3.I. Inservice Inspection

A-53
7.9.79

In accordance with the provisions of 10 CFR 50.12 (a) an exemption from the provisions of 10 CFR 50.55a (g) is granted, and the effective date for the start of the next 40-month period as it relates to inservice inspection is extended from July 30, 1979 to January 30, 1980.

4. This license is effective as of the date of issuance and shall expire at midnight on February 28, 2013.

FOR THE ATOMIC ENERGY COMMISSION

A. Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing

Enclosures:
Appendices A & B - Technical Specifications

Date of Issuance: MAY 2 2 1973

ATTACHMENT 1

SIGNIFICANT HAZARDS CONSIDERATION EVALUATION FOR THE PROPOSED CHANGE TO THE EXPIRATION DATE OF THE VERMONT YANKEE NUCLEAR POWER STATION

APRIL 1989

The proposed amendment to the Vermont Yankee operating license does not involve any changes in the design or operation of the facility, but instead, only contemplates a change to the expiration date of the current license[8]. This extension is within the range permissible by the Commission's regulations, specifically 10CFR, Section 50.51. In addition, a finding of no significant hazards consideration is consistent with recent NRC actions on applications of this type. As discussed in Attachment 2 (safety and environmental assessments) and the following evaluation, the proposed extension will have no significant impact on the safe operation of the plant or present an undue risk to the health and safety of the public.

The proposed license amendment to permit the 40-year operating life does not constitute a significant hazards consideration as defined in 10CFR, Section 50.92 for the following reasons:

a. The proposed amendment does not involve a significant increase in the probability or consequences of any accident previously evaluated.

Age-related degradation was identified as the only mechanism having potential impact on the probability of occurrence of an accident previously evaluated. Changes in the population size and distribution were identified as the only parameter having potential impact on previous conclusions concerning the consequences of an accident previously evaluated.

Conservatisms have been incorporated, in the design, construction, and operations of the Vermont Yankee facility. Furthermore, programs have been developed and implemented to: (1) evaluate and maintain the service life of structures, systems, and components; (2) conduct technical analyses for verifying the adequacy of structures, systems, and components; and/or (3) allow surveillance, maintenance, and inspection of the facility. Such programs assure that the Vermont Yankee facility will be operated as intended by its design and the Technical Specifications. That is, regardless

of the age of the overall facility, these programs assure that the structures, systems, or components will be refurbished and/or replaced to maintain component functional capability and the margins of safety required by the Technical Specifications.

No changes to the above programs are necessary for assuring that during the proposed amendment term, Vermont Yankee continues to perform as intended by its design and the Technical Specifications. Therefore, the proposed amendment will have no significant impact on plant safety.

In 1986, Vermont Yankee Nuclear Power Corporation conducted a study to update the population figures found in the ER[5] and FSAR[3] and to project populations through the year 2012. As the report[7] indicates, the projected population in the 50-mile area surrounding the Vermont Yankee facility is expected to remain unchanged during the proposed amendment term. There are no changes to the exclusion area boundaries, the increase in population in the Low Population Zone is projected as being negligible, and the nearest population center is expected to remain more than 1-1/3 times the current five-mile Low Population Zone (LPZ) radius from the facility as required by 10CFR100.11(a)(3). Based on the results of this study, the off-site exposures from releases due to postulated accidents are expected to remain well within the limits set forth in 10CFR, Part 100.

Because there will not be significant changes in the population and its distribution surrounding the plant, and Vermont Yankee Nuclear Power Corporation will continue to operate the plant in accordance with its design and Technical Specifications, the potential radiological consequences of an accident previously evaluated remain unchanged.

The proposed amendment will not result in an increase in the probability or the consequences of an accident previously evaluated in the FSAR because: (1) facility operations will be continued in accordance with the facility's approved design and Technical Specifications, and (2) changes to the population and distribution surrounding Vermont Yankee are expected to be negligible and will not impact on the previously determined LPZ boundary.

b. The proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

Conservatisms have been incorporated in the design, construction, and operations of Vermont Yankee. Furthermore, programs have been developed and continue to be implemented to assure that the facility is operated as intended by design and in accordance with the Technical Specifications. In particular, the In-Service Inspection/Testing, Environmental Qualification, and Maintenance Programs assure that facility structures, systems, and components will be refurbished or replaced, as appropriate. That is, regardless of the age of the facility, these programs ensure that structures, systems, and components are refurbished and/or replaced to maintain component functional capability and the margins of safety required by the Technical Specifications. No changes to these programs are necessary for assuring that Vermont Yankee will continue to perform as designed and in accordance with the Technical Specifications during an additional five years and three months of operation. Therefore, there is no possibility that a different type of accident is created.

c. The proposed amendment does not involve a significant reduction in a margin of safety.

The margins of safety identified in the Technical Specifications have been incorporated into the facility's design, construction, and operations. With respect to operations, such margins are the basis for the facility operating and emergency procedures, as well

as the Vermont Yankee In-Service Inspection/Testing, Environmental Qualification, and Maintenance Programs.

The inspection, surveillance, and maintenance requirements of these programs assure that, regardless of the age of the overall facility, the functional capabilities of structures, systems, and components will be maintained throughout the life of the facility through refurbishment and/or replacement, as appropriate, to meet the Technical Specifications. No changes to these programs are necessary to assure that during the additional five years and three months of operation, Vermont Yankee will continue to perform as intended by its design and the Technical Specifications.

Therefore, the proposed amendment does not reduce the margin of safety as defined in the Technical Specification bases.

Conclusion

Based on the above considerations, we contend that the extension of Vermont Yankee's operating license in accordance with the proposed amendment will not involve a significant increase in the probability or consequences of accidents previously considered, nor create the possibility of a new or different kind of accident, and will not involve a significant reduction in a safety margin. Therefore, we conclude that there is no significant hazards consideration associated with the proposed amendment to the Vermont Yankee operating license.

ATTACHMENT 2

ASSESSMENT OF BENEFITS AND POTENTIAL IMPACTS OF PROPOSED CHANGE TO EXPIRATION DATE OF THE VERMONT YANKEE NUCLEAR POWER STATION OPERATING LICENSE

April 1989

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1.0 SUMMARY AND CONCLUSIONS

1.1 General

Section 103.c of the Atomic Energy Act of 1954 authorizes the issuance of facility operating licenses for a period of time up to 40 years. The current license term for Vermont Yankee began with the date of issuance of the construction permit[16], December 11, 1967, and ends on December 11, 2007. Accounting for the five years required for plant construction, this represents an effective operating license term of only 34 years and 9 months.

