UNITED STATES OF AMERICA

ATOMIC ENERGY COMMISSION

IN THE MATTER OF	)	
	)	
	)	DOCKET NO. 50-29
YANKEE ATOMIC ELECTRIC COMPANY	)	

Appearances

Donald G. Allen, Esq., and Allen O. Eaton, Esq.
For Yankee Atomic Electric Company

Troy B. Conner, Jr. Esq., and William R. Stewart, Esq.
For the Staff of the Atomic Energy Commission

FIFTH INTERMEDIATE DECISION
AND AUTHORIZING POWER OPERATIONS TO 485 MEGAWATTS THERMAL

Yankee Atomic Electric Company of Boston, Massachusetts, (Yankee) on February 13, 1961, filed with the Atomic Energy Commission a report covering the operation, under previously issued Commission License No. DPR-3, of its nuclear power utilization facility, located in Rowe, Massachusetts, during a six month's period ending January 29, 1961, as well as results of a 500-hour test run at 392 megawatts thermal (MWT) which was completed on February 9, 1961. This report of these operations was required of Yankee by virtue of the terms 1/ of the operating license issued in

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1/ The pertinent provision of the license is as follows:
"This license is effective as of the date of issuance and shall expire upon the effective date of a final decision by the Commission following a public hearing to be held respecting operations of the facility at the 392 MW (thermal) steady state power level after the filing by Yankee with the Secretary of the Commission of the report required under paragraph 3.C.(2) of this license. Such hearing will be held upon 15 days notice to the public and no later than 90 days following the filing of the aforesaid report."

accordance with the Third Intermediate Decision made effective by the Commission on July 19, 1960, and is needed as a basis for consideration of any request for authority to operate the nuclear reactor at any increased power level.

On March 31, 1961, Yankee filed Amendment No. 25 to its original application for an operating license and thereby requested that License No. DPR-3 be further amended so as to authorize operation of its nuclear power utilization facility at steady state power levels not in excess of 485 MWT and to extend the expiration date of the license to a date forty years after the date of Construction Permit No. CPPR-5, issued on November 4, 1957.

On April 25, 1961, the Commission issued a Notice of Hearing providing for a public hearing to be held on May 12, 1961 as contemplated by the terms of the license issued to Yankee, with the issues specified as follows:

(1) Whether on the basis of the report dated February 13, 1961, filed by Yankee, the processes to be performed, the operating procedures, the facility and equipment, the use of the facility and the technical specifications, collectively, provide reasonable assurance that the health and safety of the public will not be endangered by operation of the facility at power levels up to 392 megawatts thermal steady state.

(2) Whether or not an operating license should be issued to the Yankee Atomic Electric Company pursuant to Section 50.56 of the Commission's regulations (10CFR Part 50), such license to expire on a date 40 years after the date of the Construction Permit CPPR-5, which was issued on November 4, 1957, and whether the license proposed to be issued for a period of 40 years would then expire on November 4, 1997.

On April 25, 1961 the Staff filed a motion to postpone the date of hearing until June 1, 1961, or a later date, and to enlarge the issues in the proceeding to include:

Whether Facility License No. DPR-3, as amended, should be further amended to increase the maximum authorized power level from 392 megawatts (thermal) to 485 megawatts (thermal),

This motion was based upon the ground that by a postponement, the Advisory Committee on Reactor Safeguards may have an opportunity to consider Yankee's Amendment No. 25 requesting authority for a power level of 485 MWT. Yankee concurred in the motion, which was granted, the issues to be considered were enlarged and postponement was made on May 12, 1961 to June 8, 1961, when the case convened. No persons sought permission to intervene in the proceeding nor to otherwise participate in the proceeding in accordance with the Rules of Practice of the Commission. The case was concluded on June 8, 1961, after which the participants submitted proposed findings and conclusions and comments, the last on June 12, 1961.

