



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO AMENDMENT NO. 54 TO FACILITY OPERATING LICENSE NO. DPR-41

FLORIDA POWER AND LIGHT COMPANY

TURKEY POINT PLANT UNIT NO. 4

DOCKET NO. 50-251

INTRODUCTION

By letter dated December 18, 1980 Florida Power and Light Company (the licensee) submitted the results of the most recent steam generator inspection at Turkey Point Unit 4 and requested authorization to operate Unit 4 for six equivalent months from the time of the inspection. Equivalent operation is defined as operation with the reactor coolant greater than 350°F. The implemented steam generator inspection and preventive plugging program are similar to those performed previously at this and other similarly degraded units and have been determined adequate by the NRC to support six (6) equivalent months of operation, subject to the licensee submittal for staff review, information concerning the tube wastage predicted to occur during the later half of the operating period which begins January 13, 1981 and extends for six equivalent months of operation. This information is to be supplied by February 28, 1981.

DISCUSSION

The steam generator tube inspection performed at Turkey Point Unit 4 during November 1980 included programs to assess tube degradation associated with both the denting and wastage phenomena. For denting, tube gauging was performed in all three steam generators using 0.650, 0.610, and 0.5 inches (diameter) eddy current probes. The implemented gauging program was similar to those implemented previously at this and other similarly degraded units and included the gauging of all unplugged tubes within areas (tubelane, periphery, wedge, and patch plate regions of the hot leg, and tubelane region of the cold leg) where significant denting activity had been observed previously. Significant denting, in this context, is considered to include (in addition to leakers) tubes restricting passage of a .610 inch probe (or less) and tubes at the periphery of the hot leg wedge location and on either side of the patch plate boundary which restrict passage of a .650 inch probe (or less), since these tubes are the most likely candidates to develop inservice leaks.

In previous inspections of the tubelane region, finite element analysis had been used to determine the progression of significant tube restriction activity for purposes of defining the boundary for the tubelane gauging inspection. However, the 17.5% tube hoop strain contour which realistically bounded the significant tube restriction activity in the tubelane following the previous inspection is now predicted to cover most of the support plate. Thus, the licensee elected to gauge the tubelane tubes within a boundary incorporating regions of previously observed activity (i.e. tubes restricting passage of 0.650 inch probes), plus several rows of tubes beyond.

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With regard to the defined regions (discussed above) within which all tubes were gauged, if a restricted tube (tube restricting a 0.650 inch probe) was found close to the inspection boundary, the inspection was expanded in that area. In addition, a sample population of tubes in the central bundle region, located outside these defined regions, was tested with a 0.700 inch probe in the hot and cold legs, respectively, as part of the Regulatory Guide 1.83 eddy current inspection (to be discussed). These latter inspections provide an early indication of any new deformation which exists away from the regions usually regarded as active (i.e. the tubelane, patch plate, wedges and periphery). Tubes restricted in previous sample inspections, but not adjacent to the areas of predominant activity were also incorporated into the inspection.

Measurements of the visible support plate flow slots in all steam generators were made to assess the condition of the support plates and to provide a gross measure of the continuation of denting.

Eddy current inspection for wastage was conducted in accordance with Regulatory Guide 1.83 in all of the steam generators. The U-bends of the unplugged tubes in rows three through five in steam generator C were also eddy current inspected.

The following tabulation summarizes the number of tubes included in the gauging and eddy current inspections:

	<u>A Hot Leg</u>	<u>A Cold Leg</u>	<u>B Hot Leg</u>	<u>B Cold Leg</u>	<u>C Hot Leg</u>	<u>C Cold Leg</u>
Gauging	1184	154	1159	117	1324	161
U-Bend Rows 2-5	-	-	-	-	-	79
R. G. 1.83	397	317	383	527	268	461

### INSPECTION RESULTS

The results of the gauging inspection in terms of the number of tubes restricting passage of a given size probe of 0.65 inch or less are summarized below:

	<u>Tubelane</u>		<u>Periphery &amp; Wedge</u>		<u>Patch Plate</u>
	<u>Hot Leg</u>	<u>Cold Leg</u>	<u>Hot Leg</u>	<u>Cold Leg</u>	<u>Hot Leg</u>
<u>SG A</u>					
.650"	29	0	25	0	3
.610"	7	0	3	0	1
.540"	0	0	1	0	0