Current Nuclear Regulatory Commission (NRC) policy is to issue operating licenses for a 40-year period, commencing with the date of issuance of the operating license, not the construction permit. For Vermont Yankee, this date was February 28, 1973[17]. Accordingly, it is proposed that the Vermont Yankee operating license be amended to change the expiration date to February 28, 2013 consistent with current NRC policy. This would permit an additional five years and three months of plant operation.

Sections 2.0, 3.0, and 4.0 of this document describe the assessments that have been made to determine the potential benefits and impacts of an additional five years and three months of operation. The remainder of this section provides a summary of those assessments in a consolidated format. Finally, the conclusions of the assessment provided herein are presented.

1.2 Summary

1.2.1 Benefit Assessment

Need for Power - Projections[18, 19, 20] indicate that the demand for electricity in New England will increase by about 48% through the year 2012, the final year of the proposed amendment term. Because Vermont Yankee is a very reliable power plant with a cumulative capacity factor in excess of 70%, its operation for a full 40 years would be beneficial. In its absence, it is likely that a fossil-fired power plant will have to be sited and constructed (Section 2.3).

Economics - Vermont Yankee is currently one of the most economical base load plants in New England, producing electricity for less than four cents per kilowatt hour in 1988. Using a simple spread sheet model, it is projected that the plant's operation during the proposed amendment term would save consumers some $443 million in 1988 dollars (Section 2.3). As Vermont's fifth largest business entity, the facility also provides significant economic benefits to the state and local economies through taxes, payroll, and goods and services expenditures (Section 2.5). Such benefits are expected to continue through the proposed amendment term.

Environmental Benefits - Substantial environmental benefits would result from the proposed amendment (Section 2.4). The replacement of Vermont Yankee with a fossil-fired power plant of comparable generating capacity could cause the emission of up to 44 million pounds per year of sulfur and 7 billion pounds per year of carbon dioxide. These emissions, which are not produced by Vermont Yankee, are strongly linked to acid rain and the "greenhouse effect" phenomena.

1.2.2 Safety Assessment

Mechanical Components - The functional capabilities of mechanical components (Section 3.4.2) will continue to be maintained to the conclusion of the proposed amendment term. Such assurance is provided through the conservatisms inherent in the design, construction, and operations of the facility and directly through the inspection, maintenance, and surveillance practices of the Vermont Yankee In-Service Testing/Inspection (Section 3.2.2.1) and Maintenance (Section 3.2.2.3) Programs. Both programs ensure that, regardless of the age of the overall facility, mechanical components will be refurbished and/or replaced as necessary to maintain the margins of safety identified in the Technical Specifications (Section 3.2.1). No changes to these programs are necessary to assure that during an additional five years and three months of operation, that Vermont Yankee will be operated as intended by its design and in accordance with the Technical Specifications.

The subset of mechanical components that lie within the reactor coolant pressure boundary are also included in the In-Service Testing/Inspection Program and have been designed to a fatigue life well in excess of the original 40-year design life (Section 3.4.1.1). A recent update of the fatigue analysis included the plant's reactor vessel, with the results showing that the present operating transient frequency can be sustained well beyond the term of this proposed amendment. Furthermore, reactor vessel pressure/temperature operation curves (Section 3.4.1.2) have been developed to meet the requirements of 10CFR50, Appendix G and Regulatory Guide 1.99, Revision 2 which were formally accepted by the NRC in June 1986. Vermont Yankee will continue to meet these requirements without modification or operational hardship through the end of this proposed amendment.

Electrical Components - The functional capabilities of electrical components will continue to be maintained to the conclusion of the proposed amendment term. Such assurance is provided through the conservatisms inherent in the design, construction, and operations of the facility and directly through the inspection, maintenance, and surveillance practices of the Vermont Yankee Maintenance (Section 3.2.2.3) and Environmental Qualification (Section 3.2.2.2) Programs. Both programs ensure that, regardless of the age of the overall facility, electrical components will be refurbished and/or replaced as necessary to maintain the margins of safety as identified in the Technical Specifications (Section 3.2.1). No changes to these programs are necessary to assure that during an additional five years and three months of operation, that Vermont Yankee will be operated as intended by its design and in accordance with the Technical Specifications.

Structural Components - A service life well in excess of 40 years is anticipated for Vermont Yankee's structures. Inspections of critical structures have, to date, identified no signs of deterioration in structural integrity (Section 3.4.4). Through the continued use of good maintenance practices such as corrosion prevention, concrete surface repair, and protective coating makeup, the structural integrity of Vermont Yankee can be ensured well beyond a full 40-year licensing period.

Plant Modifications - Significant design modifications, as well as procedural changes, have been made during the 16 years since Vermont Yankee went into operation (Section 3.3.2), with the net effect enhancing the safety provided by the plant systems. In the future, Vermont Yankee expects to implement further design modifications and procedural changes as the appropriate need or regulatory requirement arises.

1.2.3 Environmental Assessment

Occupational Radiation Exposure - Occupational exposures resulting from the proposed amendment term will remain well within the limits of 10CFR, Part 20. The Vermont Yankee ALARA Program (Section 4.2.1.2), established in response to the requirements of 10CFR, Section 20.1(c), will contribute, in a large part, to minimizing the already low levels of occupational exposure at the facility.

Through continued implementation of the ALARA Program and operation of the Area and Process Radiation Monitoring System (Section 4.2.2.1), it is expected that the average annual exposure at the Vermont Yankee facility will be maintained at or below the current low level through the present license term as well as the proposed amendment term. These annual exposures have been consistently below the average industry BWR. Through fuel management, Vermont Yankee will continue to operate with long cycles which will contribute to the already low level of occupational exposure (Section 4.3.1.4) by reducing the frequency of refueling outages.

Off-Site Radiation Exposures - Calculations based on the Area and Process Radiation Monitoring System measurements demonstrate that the Waste Disposal System (Section 4.2.1.1) is extremely effective in limiting annual doses from normal plant operation. Doses have been calculated at less than 5% of the ALARA objectives of 10CFR50, Appendix I (Section 4.3.1.2), and are expected to remain at or below these levels during facility operations through the proposed amendment term.