Yankee's report of operations at 392 MWT and the data submitted in support of its request for an increase of power to 485 MWT were reviewed by the Advisory Committee on Reactor Safeguards on May 18, 1961. The Committee's report dated May 22, 1961 was included in the public record in this proceeding and in part is as follows:

> "In previous letters dated February 1, 1960, May 9, 1960, and June 27, 1960, the Committee dealt with safety matters including those covered in the Final Hazards Summary Report, Technical Specifications, and all pertinent amendments through No. 23. The one major point which was unresolved related to testing the reactor for effects of plutonium build-up at about 2000-hour intervals. In letters dated October 21, 1958, February 1, 1960, and May 9, 1960, the Committee indicated that such testing could be done in the reactor without undue hazard, but that the program and its results should be reviewed by the Committee. The program and its results to date have been reported by the applicant. The Committee finds the procedures to be acceptable and notes that there have been no detectable effects of plutonium build-up during the first 2000-hour period. The Committee believes that continued use of in-core monitoring of at least the first core is essential to an understanding of how the core is changing with time. The Committee wishes to be kept informed of any significant data that may be developed in this program.
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> "Amendments 24, 26, 27 and 28, and Proposed Changes 1-8 deal with minor modifications to the plant and changes in the Technical Specifications. These should be worked out by Yankee Atomic Electric Company and the AEC staff. Amendment 25 is a request to amend License No. DPR-3 so as to authorize operation of the reactor at steady state power levels to 485 MW(t) and to extend the expiration date of the license to a date forty years after the expiration date of the construction permit.
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> "It is the opinion of the ACRS that with continued surveillance of the plant by the applicant, as proposed, the plant can be operated at steady state power levels of approximately 485 MW(t), with the changes requested, without undue hazard to the health and safety of the public."

The foregoing designated third intermediate decision provided for a substantial period of test operation prior to the issuance of a permanent operating license, in order to confirm the design characteristics of the reactor by actual experimental data. The maximum authorized power level of the reactor during this period was limited to 392 MWT to correspond with the design criteria established for the initial core. Yankee had presented evidence that the initial core had been deliberately undersigned in the expectation that actual performance would exceed design specifications, and might well prove adequate for operation at the full nominal rating of the plant of 485 MWT (estimated to correspond to 145 MWE, or 136 MWE after deducting station use). It was concluded, however, that the final increase of power to 485 MWT could better be evaluated after the results of operation at 392 MWT had been established.

In the technical specifications, which are a part of the Yankee License No. DPR-3, provision was made for the procedure to be followed during the initial start-up of the Yankee reactor, including the tests to be performed prior to core loading, the procedures to govern initial core loading and the approach to initial criticality, and the tests to be performed at low power and during initial power operations as stepwise increases were made to the maximum power level of 392 MWT authorized by the license which was provisional in this respect.

Prior to the issuance to Yankee of the operating license on July 9 1960, construction of the reactor and all associated systems had been completed so far as possible prior to the introduction of the initial fuel material, and all necessary preoperational testing had been satisfactorily accomplished.

After issuance of the operating license, the reactor vessel head was removed and the reactor vessel was filled with borated water to the core loading level. Core loading commenced on July 15 with the installation of the first neutron source. After calibration and adjustment of the temporary neutron detectors, core loading proceeded with the installation of the shim rods and thereafter with individual loading of control rods and fuel elements. Core loading was carried out in accordance with operating restrictions in the technical specifications which required boron concentrations to be maintained at a level sufficient to render the fully loaded core at least 10% subcritical, and permitted core loading to be continued only if a projection of inverse source multiplication count rates indicated that the core would remain subcritical with double the number of fuel assemblies then in place. Core loading was completed on July 26. Normal plant source range instrumentation was then tested and more sensitive source range detectors were installed when it was found that the detectors originally installed would not give satisfactory readings from the neutron sources through heavily borated water.[2/] The control rod drive shafts and the in-core nuclear instrumentation were then installed. Final closure of the reactor vessel was delayed while the ports in the vessel head were enlarged to accommodate the in-core instrumentation.[3/]

2/ Yankee replaced the initially installed source range detectors with more sensitive detectors.

3/ The evidence from Yankee was that a major delay was occasioned by a mistake in design which resulted in a misfit between the in-core instrumentation lead columns and the ports in the vessel head through which they pass.

Electrical leads from the in-core instrumentation and the control rod drive mechanisms were then connected and tested,[4/] and cold drop tests were performed to verify functioning of the control rods.

