern used is based on criteria that reasonably predict areas of increased strain. To assure early detection and repair of leaks in tubes that have not been plugged, the licensee proposed in his November 30, 1977 submittal to continue the operating limitations of the May 6, 1977 Order applicable to this facility. With the plugging that has been performed and these operating limitations, the assessment of accidents in our May 6, 1977 Safety Evaluation remain valid. As described in our Safety Evaluation, continued operation under these limitations will

provide reasonable assurance that the public health and safety will not be endangered. The NRC staff believes that under the circumstances, the limitations proposed by the licensee are appropriate and should be confirmed by NRC order.

Copies of the following documents are available for public inspection in the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C. 20555, and at the Swem Library, College of William and Mary, Williamsburg, Virginia, (1) licensee's submittal of November 30, 1977, (2) Order for Modification of License dated May 6, 1977, (3) this Order for Modification of License, In the Matter of Virginia Electric and Power Company, Surry Power Station, Unit No. 1, Docket No. 50-280, and (4) the Commission's concurrently issued Safety Evaluation supporting this Order*/.

*/ A copy of items (2), (3), and (4) may be obtained upon request addressed to the U. S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director, Division of Operating Reactors.

III.

Accordingly, pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's Rules and Regulations in 10 CFR Parts 2 and 50, IT IS ORDERED THAT Facility Operating License No. DPR-32 is hereby amended by replacing in its entirety existing paragraph 3.E. of the license with the following:

E. Steam Generator Inspection

(1) Unit No. 1 shall be brought to the cold shutdown condition in order to perform an inspection of the steam generators within six equivalent months of operation from December 3, 1977. Nuclear Regulatory Commission approval shall be obtained before resuming power operation following this inspection. Equivalent operation is defined as operation with the reactor coolant at or above 350°F.

(2) Primary coolant leakage from the primary system to the secondary system through the steam generator tubes shall be limited to 0.3 gpm per steam generator, as described in the NRC Safety Evaluation of May 6, 1977. With any steam generator tube leakage greater than this limit the reactor shall be brought to the cold shutdown condition within 24 hours. Nuclear Regulatory Commission approval shall be obtained before resuming reactor operation.

(3) Reactor operation will be terminated if primary to secondary leakage which is attributable to two or more tubes occurs during a 20 day period. Nuclear Regulatory Commission approval shall be obtained before resuming reactor operation.

(4) The concentration of radioiodine in the primary coolant shall be limited to 1 μCi/gram during normal operation and to 10 μCi/gram during power transients as defined in Appendix A-1 to the Technical Specifications of the license. Appendix A-1 was issued with the May 6, 1977 Order and shall remain in effect for six equivalent months of operation from December 3, 1977.

FOR THE NUCLEAR REGULATORY COMMISSION

Victor Stello, Jr., Director
Division of Operating Reactors
Office of Nuclear Reactor Regulation

Dated in Bethesda, Maryland,
this 3rd, day of December 1977.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING ORDER FOR MODIFICATION OF LICENSE

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION, UNIT NO. 1

DOCKET NO. 50-280

INTRODUCTION

By letter dated November 30, 1977, Virginia Electric & Power Company (VEPCO) requested NRC's approval for the return of Surry Unit No. 1 to power operation for six equivalent months. Surry Unit No. 1 has been operating under an NRC Order for Modification of License dated May 6, 1977, which permitted operation of the unit for six equivalent months.

Among other operational limitations delineated in the May 6 Order, the NRC required that at the expiration of the Order all three steam generators in Unit No. 1 be inspected and that NRC approval be obtained prior to resumption of power operation.

DISCUSSION

Inspection Program

During the current shutdown, VEPCO inspected all three steam generators in Surry Unit No. 1 to determine, to the extent possible, the adequacy of the preventive tube plugging criteria that was implemented during the April-May 1977 outage and to determine whether the unit may continue to operate in a safe manner.

The inspection program, which was primarily based on the results of a finite element analysis of growth of strain contours, included all regions containing strains in excess of 12.5%. The ID gauging for denting was performed utilizing a series of different probe sizes, i.e., 0.540, 0.610, and 0.650" probe diameters. The areas probed were chosen on the bases of the analysis of the critical strain contours in the tube support plate, the predicted growth of magnetite in the tube/tube support plate annuli and at the patch plate and wedge locations, and data from previous inspections. The tubes were initially gauged with the 0.650" probe. Those tubes that did not allow passage of this probe

were then gauged with the 0.610" probe. Any tubes which did not allow passage of the 0.610" probe were then gauged with the 0.540" probe. The results of this gauging process did indicate a fair correlation with the strain analysis in the support plate. Severely dented tubes were plugged in accordance with the tube plugging criteria (to be discussed). Details of the steam generator inspection program actually conducted are summarized as follows:

1. Tube gauging was performed the hot leg sides of all three steam generators. The following tubes including all lower row numbered tubes back to the tube lane were inspected: R7C1, R12C2, R15C3, R17C4, R19C5, R21C6, R23C7 thru R23C15, R12C15 thru R12C80, R23C80 thru R23C88, R21C89, R19C90, R17C91, R15C92, R12C93, and R7C94. In addition, gauging was performed on all tubes two rows beyond any tube that did not pass a 0.650" probe.