Off-site exposures from releases due to postulated accidents will remain within the limits set forth in 10CFR, Part 100. Based upon a 1986 study[7], it is expected that projected population size and distribution will remain essentially unchanged and, therefore, within previously projected bounds through the term of this proposed amendment (Section 4.4). The area is projected to remain predominantly rural throughout the remainder of the operating license term and proposed amendment period. Therefore, the exposure locations analyzed in the Vermont Yankee FSAR remain valid.

Solid Waste Generation - As a result of continuing plant efforts to minimize solid waste, it is expected that the annual volumes of dry and wet waste shipped from the plant will continue to follow industry's long-term trend of lower volumes. (Section 4.3.1.3).

Uranium Fuel Cycle - Vermont Yankee is expected to operate in an 18-month fuel cycle mode through the end of the proposed amendment term. The better utilization of fuel allowed through this type of operation means that, in relative terms, the cumulative increase in fissile uranium consumption will be proportionally smaller than any other five-year period to date (Section 4.3.1.4). This small increase in the amount of uranium required is justified in light of the continued benefit received from Vermont Yankee's operation.

Spent Fuel Storage - Through the end of the proposed amendment term, the plant is projected to generate approximately 3545 spent fuel bundles, which is consistent with preoperational predictions. However, the plant's spent fuel pool currently has a licensed capacity to meet operational needs only through 1995 (without maintaining full-core reserve discharge capability). Vermont Yankee's strategy for dealing with this issue is twofold. First, Vermont Yankee will continue to explore environmentally and technically safe options for on-site expansion of storage capacity. Second, a contract is in place with the U.S. Department of Energy for both the removal (from the plant site) and disposal of spent fuel.

Nonradiological Impacts - An additional five years and three months of facility operation will result in only negligible additions to the cumulative thermal and ecological impacts to the environment. Assessments made by Vermont Yankee have indicated that no detectable environmental degradation has occurred as a result of 16 years of plant operation. Therefore, no significant impact is expected from an additional five years and three months of operation in accordance with applicable regulatory requirements (Section 4.3.2). Likewise, the plant's operation through the end of the proposed amendment term will not impact any known historic sites as defined in 36CFR, Part 800 (Section 4.3.2.2).

1.3 Conclusions

The functional capabilities of the mechanical, electrical, and structural components of the plant are assured through the conservatisms inherent in the design, construction, and operations of the facility and directly through the inspection, maintenance, and surveillance practices of the Vermont Yankee In-Service Inspection/Testing, Environmental Qualification, and Maintenance Programs. These programs ensure that structures, systems, and components will be refurbished and/or replaced, as necessary, to maintain the margins of safety required by the Technical Specifications. Vermont Yankee Nuclear Power Corporation concludes that extension of the plant's operating license by five years and three months to February of 2013 is consistent with the existing safety assessment in that all issues associated with plant aging have already been addressed in the FSAR and other licensing submittals. The proposed amendment has no significant impact on plant safety. Likewise, there will be no significant changes to previously determined levels of radiation exposures as a result of the proposed amendment. Likewise, the increase in plant radioactivity inventory will not have a significant effect on either on-site or off-site radiation exposures. Radioactive waste and fuel cycle effects are minimal. No significant nonradiological environmental effects are likely to be encountered.

Based upon the attached analyses, it is concluded that there are no significant radiological or nonradiological impacts associated with the proposed action. Issuance by the NRC of the proposed license amendment will have no significant impact on the public or environment.

2.0 BENEFITS ASSESSMENT

2.1 Introduction

The purpose of the following discussion is to provide an assessment of the benefits expected from the additional five years of operation that would be permitted by the proposed amendment. The benefits considered include: (1) continued availability of reliable baseload generation, (2) avoided increase in electric rates to consumers, (3) avoided environmental effects of a fossil-fueled replacement power source, and (4) continued benefits to the state and local area economy.

2.2 Continued Availability of Reliable Baseload Generation

Vermont Yankee provides baseload generation to consumers through the New England Power Pool (NEPOOL) . As discussed elsewhere, the plant has produced over 50 billion kilowatt hours (KWh) of electricity during the past 16 years and is one of the most reliable nuclear power facilities in the country with a lifetime capacity factor of 70.2% (see Section 3.3.1). Accordingly, it is prudent and beneficial to keep this reliable source of power in operation, particularly in light of the projected growth of New England's electricity demand.

The present New England electrical demand is more than 100 billion KWh annually and expected to grow substantially through the early 2000's. Recent projections by NEPOOL show the demand for electricity growing at a levelized rate of about 2.0% compounded annually through 2003[18,19]. Subsequent demand from 2003 through 2012 was estimated in a 1986 study by the Amos Tuck Business School at Dartmouth College[20] to grow at half the previous rate or approximately 1.0% compounded annually. Overall, New England's electricity demand is projected to increase by 48% over the next 23 years (up to 2012) at a levelized annual rate of 1.7%. This estimate is conservative in that for the past twenty years New England's electricity demand has grown at a levelized annual rate of over 2%. Only in the years of 1974 and 1979 was growth not experienced, most notably because of the international oil crises.

Also, this demand growth has been sustained even in the presence of inherent conservation, as New Englanders currently use about 30% less electricity per capita than other regions.

The projected growth in New England's electricity usage through 2012 will require, at a minimum, the construction (to include "small producers"), importation, and conservation of generation capacity equivalent to nine plants the size of Vermont Yankee. Actually, additional capacity above and beyond the equivalency cited above will be likely when existing plant retirements and reserve margin capacity requirements are considered.

Given the projections for electricity demand and associated increased capacity requirements through 2012, the construction of some new centralized power plants will probably be required. A permanent absence of Vermont Yankee will only exacerbate such requirements. Therefore, Vermont Yankee's continued availability, by amending the license term to allow operation during the period December 2007 through February 2013, will be of substantial benefit to the New England region.

2.3 Avoided Increase in Electric Rates to Customers

In addition to providing reliable baseload generation, Vermont Yankee is also one of the most economical plants in the New England region. For instance, in 1988 the generation costs for Vermont Yankee were 3.4 cents per kilowatt hour. A study performed by the State of Vermont in 1988 showed that the plant's operation is cost-effective through its existing license term.[23] In 2007, should the proposed amendment be granted, power costs are projected to be 8.6 cents per kilowatt hour which reflects a rate of increase of only 5.03% per year. As has been shown, if the plant is not operated beyond December 2007, then it is likely that new baseload capacity will be necessary to replace it. Accordingly, continued operation of Vermont Yankee through the proposed amendment term would avoid increased electric rates related to replacement power to New England consumers.