SG B					
.650"	32	0	42	0	3
.610"	4	3	8	2	0
.540"	0	0	0	0	0
SG C					
.650"	34	0	15	0	13
.610"	5	1	5	3	1
.540"	1	0	1	0	0

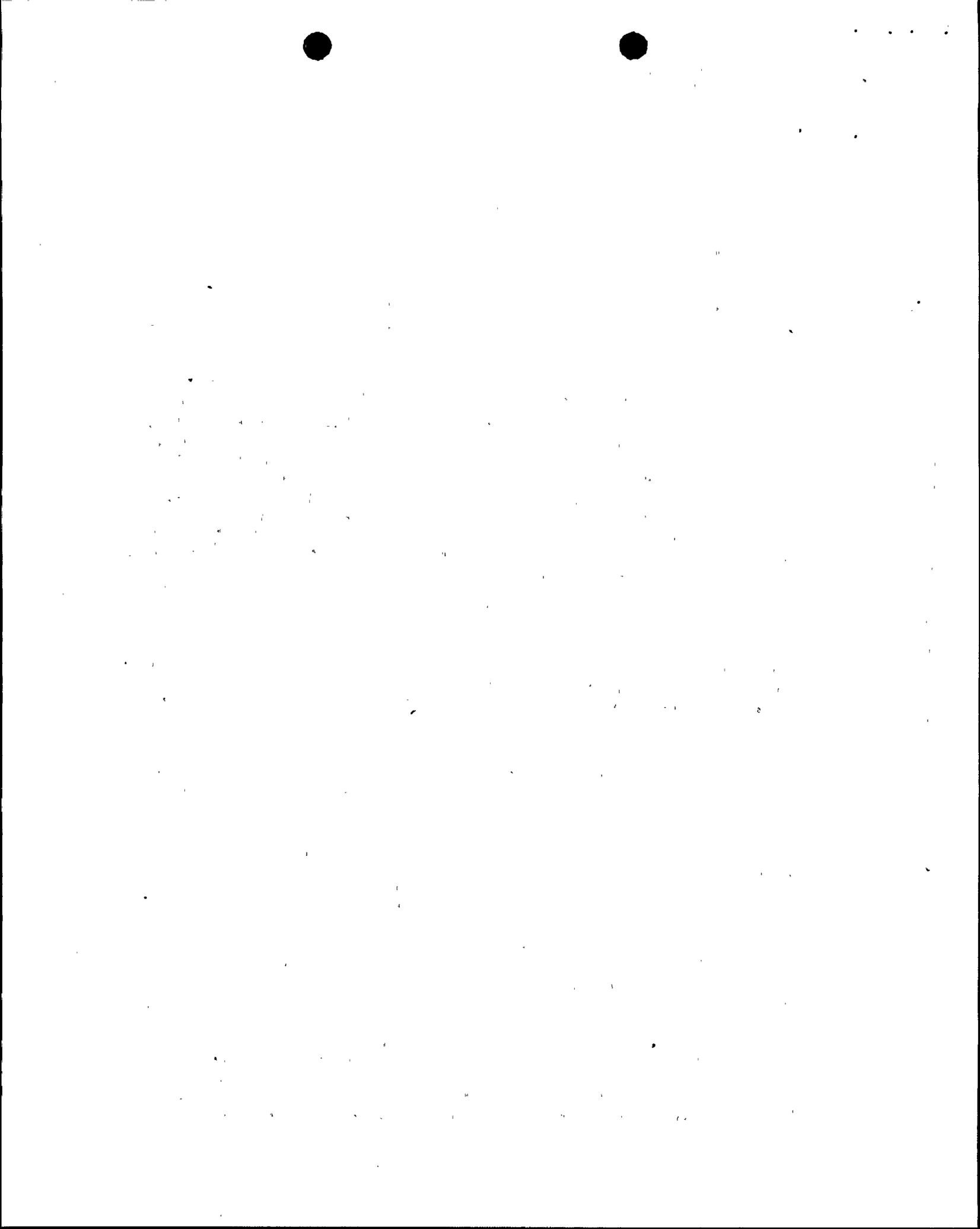
Tubes in the tubelane region that restrict a 0.650 inch probe or less are located adjacent to the areas in which such restrictions have been observed during previous inspections. In general, tube restriction activity observed in the periphery, wedge, and patch plate areas appears consistent with previous experience at this and other similarly degraded units. In Steam Generator B, four tube restrictions occurred away from the pattern of prior results. Two tubes, one restricts a 0.610 inch probe and the other restricts a 0.650 inch probe, were located adjacent to a tube which had been pulled in September 1975 as part of the earliest field investigations of denting. The other two tubes, which restrict passage of 0.650 inch probes, were located adjacent to the patch plate inspection area. In Steam Generator C, one tube restricting a 0.650 inch probe was located adjacent to the patch plate inspection area. The level of denting activity in the cold leg remains low compared to the hot leg activity.