On August 19 the initial approach to criticality was commenced[5/] by the partial withdrawal of the outer group of control rods. The remaining groups of control rods were withdrawn in small increments, and initial criticality was achieved with all control rods slightly more than one-third withdrawn.

The period from August 19 to November 10, 1960 was devoted to low-power testing in accordance with a schedule previously described in the license application and incorporated in the technical specifications. An expanded test program on control rod drives and rod drop times was carried out at operating temperatures and pressures. Control rod worth and boron worth were then measured over a range of temperatures from ambient temperature to operating temperature, and over a range of boron concentrations from 1150 ppm to zero. These tests showed control worth in good agreement with previously calculated values, and indicated that the initial reactivity of the core was slightly in excess of design criteria. As predicted, the reactor can be shut down and maintained 3% subcritical at operating temperatures by the use of the control rods alone, and the cold clean core can be maintained 5% subcritical by the addition of boric acid to the main coolant water in a concentration of 1150 parts per million.

4/ In testing control rod drive mechanisms some electrical grounds occurred in some of the operating coils, which had to be returned to the manufacturer.

5/ Yankee stated that during core loading, there developed an unexpectedly high increase in count rate as additional fuel assemblies were added. Core loading was suspended for several days while data was analyzed by the physicists. The problem was ultimately traced to geometric effects arising from loading sequence, which was thereafter changed.

Measurements of the temperature coefficient of reactivity over a range of temperatures and with varying boron concentrations confirmed the negative character of this important coefficient, and indicated that its value, at operating temperatures and conditions, is slightly in excess of that previously calculated. Measurements of the smaller positive pressure coefficient indicated agreement with prior calculations and the flow coefficient was found to be essentially zero. Tests of the nuclear instrumentation used for the control of the reactor indicated excellent response to the changes in control rod positioning and other changes in the distribution of flux within the core.

At the completion of low-power testing, the turbine generator was brought up to speed and synchronized, and the initial generation of electricity occurred on November 10, 1960. A further series of tests was then performed as the plant was brought up in power in steps of 30 MWE to 120 MWE, corresponding to 392 MWT, the maximum level authorized by the license. Plant instrumentation and control systems performed in accordance with design, and the reactor regulated automatically on temperature control with no rod motion required for small load variations throughout the power range. Loss of load tests were performed at 30 MWE and 60 MWE, and indicate that transient temperature and pressure limitations will not be exceeded throughout the power range, even if the reactor is not automatically scrammed upon loss of the electrical load. Initial measurements of the power coefficient of reactivity were made and a satisfactory

method of future measurements at 2000-hour intervals throughout core life was established. Measurements of radioactivity levels throughout the plant were carried out, and upon the addition of extra shielding 6/ at the top of the neutron shield tank all levels of radioactivity were within prescribed limits. Tests of emergency cooling by natural circulation were carried out at 60 MWE and 120 MWE, and established that after a scram caused by loss of the main coolant pumps, adequate cooling will be provided by natural circulation to remove decay heat from the core. However, continued circulation of cold water through the secondary side of the steam generators was found to increase the reactivity of the core and, although the reactor will remain sub-critical during this transient, an automatic boiler feed pump trip is to be installed as an additional protective feature.

Excessive vibration in the shaft of the turbine-generator caused a two weeks' delay in the completion of power testing, which was resumed on January 16, 1961 after satisfactory modifications of turbine blade rings had been made. A full load of 120 MWE was attained on January 17. With only slight interruptions, operations continued at this power level during the required 500-hour run, which concluded on February 8, 1961.

Operations have since continued at substantially full power level except for a shutdown in February occasioned by excessive valve stem leakage, a shutdown in early April for making the required tests and measurements at the end of 2,000 hours of core life, and a shutdown in

6/ The extra shielding was first in the form of barrels of water which have now been replaced by blocks made up of ½-inch sheets of tempered masonite. Each block is covered with 20-guage sheet aluminum.

May for maintenance on the turbine governor system. It is the Yankee view that operating results have established a higher over-all plant efficiency than it originally predicted, with the result that a 392 MWT reactor power level has been found to correspond to gross electrical power level of 125 MWE.