The Amos Tuck School analysis[20], cited earlier in this section, anticipates that a fossil-fired type power plant (most likely oil) would replace Vermont Yankee if operations were to cease in 2007. Using a simple spread sheet model and publicly available data from NEPOOL and others, the estimated "avoided cost" of operating Vermont Yankee for an additional five years, as well as the resulting absolute savings to consumers, was computed. Essentially, avoided cost has two parts termed "capacity" and "energy" as defined below:

Capacity - Approximates the cost of bringing on new capacity. It is what an energy provider will be charged, should scheduled output not be achieved, or what a new energy provider will be paid, for committing to provide a defined level of capacity.

Energy - Includes the fuel cost of producing electricity.

Table 2-1 summarizes the results of the model. The difference between the estimated total avoided cost and projected Vermont Yankee cost shown in Table 2-1 defines the consumer savings. When the adjustment for the plant's depreciation and decommissioning costs are factored in (called extension savings), it is estimated the five year extension of Vermont Yankee operations will save consumers up to $443 million (1988 dollars).

2.4 Avoided Environmental Effects

Substantial environmental benefits would also result from the proposed amendment because the burden on the environment from an oil or other fossil-fired replacement power source would be much greater than from Vermont Yankee. Sulfur dioxide and carbon dioxide emissions from fossil-fired generation are of concern because of acid rain in the Northeast region and global warming consequences. Vermont Yankee does not, and would not, contribute to these problems, but a fossil-fueled replacement power source would exacerbate them.

If the assumed replacement oil-fired power plant is operated instead of Vermont Yankee, it would result in the annual emission of about 44 million pounds per year of sulfur dioxide and 7 billion pounds per year of carbon dioxide.

2.5 Continued Benefits to the State and Local Economy

Vermont Yankee is the fifth largest business in the state of Vermont and a major taxpayer, paying almost $7 million per year to state and local governments. Since 1972, when commercial operation was first achieved, Vermont Yankee has paid over $60 million in taxes. Equally as important, Vermont Yankee pays about $4 million annually to Vermont vendors for goods and services and an annual total of about $30 million to Vermont entities.

The facility has over 345 full-time employees and 200 contract personnel year round. All of the wages that employees earn, which in 1987 totalled some $14 million, are subject to Vermont income tax. During refueling outages, which will occur every 18 months, several hundred additional contract personnel are employed on site. According to Vermont Business magazine, a plant outage contributes an additional $250,000 per week to the local economy.

Clearly, these benefits will continue through the term of the proposed amendment with their value increasing proportionately.

2.6 Conclusions

The preceding discussion shows that continued operation of the Vermont Yankee plant through the proposed amendment term would provide significant economic and environmental benefits to both the New England region and the state and local area. These benefits include:

- Continued availability of reliable baseload generation. Vermont Yankee is one of the most reliable nuclear plants in the country with a cumulative capacity factor of 70% over 16 years of

operation. Electricity demand projections for the New England Power Pool reflect an increase of about 48% by 2012, which is approximately the end of the proposed amendment term.

- Avoided increase in electric rates to consumers. The Vermont Yankee plant is one of the most economical sources of power in the New England region. If the plant is not operated beyond December 2007, it will be necessary to replace it with another power plant, most likely oil fired. The present value savings to consumers of Vermont Yankee operating in lieu of an oil fired power plant for an additional five years is estimated to be $443 million.

- Avoided environmental effects. The burden on the environment from a fossil-fueled replacement power source would be much greater than from Vermont Yankee. Sulfur and carbon dioxide emissions from fossil-fired generation are of increasing concern given their linkage to acid rain and the so called "greenhouse effect". Vermont Yankee does not contribute to these problems.

- Continued benefits to the state and local economy. Throughout the proposed amendment term, the operation of Vermont Yankee will continue to make a positive and substantial contribution to the state and local economies. For instance, the plant over the past 16 years has paid over $60 million in taxes to Vermont. Also, as the state's fifth largest business entity, it has and will continue to be a major influence on the local economy by employing over 350 people and providing some $34 million per year to local vendors and other Vermont entities for goods and services.

TABLE 2-1

Summary of Probable Savings Derived by Vermont Yankee's Operation
From 2007-2012

Parameter	Cost ($/KWhr) 2008	2009	2010	2011	2012
Capacity Cost	$0.022	$0.023	$0.024	$0.025	$0.026
Energy Cost (Oil Fuel)	$0.122	$0.133	$0.139	$0.149	$0.157
Total Avoided Cost	$0.144	$0.156	$0.163	$0.174	$0.183
Vermont Yankee Cost	$0.090	$0.083	$0.101	$0.121	$0.084
Total Saving	$0.054	$0.073	$0.062	$0.053	$0.099

Nominal Value of Savings*	$1,470 million
NPV of Savings**	383
Extension Savings***	60
TOTAL	$ 443 million

*Assumes Vermont Yankee operating capacity of 70%.
**Discounted at 9.7% to 1988 dollars.
***Savings resulting because of deferred depreciation and decommissioning costs 1989-2007.

3.0 SAFETY ASSESSMENT

3.1 Introduction

The purpose of this assessment is to demonstrate that the proposed license amendment to permit an additional five years and three months of plant operation would not adversely affect the public health and safety. Most of the information that follows summarizes material previously provided to the NRC.

Section 3.2 provides a review of reference documents which describe the basis for assuring continued plant safety through its licensed operating lifetime. Section 3.3 gives a summary of the plant performance and safety record over 16 years of operation. Finally, Section 3.4 provides a review of the assurances for continued functional capability of safety-related components through at least 40 years of plant operation. The assessment conclusion is provided in Section 3.5.

3.2 Licensing Basis Documents/Programs

3.2.1 FSAR and Technical Specifications

The plant design and safety analyses were initially documented in the FSAR[22]. This report was submitted to the (then) AEC in December 1969 in support at the initial plant construction and operation. The report included facility and systems design descriptions, site characteristics, analyses of design basis accidents, and descriptions of plant operations. The then AEC documents their review of this report in the Safety Evaluation Report.[6] In 1982, a major update of the FSAR[3] was submitted to the NRC in accordance with a revision to 10CFR, Part 50.71. In compliance with that regulation, the Vermont Yankee FSAR is updated annually to reflect changes in the plant design.

The plant Technical Specifications were issued in February of 1973 as Appendix A to the operating license. Vermont Yankee, in response to either

the AEC/NRC or on its own initiative, has requested and received over 100 amendments to the Technical Specifications to date. The Technical Specifications include sections on safety limits and limiting safety settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls. Of these sections, the first three are most pertinent to this assessment and will be described briefly.