The eddy current inspection performed in accordance with Regulatory Guide 1.83 identified 25 tubes that required plugging due to thinning indications. The following summarizes the results of the Regulatory Guide 1.83 inspection:

Size of Indication (% Wall Penetration)	SG A		SG B		SG C	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
<20	54	76	50	125	4	132
20-29	40	174	30	133	4	194
30-39	20	71	21	83	1	57
40-49	1	0	0	13	1	2
50-59	1	0	1	4	1	0
60-69	1	0	0	0	0	0

It should be noted from the above tables that the results for the cold leg side of Steam Generator A include four (4) indications which were picked up during gauging.

The results of the Regulatory Guide 1.83 inspection for wastage indicate an apparent increase in thinning activity relative to previous inspections, particularly in the cold leg side of steam generator B where 17 pluggable indications were found at the top of the tubesheet elevation. The licensee reports an average increase in thinning during the period April 1979 to



November 1980 of 9.9% in steam generator B and approximately 1% in steam generators A and C. Data provided by phone on January 6, 1981 indicates that during the period May 1980 to November 1980 thinning increased by an average of 13% for the 17 tubes in the cold leg of steam generator B which were found to contain pluggable indications.

The licensee believes that while some additional thinning may have occurred since the previous inspections, the overall increase is likely to be smaller than that indicated by the reported data. Comparison of the affected tubes in steam generator B with corresponding signals from previous inspections shows the presence of an increased denting component. The dent signal influences the thinning signal, causing slight phase rotation and overestimations of the depth of penetration. Westinghouse is currently reevaluating the eddy current signals from both the November and May 1980 inspections in an attempt to determine a more realistic value of thinning increase during this period.

No eddy current indications were identified in the U-bends of the unplugged tubes in Rows 3 through 5.

The measurements of the support plate flow slots indicated no deviations from anticipated conditions.

#### TUBE PLUGGING PROGRAM

The plugging criteria implemented for dented tubes during the November 1980 steam generator inspection are the same as those implemented previously at this and other similarly degraded units. These criteria include the plugging of two tubes beyond any 0.540 inch restricted tube found in the tubelane region. This latter criterion was based in the past upon finite element predictions regarding the progression of tube denting during the next operating interval. Based upon their experience, the licensee believes that the finite element model no longer provides an appropriate basis for tube plugging. Thus, they have discontinued the practice of updating the analyses with each succeeding inspection. The criterion for plugging two tubes beyond 0.540 inch restricted tubes, which was previously developed using the finite element model, has been retained by the licensee since its application has generally been effective in reducing the frequency of tube leakage events resulting from denting. The licensee notes that only one 0.540 inch restricted tube in the tubelane region, where this criterion is applicable, was found during this inspection.

Tubes with greater than 40% through wall eddy current indications were plugged.

Implementation of the plugging criteria resulted in 24, 37, and 44 tubes being plugged for denting and 3, 18, and 4 tubes being plugged for wastage in steam generators A, B, and C, respectively. Total steam generator tube plugging in all three steam generators is approximately 23.8% which is conservatively bounded by the 25% tube plugging assumption ECCS analysis, approved on May 15, 1980.



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## EVALUATION

The November 1980 gauging and preventive plugging program at Turkey Point Unit 4 is similar to previous programs conducted in at this and other similarly degraded units. This inspection included the gauging of all tubes within areas (tubelane, periphery, wedge, and patch plate regions) where significant denting activity, has been observed previously. In addition, a sample population of tubes in the central bundle region were gauged as part of the Regulatory Guide 1.83 inspection for wastage.

Based upon our review of the gauging results, we find that the observed denting activity is generally consistent with previous experience at this and other similarly degraded units. Although denting in four (4) tubes in Steam Generator B and one (1) tube in Steam Generator C occurred away from the pattern of prior results, we find significant tube restriction activity remains confined to areas immediately adjacent to previous activity. The implemented gauging program was sufficient to adequately determine the condition of the steam generator from a denting standpoint.