A detailed description of power operations and test results to date is contained in the six-months' operating report as supplemented by testimony introduced on behalf of Yankee, and confirmed by testimony of the AEC inspector assigned to this project. It is concluded that operation of the reactor has been carried out in accordance with the terms of the license, and that the nuclear characteristics and performance of the reactor have been substantially in agreement with design expectations and previously calculated[7/] and predicted values. No hazards have been disclosed[8/], either different from or greater than those previously analyzed in the license application and reviewed by the Commission in connection with the issuance of the presently outstanding license. It is further concluded, therefore, that operation of the reactor pursuant to the outstanding license has confirmed the safety of continued operations, subject to the restrictions now in effect, and provides a satisfactory basis for the issuance of a permanent 40-year operating license for this facility.

As indicated by the Third Intermediate Decision, the purpose of requiring a substantial period of operation at 392 MWT was first, to confirm the nuclear characteristics of the reactor through actual operating

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7/ The change in the core loading sequence to avoid the geometric effects first experienced as shown by the "unexpectedly high increase in count rate" constitutes a variance from initial calculations, and warrants reference of such nuclear characteristics to competent physics, which Yankee has done.

8/ Certain scrams have occurred which were due to human error, which will warrant continued alertness to avoid hazards.

experience, and second, to provide measured values of important nuclear characteristics at the design power level of the initial core in order to predict core capability and performance at higher power levels. Of particular importance in determining the capability of the core are the thermal limitations known as the "hot channel factors", which state the relationship of average heat conditions in the core to the maximum conditions in the hottest channel. The principal function of the in-core instrumentation is to provide a means of determining flux and temperature distributions within the core in order to provide accurate data for the calculation of the hot channel factors.

At the conclusion of the preliminary testing program and the 500-hour run at 392 MWT, Yankee and Westinghouse Electric Corporation, the nuclear designer of the plant, reanalyzed core capability and performance on the basis of experimentally determined values, to determine whether the power level could be increased within the limits set by existing operating restrictions. The results of this analysis are contained in the data submitted as a part of the foregoing identified Amendment No. 25 to Yankee's license application. These calculations indicate that, based on the most extreme conditions anticipated throughout core life, the thermal limitations in the technical specifications will not be exceeded by steady state operation at 485 MWT. Specifically, heat flux at the point closest to burnout in the hottest channel will not exceed 50% of the burnout heat flux, as predicted by the Bettis Correlations; coolant

temperature at the exit of the hottest channel will not exceed 603°F; and the maximum clad surface temperature in the hottest channel will not exceed 663°F.

In addition, all transients associated with the accidents, postulated in the hazards summary report, were reanalyzed at 485 MWT on the basis of operating experience to date, and the experimentally established hot channel factors. Identification of the maximum credible accident and the ev[illegible]more severe hypothetical accident remained unchanged, with consequences no more severe than those originally analyzed. Reanalysis of the loss of load transient, however, has indicated the desirability of additional protective features, authorization for which has already been given by the Commission's Division of Licensing and Regulation on change requests[9/] submitted by Yankee.

9/ These Yankee requests were approved on May 25 and June 6, 1961 and include authority for installation of a vent system for the distillate accumulator tank in the radioactive waste disposal system, change in the circuitry and set points of the safety injection system, installation of the control circuitry necessary to initiate a trip of the boiler feed pumps in the event of a reactor scram above 15 MW electric, addition of a scram initiation circuit which would provide a reactor scram in the event of high water level in the pressurizer, assumption of a dilution factor of 1000 for radioactive noble fission gasses, clarification of the use of the monitor in the incinerator stack and maintenance of the monitor in continuous service, change in the relative position of a motor operated valve and manually operated valve. These changes were authorized on the basis that none of the foregoing present significant hazard considerations not described or implicit in the license application as amended to January 12, 1961, and that there is reasonable assurance that the health and safety of the public will not be endangered by operation of the nuclear facility as thus modified. The scope of this authority for change may be limited somewhat by Yankee's representation that for instance, in the course of loss of load transient tests, the negative temperature transient drop in temperature following the scram, "was more severe than had been calculated in the course of design work and in the accident analysis in the license application."