Safety limits and limiting safety settings, together, provide a "margin of safety" to protect the integrity of the reactor core and reactor coolant pressure boundary during plant operation. The safety limits are chosen to maintain plant operating parameters to values that are well below conservatively-chosen design basis failure limits. The limiting safety settings are chosen to assure that automatic protective action will prevent operating parameters from exceeding the safety limits during an abnormal situation.

Limiting Conditions for Operation (LCO) establish minimum conditions necessary to assure the required functional capability of safety-related components and systems. Examples are: (1) operability requirements for redundant safety system components and (2) limits on Reactor Coolant System temperature and pressure.

Surveillance requirements are established to assure early detection of unexpected degradation or failure of safety-related components. These include requirements for component monitoring, inspection, and/or functional testing. Monitoring requirements focus on operating parameters which are indicators of component performance. Requirements for inspections focus on mechanical integrity of component materials while testing requirements focus on assuring the operability of components associated with standby systems.

3.2.2 Surveillance and Maintenance Program

In accordance with the Technical Specifications and the requirements of the Code of Federal Regulations (10CFR), Vermont Yankee has established a program for maintenance and surveillance of safety-related equipment. This

program includes an In-Service Inspection (ISI) Program, In-Service Testing (IST) Program, and Environmental Qualification (EQ) Program which are complemented by a Maintenance Program.

3.2.2.1 In-Service Inspection Program/In-Service Testing Program

The original Vermont Yankee ISI Program was initiated in 1973 with the present program being submitted to the NRC in 1979. This program was developed and is being implemented in accordance with (1) 10CFR50.55(a), (2) Section XI of the ASME Boiler and Pressure Vessel Code, and (3) the plant Technical Specifications. The purpose of the program is to assure continued maintenance of the integrity and functional capability of mechanical components (including their structural supports). Such components include pressure vessels, tanks, and piping. The evolution of the ISI Program is highlighted below:

- 1973 - Began first inspection interval. Inspections performed in accordance with the 1970 Edition of ASME, Section XI.

- 1979 - Updated ISI Program implemented to reflect revision of 10CFR50.55.

- 1983 - Completed first inspection interval. Began second inspection interval. Inspections performed in accordance with 1980 Edition of ASME Section XI.

- 1988 - A separate In-Service Testing Program was established to provide for the inspection and testing of pumps and valves in accordance with (1) 10CFR50.55(a), (2) Section XI of the ASME Boiler and Pressure Vessel Code, and (3) the plant Technical Specifications.

As shown above, Vermont Yankee is presently implementing planned inspections for the second ten-year interval. The components within the scope of this plan include pressure-retaining components (including their support

structures) classified as Safety Class 1, 2, and 3 in accordance with the Yankee Atomic Electric Company Operational Quality Assurance Manual (YOQAP-1-A), Appendix C, and the Vermont Yankee Safety Classification Manual.

The ISI Program includes visual, surface, and volumetric examinations. The surface examinations are done with the liquid penetrant or magnetic particle methods. The volumetric examinations are done using the ultrasonic or radiographic examination methods. The objectives of these examinations are to:

1. Identify unexpected service-induced component degradation, evidenced by surface cracks, wear, corrosion, or erosion.

2. Locate any evidence of component leakage during system pressure or functional tests.

3. Verify operability of components and integrity of their supports.

Records of inspections completed under the ISI Program are kept in accordance with the requirements of ANSI N45.2.9 and ASME Section XI, and transmitted to the NRC.

In future years of operation, the ISI Program Plan will be revised as necessary to comply (to the extent practical within the limitations of design, geometry, and materials for construction of components) with the edition of the ASME Code and Addenda in effect 12 months prior to the start of each required 10-year interval.

3.2.2.2 Environmental Qualification Program

The Environmental Qualification (EQ) Program was established in June 1984 in accordance with the requirements of 10CFR50.49. Its purpose is to document that safety-related electrical components will perform as required under all environmental conditions anticipated or postulated to occur during their specified service life. The program is described in the Environmental

Qualification Program Manual. It includes: an Environmental Qualification (EQ) Master List, Qualification Worksheets, and Qualification Documentation Reports (QDRs).

In developing the EQ Master Lists, equipment was included if it: (1) was relied upon to function during and following anticipated transients, postulated accidents or external events and (2) would be subjected to a "harsh" environment (significantly more severe than during normal operation). Such equipment also includes all electrical equipment whose failure could prevent the required equipment from performing its intended function.

The Qualification Worksheets specify for each component the most severe environmental conditions under which the component is expected to perform. The environmental conditions include consideration of: temperature, pressure, humidity, chemical effects, radiation, aging, and submergence. Consideration is also given to synergistic effects. The QDRs provide, for each piece of equipment, evaluations of test data and/or analyses as necessary to demonstrate qualification for the environmental service conditions specified by the worksheets. Together these documents provide the evidence that EQ has been established for each item on the EQ Master Lists. Plant procedures establish the methods by which environmental qualification of electrical equipment is maintained at Vermont Yankee. The QDR for a given component specifies special installation details, maintenance, and surveillance required in order to maintain its qualification. This part of the EQ Program is implemented in accordance with YOQAP-1-A and the overall plant Maintenance Program.

The EQ Program is a continuing program. The Qualification Worksheets, QDRs, and any related plant procedures for a given component, will be updated as required throughout its service life. In some cases, this service life may be specified such that it would be reached prior to the plant operating license termination date. Such components would either be requalified to a longer service life, replaced, or upgraded.

3.2.2.3 Maintenance Program

Vermont Yankee's Maintenance Program was established at the beginning of plant operation. The purpose of the program is to maintain the continued functional capability of all important plant components. The program complements the EQ and ISI/IST Programs in that it covers safety-related components not necessarily included under those programs.

The program is implemented through procedures which have been developed in accordance with the Yankee Operational Quality Assurance Program, the Technical Specifications and Vermont Yankee operational philosophy. These procedures specify requirements for scheduling, implementing, and documenting all activities within the program scope. These activities include: (1) component inspections and/or tests, (2) trending, (3) failure or root cause analysis, (4) preventive or correct maintenance, and (5) record keeping.

Surveillance and maintenance records are kept for each component covered by the program. These records include component operating and maintenance specifications, date of installation, subsequent maintenance or repair history, parameter trends obtained from past surveillance, and future surveillance or maintenance schedule.