The preventative plugging criteria implemented during this and previous inspections have proven successful in removing from service those tubes which are the most likely candidates to develop inservice leaks. The inspection data and recent operating experience provide adequate justification for the implemented criterion of plugging two tubes beyond 0.540 inch restricted tubes in the tubelane. We find that the implemented gauging program and preventive plugging criteria provide reasonable assurance that the vast majority of tubes most likely to develop inservice leaks have been identified and removed from service. No forced shutdowns because of steam generator tube leakage occurred during the 4.75 months of operation since the previous inspection in May 1980. The 0.3 gmp leak rate limit in the license provides adequate assurance that even if through wall cracks and leaks occur, they will be detected and appropriate corrective action taken before excessive leakage can occur from tube degradation during normal operating, transient, or accident conditions.

With regard to the wastage phenomenon, the November 1980 eddy current inspection (in accordance with Regulatory Guide 1.83) and 40% plugging limit are similar to those implemented in previous inspections. The results, however, indicate an apparent increase in thinning activity relative to previous inspections, particularly in the cold leg side of steam generator B where 17 pluggable indications were found. A comparison of the November 1980 eddy current results with the previous May 1980 results indicates an apparent average increase of 13% in wall thinning penetration during this period for the 17 tubes in the cold leg of steam generator B containing the plugging indications. The licensee believes that the increase in thinning is likely to be less than that indicated by the reported data due to the confounding effect of increased denting component on the eddy current signal. They have not submitted adequate confirmatory data to support this belief.

In view of data indicating a possibly high rate of wastage degradation in the Turkey Point Unit 4 steam generator, we have performed an evaluation to determine if the implemented 40% plugging limit provides adequate assurance that unacceptable wastage degradation of the tube walls will not occur during the six months preceding the next steam generator inspection. We have used Regulatory Guide 1.121 (issued for comment in August 1976) as guidance in evaluating the reported data. Regulatory Guide 1.121 defines the basis for plugging degraded steam generator tubes. The Regulatory Guide specifies, in part, that degraded steam generator tubes should meet the following criteria:

- (1) A margin of safety against tube failure during postulated accidents consistent with ASME code requirements.
- (2) A factor of safety against tube burst of at least 3 under normal operating conditions, and
- (3) Loadings during normal operating conditions should not produce a primary membrane stress in excess of the material yield stress at operating temperature.

In meeting these criteria, the Regulatory Guide states that allowance is to be made for future degradation. On the basis of wastage degradation at the average rate of 13% (through wall) during the previous 4.75 equivalent full power months of operation, we estimate that the above criteria can only be complied with during the first 3.5 months of operation from the time of the November 1980 inspection. Based on information supplied by the licensee in telephone conversations, we have performed simplified calculations that indicate that acceptable margins against tube failure during postulated accidents will exist throughout a six month operating period. However, we estimate that during normal operating conditions the minimum margin to burst would be approximately 2.5 rather than 3 and the material yield strength would be exceeded by approximately 10% at the end of the six month operating period.

Although compliance with Regulatory Guide Criteria pertaining to normal operating pressure cannot be shown to exist beyond 3.5 months, we believe that the unit can be safely operated for six months for the following reasons:

- (1) Margin with respect to tube failure under postulated accident conditions provides reasonable assurance against the occurrence of multiple tube failures and excessive leakage.
- (2) Margin of approximately 2.5 with respect to tube burst exists under normal operating conditions and provides assurance that multiple tube ruptures will not occur.
- (3) In degraded tubes where stresses exceed yield under normal operating conditions, the consequences would likely be limited to small leaks of individual tubes. The 0.3 gpm primary to secondary



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leak rate limit in the Plant Licensee provides assurance that in the event that a leak occurs in service, appropriate and timely corrective action will be taken.

From a denting standpoint, we find that the gauging inspection results, implemented plugging and existing leak rate limits adequately support six equivalent months of operation from the time of the November 1980 inspection. By February 28, 1981, confirmatory data and analysis which demonstrates that unacceptable wastage degradation of the tube walls will not occur prior to performing the next steam generator inspection will be submitted.

#### ENVIRONMENTAL CONSIDERATION

We have determined that the amendment does not authorize a change in effluent types or total amounts nor an increase in power level and will not result in any significant environmental impact. Having made this determination, we have further concluded that the amendment involves an action which is insignificant from the standpoint of environmental impact and, pursuant to 10 CFR §1.5(d)(4), that an environmental impact statement or negative declaration and environmental impact appraisal need not be prepared in connection with the issuance of this amendment.

#### CONCLUSION

We have concluded, based on the considerations discussed above, that: (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously considered and does not involve a significant decrease in a safety margin, the amendment does not involve a significant hazards consideration, (2) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public.

Date: January 15, 1981