2. Gauging was performed in all three steam generators in several small regions bounded by 12.5% strain contours.

3. Gauging was performed in all three steam generators in the one o'clock and eleven o'clock wedge regions including two rows beyond any tube restricting a 0.650" probe.

4. Gauging was performed in all three steam generators in the patch plate regions including two rows beyond any tube not allowing passage of a 0.650" probe.

5. Gauging was performed in steam generator A from the cold leg side through the U-bends of the following tubes including all lower row numbered tubes back to the tube lane: R7C1, R12C2, R15C3, R16C4 thru R16C12, R5C12 thru R5C83, R16C83 thru R16C91, R15C92, R12C93, and R7C94.

6. Gauging was performed in steam generators B and C from the cold leg side through the U-bends of the first five rows of tubes including two rows out from any tube restricting a 0.610" probe.

7. The flow slots in the first tube support plate were inspected in all three steam generators.

Results of Inspections and Corrective Actions

During the initial inspection, at a 500 psig secondary side pressure, leaks were found in cold leg tube R14C92 and at the plug in cold leg tube R18C57 in generator A, hot leg tube R12C7 in generator B, and hot leg tubes R3C26 and R7C88 and at the plug in hot leg tube R1C77 in generator C. The leak rate for the unit, prior to shutdown, was less than 0.3 gpm. The leaking tubes are located within areas that were inspected. The leaking plugs were repair welded using the Westinghouse technique.

Results of the current inspection program just completed show that only three tubes have leaked within the normal inspection program. One additional tube leaked from the cold leg side of generator A and subsequent gauging indicated that some measure of inspection was required. Three tubes on the hot leg side restricted the 0.540" probe. All tubes which restrict the 0.610" probe on the hot leg side lie adjacent to tubes which were previously preventative plugged and well within the 15% strain contour.

Of the cold leg tubes inspected in generator A, 14 tubes did not allow passage of the 0.540" probe. All but two of these tubes lie outside of row 5 and thus were never gauged before. However, it was noted that they all lie in the peripheral columns, fall within the 15% strain contours, are clustered together, and would have been gauged were a cold leg program instituted previously. All the tubes which restrict the 0.610" probe on the cold leg side lie well within regions of high tube strain contours indicating a cold leg denting progression similar to the hot leg progression, but at a reduced rate.

No tubes restrict the 0.650" probe in all the discrete zones bounded by 12.5% strain contours.

No restrictions occurred in the wedge or patch plate regions.

Of all the tubes that restricted 0.650" probes at both the previous and current outages, 60% still pass the 0.610" probe and more than 98% still pass the 0.540" probe. Again, all of these tubes lie well within the 15% strain contours.

The flow slots in the first tube support plate were inspected in all three steam generators. No unusual indications were found and the details are to be used in the on-going evaluation of the strain model.

The inspection results indicate that in no case where there is a so-called "spiked" preventative plugging pattern has there been any significant restriction of tubes in adjacent columns. However, in regions of the tube lane where a given column is surrounded by columns with significant plugging and tube restrictions, thereby creating a "valley" in the pattern, some increase in tube deformation has been observed at the bottom of the valleys.

Plugging Criteria

The licensee has implemented the following plugging criteria to justify a period of six (6) months of operation:

(a) All tubes which did not pass the 0.540" probe were plugged.

(b) Additionally, for in excess of six months operation, two tubes beyond (i.e., higher row numbers) any tube in columns 15-79 which did not pass the 0.540" probe were plugged; for such tubes in column 1-14 and 80-94 five tubes beyond were plugged on the hotleg side and four tubes beyond were plugged on the coldleg side.

(c) All tubes which did not pass the 0.610" probe were plugged.

(d) The tubes in any column for which plugging under criteria (a), (b), or (c) above was implemented would also be plugged in the lower row numbered tubes back to the tubelane if not already plugged.

(e) As a conservative measure, tubes completely surrounding any known leaky tubes including the diagonally next tube -- were plugged, if not already covered by the foregoing criteria.

(f) In any given column which is surrounded by columns containing tubes with significant tube restriction or prior plugging, (thereby creating a "plugging valley" in the pattern) engineering judgment was used to fill the bottom of the valley. In the peripheral tubelane areas near the three and nine o'clock wedges, tubes surrounded by previously plugged tubes or tubes exhibiting high deformation activity were plugged based on engineering judgment.