3.3 Plant Operating History

Vermont Yankee has been in operation for over 16 years. During that time, a substantial amount of data and experience have been accumulated which demonstrate the safety and reliability of the plant. This data and experience is reviewed briefly in the following discussion. This discussion considers: operating performance, component integrity, plant modifications, and regulatory performance.

3.3.1 Operating Performance

The cumulative capacity factor for Vermont Yankee over its 16 years of operation is 70.2%, which is among the very highest in the industry. For

instance, through the end of 1988, the cumulative capacity factor for all U.S. reactors was only slightly above 60%. As shown in Figure 3-1, Vermont Yankee's achievement of its very high capacity factor is the result of consistency over many years of operation.

The plant first gained international recognition for its operating performance in 1982 when it became the world's number one Boiling Water Reactor (BWR), completing the year with an operating capacity of 93.3%. Compared to the then-world-wide operating 244 nuclear plants, Vermont Yankee's 1982 performance placed the reactor in third place overall, regardless of design. In 1984, Vermont Yankee was cited in Nucleonics Week as, "the highest-ranking boiling water reactor in the United States," based on its average electrical generation per 1,000 megawatts of turbine nameplate rating per year of commercial operation. Later, when Vermont Yankee shut down in September 1985 for a scheduled refueling and recirculation pipe replacement outage, the plant had concluded 255 days of continuous electrical generation, a company record. This achievement of operating availability, at the time of shutdown, placed Vermont Yankee as the number three BWR in the world.

When Vermont Yankee shut down in August 1987 for a refueling outage, it had completed the most successful operating cycle in the plant's history. The unit generated electricity over 99% of the time during the cycle; it was off-line for only 65 hours in 13 months of operation. The plant's capacity factor for the cycle was 95%. At the end of 1987, Vermont Yankee was rated the number one BWR in the US for availability with a refueling outage (83.2%). Nucleonics Week also cited the plant as, "the top domestic BWR for plant generation." Vermont Yankee's 1987 capacity factor was 80.1%, which tied a plant record for a year with a scheduled outage. For 1988, the second year in Vermont Yankee's history without a refueling outage, a capacity factor of 92.9% was achieved, demonstrating a continuing high level of performance.

In addition to historical capacity factors, there are other commonly-used performance indicators that also show the plant to be a top performer; Licensee Event Reports (LERs), and automatic scrams. As indicated in Tables 3-1 and 3-2, Vermont Yankee compares favorably with industry averages for these indicators.

3.3.2 Plant Modifications

A number of major design modifications have been made during the 16 years since Vermont Yankee went into operation. These changes have been made to upgrade plant equipment or safety systems or to a lesser degree to replace equipment which has failed, become obsolete, or reached its end-of-useful life. A listing of some of the more significant modifications is summarized below.

- Recirculation Pipe Replacement - The Recirculation System piping was completely replaced with material which is resistant to intergranular stress corrosion cracking. This essentially removed this phenomenon as a future concern for Vermont Yankee piping.

- Computer Replacement/ERFIS/SPDS - This change, which is still under implementation, will replace the existing plant process computer with more modern equipment, providing SPDS capability in the Control Room and enhanced information regarding critical plant parameters to the Emergency Response Facility.

- State-of-the-Art Plant Simulator - A Vermont Yankee-specific plant simulator has been constructed and approved by the NRC to ensure the best possible training is provided to Vermont Yankee operators.

- RPS Analog Trip System - This modification replaced mechanical pressure switches in the Reactor Protection System with modern solid-state components of higher reliability and accuracy.

- o CRDR Modifications to the Control Room - As a result of the Vermont Yankee Control Room Design Review, extensive modifications have been made to Control Room panels to improve the man-machine interface in accordance with modern human factors considerations.

- o Grid Undervoltage Protection - This modification provided a means for automatically isolating safety-related electrical loads from the power grid in the event that a grid undervoltage condition existed which could impact plant safety.

In reviewing the plant modifications during the first 16 years of operation, it can be concluded that:

1. Most of the modifications have involved additions rather than replacements of equipment due to age-related failure. Component aging has not had a significant effect on plant operation, mainly because the effects are gradual, not precipitous and can be detected and tracked by routine plant surveillance and maintenance.

2. The net effect of these changes has been to enhance the safety provided by the plant systems. This conclusion is supported by the results of the Vermont Yankee Containment Safety Study[13] which was concluded in 1986 (see Section 3.4.4.1).

3.3.3 Regulatory Performance

The Systematic Assessment of Licensee Performance (SALP) Program was initiated by the NRC in 1980. The purpose of this program is to collect available observations and data on a periodic basis to evaluate licensee performance in selected functional areas important to nuclear safety and the environment. Areas evaluated under the program include: plant operations, radiological controls, maintenance and modifications, surveillance, fire protection and housekeeping, emergency preparedness, security and safeguards, refueling and outage management, assurance of quality, training and qualification effectiveness, and licensing activities.

Based on the NRC evaluations, the performance in each area is classified Category 1 (highest), 2, or 3 according to the following definitions:

Category 1 - Reduced NRC attention may be appropriate. Licensee management attention and involvement are aggressive and oriented toward nuclear safety; licensee resources are ample and effectively used such that a high level of performance with respect to operational safety is being achieved.

Category 2 - NRC attention should be maintained at normal levels. Licensee management attention and involvement are evident and concerned with nuclear safety; licensee resources are adequate and reasonably effective such that satisfactory performance with respect to operational safety is being achieved.

Category 3 - Both NRC and licensee attention should be increased. Licensee management attention or involvement is acceptable and considers nuclear safety but weaknesses are evident; licensee resources appear strained or are not effectively used such that minimal satisfactory performance with respect to operational safety is being achieved.

Table 3-3 provides a summary of historical SALP ratings received by Yankee which are notable for two reasons. First, Vermont Yankee has never received a rating below a 2 in any category. Second, when the cumulative SALP scores from all operating reactors are plotted, as shown in Figure 3-2, Vermont Yankee also ranks in the top 5%. These better than average historical SALP scores provide a high level of confidence that the plant will continue to be operated and maintained in a way which will meet, if not routinely exceed, the level of safety performance required by the approved licensing basis.

3.4 Assurances for Continued Functional Capability of Safety-Related Components

The assurance that the present level of safety at Vermont Yankee is maintained during future plant operation, is dependent upon the continued functional capability of safety-related components. These are components associated with systems which are designed to prevent or mitigate events that could cause a release of radioactivity to the environment. The following discussion reviews such components at Vermont Yankee.