Based on the foregoing, it is concluded that authorization may properly be given to operation of the reactor at a steady state power level of 485 MWT.

A revision of the technical specifications was submitted by Yankee which eliminates superseded provisions relating to initial start-up and testing and in addition makes certain revisions to correspond with change authorizations requested by Yankee, and reviewed by the Division of Licensing and Regulation of the Commission, and the Advisory Committee on Reactor Safeguards. The proposed revision of the technical specifications was concurred in by the AEC Staff and will be incorporated in the amended license authorized by this decision. The amended license will include reporting requirements suitable for a permanent operating license.

On May 4, 1961 Yankee filed a motion requesting the Commission to enter an order authorizing the Presiding Officer, in his discretion, to provide that any intermediate decision and order for the issuance of an amended license in this proceeding might become effective immediately upon issuance, subject to later review by the Commission upon exceptions or on its own motion. Yankee indicated that it desired to have the order in this proceeding become effective prior to the expiration of the period for Commission review in order to establish July 1, 1961 as the date marking the end of the period of construction and test operations and the commencement of regular operation of the plant for purposes of its accounting, power contracts and financial documents; and, further, in order

to make available the additional generating capacity of the plant at the earliest practicable date. On June 12, 1961, the Commission issued its order in this docket responsive to the motion filed by Yankee. Upon the basis of this entire record, and under the circumstances, it appears reasonable to provide for the immediate effectiveness of this intermediate decision, subject to later review by the Commission upon the terms provided in the foregoing order.

In addition to the foregoing, which constitutes findings and conclusions, and upon consideration of the record in this proceeding, including testimony, exhibits and the submissions of the parties, it is found and concluded that:

1. Yankee Atomic Electric Company, a Massachusetts corporation with its principal office at 441 Stuart Street, Boston, Massachusetts, is the holder of Facility License No. DPR-3, issued on July 9, 1960 and amended on July 29, 1960 and January 12, 1961, authorizing operation of a pressurized water reactor for use in the generation of electricity at a nuclear power plant situated in Rowe, Massachusetts. The reactor is a utilization facility as defined in the Atomic Energy Act of 1954, as amended, and the foregoing license for its operation has been granted pursuant to section 104(b) of the Act.
2. The reactor has heretofore been operated at steady state power levels of 392 MWT in accordance with the terms of the foregoing

license. On the basis of operations to date, as reported to the Commission in an operation report filed by Yankee dated February 13, 1961 and supplemented by testimony in this proceeding, the processes to be performed, the operating procedures, the facility and equipment, the use of the facility and the technical specifications, collectively, provide reasonable assurance that the health and safety of the public will not be endangered by operation of the reactor at steady state power levels up to 485 MWT.

3. Facility License No. DPR-3, heretofore issued on a provisional basis, should be further amended, pursuant to section 50.56 of the Commission's regulations, to provide for the continued operation of the reactor upon the terms prescribed herein, the license as so amended to expire on a date 40 years after the date of the Construction Permit No. CPPR-5, namely, on November 4, 1997.

WHEREFORE, IT IS ORDERED, subject to the review procedures provided for this proceeding by the Commission, and in accordance with the Atomic Energy Act, as amended, and the Rules and Regulations of the Commission:

A. The Division of Licensing and Regulation shall issue to Yankee Atomic Electric Company an amended license pursuant to Section 104(b) of the Atomic Energy Act of 1954, as amended, authorizing the continued operation of the foregoing reactor, said amended license

to be in the form attached as Exhibit A hereto.

'B. In accordance with the Commissior's Order in this docket dated June 12, 1961, this Intermediate Decision and Order shall become effective immediately upon issuance, subject to (1) the filing and consideration of a petition for review, if any, pursuant to Sections 2.751 and 2.752 of the Commission's Rules of Practice, and (2) such further order as the Commission may enter upon its own motion within forty-five (45) days after the issuance of such intermediate decision and order: provided, however, That, in the absence of any further Commission order pursuant to the foregoing, the intermediate decision and order shall become the final decision and order of the Commission at the end of such forty-five day period.

Samuel W. Jensch
Presiding Officer

Issued:

June 20, 1961

Germantown, Maryland