(g) Additional preventive plugging was implemented at the wedge locations. This plugging included all tubes that:

(1) restrict the 0.540" probe

(2) restrict the 0.610" probe

(3) restrict the 0.650" probe at the periphery

(4) surround leakers and tubes that restrict the 0.540" probe -- including the diagonally next tube.

Criteria stated in (b) for plugging the tubes beyond those which do not allow passage of a 0.540" probe are based on the projected growth of tube hoop strain contours at which stress corrosion cracks are observed.

OPERATING EXPERIENCE

Surry Unit No. 1 has operated without a shutdown for leakage for six months using similar plugging criteria with a leak rate at shutdown of less than 0.3 gpm. The licensee stated in the November 30, 1977, submittal that more conservative plugging criteria have been used during the current outage.

EVALUATION

By letter dated November 30, 1977, the licensee (VEPCO) proposed to continue operation of Surry Unit No. 1 for a period of six (6) months. This proposal was based on the results of the extensive examination program and the supporting conclusions discussed above. The NRC staff has reviewed the information submitted by the licensee and concluded the following:

1. Items 1 through 4 in the Safety Evaluation included in the May 6, 1977 Order are still valid.

2. Since there were no restricted tubes found in the patch plate or wedge regions, it appears that no new hardspots had developed in these areas.

3. The increase in denting observed on the cold leg side are compatible with the hot leg history and the finite element analytical results. The licensee plans to continue monitoring the progression of denting on the cold leg side during future inspections. Furthermore, a plugging criteria has been established for cold leg tubes consistent with the finite element analytical results and the hot leg plugging criteria.

4. Plugging criteria (b) attempts to address the continuing growth of tube hoop strain projected to occur over the next six months of operation. An examination of the projected tube hoop strains that will exist six months from now shows that many unplugged hot leg tubes will be at hoop strain levels in excess of 15 to 20% and many cold leg tubes will be at hoop strain levels exceeding 12.5 to 15%. At this time the staff has seen no data to substantiate VEPCO's following statements:

   "....tubes with strains less than 15% are not subject to excessive tube restrictions and hence are not vulnerable to stress corrosion cracking."

   "....the growth of the 17.5% contour is a more appropriate measure of movement of the severely dented tubes."

Even if these statements are accurate they do not justify leaving many tubes unplugged which are predicted to be at hoop strain levels above 15% in less than six months of operation. Further contradicting evidence that does not support the licensee's statements concerning excess tube restrictions occurring at hoop strain levels exceeding 15 to 17.5% comes from the fact that, although the finite element analyses appear to give a fair correlation to actual gauging results, a close examination of the hoop strains currently existing in some of the tubes that did not allow passage of a 0.540" probe show the tubes have hoop strains of approximately 12.5%.

The staff does not completely accept plugging criteria (b) due to the concerns outlined and discussed above. We feel, however, that items 3.(d), (e), (f) and (g) contained in the safety evaluation included in the May 6, 1977 Order adequately address these concerns.

5. To address any concerns that some tubes scheduled to be examined were missed or that errors were made in tube plugging, the licensee took photographs of the tube sheets to verify the plugging patterns and gauged all tubes which did not previously pass the 0.650" probe in order to improve their inspection program.

   For reasons discussed above, the staff recommends that the following operational limitations be continued:

   Operational Limitations

   1. A limit for primary to secondary leakage of 0.3 GPM will assure that no individual cracks will reach such proportions that it may become unstable during normal or accident loading conditions. If this limit is reached operation shall be terminated.

   2. A substantial increase in the frequency at which leaking tubes are encountered could signal the development of more extensive general degradation. The potential for such a development during operation has been substantially alleviated by the limitations described below, requiring operation to be terminated in the event that the frequency of the detection of leaking tubes per plant should increase substantially to more than 1 in twenty days. Specifically, the restriction is that operation is to be terminated if two (2) or more tube leaks per plant occur during any twenty (20) day period. This restriction limits the potential number of heat up and cool down cycles resulting from tube plugging, and minimizes concern for possible thermal ratcheting.

3. At the end of the proposed six (6) month operating period, the unit shall be brought to cold shutdown condition for a re-inspection of the conditions of the steam generators and to re-assess the subsequent duration and mode of operation. Detailed inspection requirements will be determined by the NRC staff and the licensee.

We have concluded, based on the considerations discussed above, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (2) such activities will be conducted in compliance with the Commission's regulation and the issuance of this Order will not be inimical to the common defense and security or to the health and safety of the public. However, this conclusion is only applicable for six (6) equivalent months operation.

Dated: December 3, 1977