3.4.1 Reactor Coolant Pressure Boundary

3.4.1.1 General

The mechanical components associated with the Reactor Coolant System pressure boundary include: the reactor vessel, piping, valve bodies, and pump casings. The design of these components included consideration of potential effects of age-related phenomena such as corrosion, thermal cycling fatigue, and radiation-induced embrittlement. The consideration of these effects was also taken into account when the operating limits and surveillance requirements were established in the Technical Specifications. In accordance with the latter requirements, the Reactor Coolant System is included in the In-Service Inspection Program (see Section 3.2.2.1). All components are located such that critical areas are reasonably accessible for the required inspections and/or tests.

The potential for corrosion was accounted for by using corrosion resistant materials in the plant's design. All mechanical components that are in contact with reactor coolant, except the fuel, are either made of or clad with stainless steel. The fuel is clad with Zircaloy. The Reactor Coolant System water chemistry is selected to minimize corrosion. A periodic analysis of the coolant chemical composition is performed to verify that the coolant quality is within specifications. Components of the Reactor Coolant System pressure boundary are designed to withstand the fatigue effects of cyclic loads due to system temperature and pressure changes. These cyclic loads are

introduced by normal load transients, reactor trips, and start-up and shutdown operations. During startup and shutdown, the heat-up and cooldown rates are limited to less than 100°F/hour, consistent with system design specifications.

A recent evaluation has been performed to compare the actual thermal transients experienced by the plant to the transients postulated to occur when the plant was designed. It has been determined that the actual thermal transients are much less severe than those envisioned by the original designers. Plant procedures provide for the ongoing collection of data relative to thermal transients. This data is compared to original design requirements and an evaluation done annually to document the remaining fatigue life of Reactor Coolant System components. Based on evaluations done to date, the Reactor Coolant System components' fatigue life is expected to extend well beyond the original 40-year design life.

3.4.1.2 Reactor Vessel

As discussed previously in Section 3.2.2.1, an In-Service Inspection (ISI) Program to assure continued component integrity has been active at Vermont Yankee since plant startup. Evaluations of the reactor vessel have been performed showing that the limiting components, from a fatigue standpoint, are the feedwater nozzles. As a result of industry experience, new interference fit feedwater spargers were installed in 1976 to minimize nozzle bypass flow leakage and, thus, reduce the fatigue usage on the inner blend radii of the nozzles. Inspections performed at each refueling outage since the sparger replacement have shown no degradation of the feedwater nozzles.

The reactor vessel was originally designed for transients considered to be enveloping design conditions over a 40-year operating period. An update of the reactor cyclic capacity calculation which included a review of plant-specific operational transients has been completed.[10] This was followed by a new reactor vessel fatigue analysis. This analysis demonstrates that present operating transient frequency will not result in any reactor fatigue problems over at least a 40-year operating period.

Reactor vessel pressure/temperature operation curves have been developed to meet the requirements of 10CFR50, Appendix G, and Regulatory Guide 1.99, Revision 2, which were formally accepted by the NRC in June 1986.[11] The curves submitted to the NRC were for operation through 1.79 E8 MWH/TH and were based on reactor belt line sample data from surveillance capsules placed inside the reactor vessel and fluence data. Pressure/temperature curves for operation through 4.45 E8 MWH/TH were developed in the same manner. These curves correspond to 40 years of operation at a .80 capacity factor and fall within the bounds of plant pressure/temperature capability. Therefore, based on a best-estimate of 40-year fluence levels and a conservative prediction of material toughness, Vermont Yankee will be able to meet the requirements of 10CFR50, Appendix G, and Regulatory Guide 1.99, Revision 2, without modification or operational hardship through the end of the proposed amendment period.[15]

3.4.1.3 Reactor Vessel Internals

The design of the reactor vessel internals is in accordance with the intent of Section III of the ASME Boiler and Pressure Vessel Code. The material used for fabrication of most of the reactor vessel internals is solution heat treated, unstabilized Type 304 austenitic stainless steel conforming to ASTM specifications. Weld fabrication was done using procedures and personnel qualified in accordance with the intent of Section IX of the ASME Boiler and Pressure Code. Evaluations performed prior to initial plant startup document the ability of the reactor vessel internals to perform their intended functions when subjected to loads imposed during normal operation, abnormal operational transients, and accidents.

The reactor internals are designed to assure adequate working space and access for inspection. Periodic inspections performed under the In-Service Inspection Program and Maintenance Program ensure that any degradation of reactor vessel internals will be detected and repaired in a timely manner.

3.4.1.4 Recirculation Piping System

The original Recirculation Piping System at Vermont Yankee was susceptible to intergranular stress corrosion cracking (IGSCC) in the areas affected by welding. This was a phenomenon common to all BWRs. During an outage which began in 1985, the recirculation piping was completely replaced with a material which is nonsusceptible to IGSCC. The new material, in concert with the improved welding techniques used in the replacement, provides assurance that IGSCC will not be a problem in the Reactor Coolant System piping in the future.

3.4.2 Other Mechanical Components

The passive components (tanks, pump casings, and valve bodies) associated with safety-related systems are designed to the same codes as the components that comprise the Reactor Coolant System pressure boundary. Also, consideration was given to possible aging effects of corrosion, erosion, and thermal cycling fatigue. Therefore, the expected service life of these passive components is greater than 40 years, as is the Reactor Coolant System boundary. Nevertheless, such components are included in the plant In-Service Inspection and Maintenance Programs, so that unexpected age-related degradation will be identified and corrected if it occurs. Many of the active (moving or rotating) mechanical components, on the other hand, are expected to wear out and be periodically replaced during the plant's operating lifetime. These components are also periodically inspected and maintained under the In-Service Inspection/Testing and Maintenance Programs. Age-related degradation will therefore be identified and corrected, and component functional capability maintained.

In summation, passive mechanical components are designed such that they are not expected to be replaced over a 40-year operating life while the functional capability of active components will be maintained through maintenance and/or periodic replacement. Accordingly, it can be concluded that safety-related mechanical components are designed to function through the period of the proposed amendment and beyond or will be inspected and maintained such as to assure continued functional capability.

3.4.3 Electrical Components

Electrical components that could be required to function in a harsh (significantly worse that normal) environment during a design basis event, are covered by the Vermont Yankee Equipment Qualification Program. This program was established in accordance with the requirements of 10CFR50.49, as discussed in Section 3.2.2.2. The program provides assurance that the components can perform their safety function in their normal or (if necessary) design basis environments for their qualified lifetime. This assurance is based on analysis and/or tests which take into account: (1) environmental conditions expected during the design basis event and (2) aging due to cumulative exposure to the normal service environment. The EQ Program is a continuing program; components covered by the program are subjected to surveillance and maintenance to ensure that they remain qualified throughout the plant service life. If the qualified lifetime of a component is determined at any time to be less than the expected plant service life, the component will be requalified to a longer qualified lifetime, replaced, or upgraded.

Safety-related electrical equipment at Vermont Yankee that is not covered by the Equipment Qualification Program is covered by the plant Maintenance and Surveillance Program. Equipment is replaced when required or when a trend analysis indicates that equipment reliability or expected life has decreased.

3.4.4 Structural Components

3.4.4.1 Primary Containment

Vermont Yankee's Mark I primary containment liner and surrounding concrete structures are designed to ACI, AISC, and ASME III Codes to severe design combinations including LOCA and seismic events. This has resulted in much heavier structures than required to support normal loadings. Strict construction procedures have also resulted in better quality structures. For example, in-place strength tests on the fuel pool floor have revealed that the

concrete strength is better than 50% stronger than the ultimate design strength.[12] Inspection and testing have not indicated any deterioration in the structural integrity of the primary containment over the first 16 years of plant operation. Using good maintenance practices such as corrosion prevention, concrete surface repair, and protective coating upkeep, the Vermont Yankee structural integrity can be ensured well beyond a full 40-year licensing period.

The capability of commercial reactor plants to withstand severe accidents, those in which the reactor core is severely damaged, has been under study for more than twenty years. In 1975, the Reactor Safety Study (WASH-1400) was published. This study examined a large BWR Mark I containment plant utilizing the best analytical tools available at that time. WASH-1400 illustrated that this plant design was acceptable from an overall safety perspective and provided a very low risk to the public health and safety.

Although there is still ample consensus that the overall design features of a BWR with a Mark I containment design like Vermont Yankee can acceptably protect the health and safety of the public, it is appropriate to re-examine Mark I containment performance and capability to function during extremely low probability severe accident sequences where core damage is assumed. In 1986, Vermont Yankee initiated a comprehensive evaluation to properly assess the performance of the plant's Mark I containment design and its ability to mitigate severe accidents. The study accounted for significant design features specific to Vermont Yankee which would affect the plant response to a severe accident.

The study concluded that Vermont Yankee's Mark I containment would perform in a reliable and satisfactory manner during a severe accident. The evaluation also provided valuable insight into areas where plant and operator

response to a severe accident could be enhanced. Recommended changes for implementation and further study were also identified and over the long term will provide continued assurance that severe accident mitigation capability is maximized. It should be emphasized, however, that Vermont Yankee has been modified throughout its operation to provide additional features and response capabilities above and beyond its design to reduce the probability of a severe accident. The plant, as currently analyzed, should not experience a severe accident.

The Vermont Yankee containment evaluation was independently reviewed by both Professor Norman Rasmussen of the Massachusetts Institute of Technology and the NRC staff. Based on his review, Professor Rasmussen could "find no major criticisms of the report and its approach to the problem." Subsequently, at the request of the state of Vermont, the NRC staff subsequently reviewed the evaluation. In a letter, dated August 24, 1988[21], Dr. Thomas Murley, NRC's Director of Nuclear Reactor Regulation, stated the following:

> Our review of the report finds it to be a systematic, thorough evaluation of potential safety improvements to the Vermont Yankee plant. We believe that the additional training and procedures described in the report should add to the ability of Vermont Yankee operators to cope effectively with events beyond the design basis for the Vermont Yankee plant. The report also describes plant modifications that are being implemented (e.g., containment spray supply from the diesel fire pump and additional back-up power to valves). These modifications add to the usefulness of plant equipment in responding to events beyond the design basis. In summary, we conclude that changes resulting from the study make a positive improvement to the safe operation of the Vermont Yankee plant.
>
> ... the safety improvements stemming from the Vermont Yankee study provide the Vermont Yankee plant with a level of containment safety that goes beyond present staff requirements. We regard this as a positive attribute.

The combination of continued testing and maintenance, further assessment, procedural changes, and actual backfits assures the reliability of Vermont Yankee's Containment System during future years of operation to include the period of the proposed amendment.

3.4.4.2 Other Structures

Other critical plant structures are made of steel and/or reinforced concrete. Structural steel components were designed and fabricated in accordance with the American Institute of Steel Construction (AISC), Steel Construction Manual. Concrete structures were designed in accordance with the requirements of the American Concrete Institute (ACI), Building Code. Plant structures are subject to periodic inspections and maintenance. Such maintenance includes periodic reapplication of protective coatings and concrete surface repair. Experience in other industries with similarly designed structures indicates that, with an aggressive inspection and maintenance program, a service life well in excess of 40 years can be anticipated. On this basis, it should also be possible to maintain the integrity of these structures well beyond 40 years.

3.5 Conclusion

The preceding assessment provides a review of: (1) documents which describe the present licensing bases, (2) plant operating history, and (3) assurances for the continued functional capability of safety-related components through at least 40 years of plant operation.

The documents which describe the present licensing bases include:

- A Final Safety Analysis Report (FSAR) which provides a description of the overall plant design and safety evaluation.

- Technical Specifications which set forth the conditions that are acceptable for plant operation.

- Surveillance and Maintenance Program documents, which describe the plant's In-Service Inspection, In-Service Testing, Environmental Qualification, and Maintenance Programs.

The plant operating history demonstrates the validity of the present licensing basis. More specifically, it demonstrates that the plant's reliability and safety have been maintained. This is evidenced by:

- A lifetime average plant capacity factor of 70.2%.

- Favorable results under the In-Service Inspection Program.

- A consistently high regulatory performance rating under the NRC's SALP Program.

- A history of plant safety improvements.

Safety-related systems and components are designed, constructed, operated, and maintained to assure their continued functional capability through at least 40 years of plant operation. In particular:

- The fracture toughness of the reactor vessel meets or exceeds the requirements set forth in Appendix G to 10CFR Part 50 and will continue to do so, at least through the amendment period.

- Reactor coolant pressure boundary components are designed to include consideration of potential effects of age-related phenomena such as corrosion, thermal cycling fatigue, and radiation-induced embrittlement. Components are also designed to withstand the fatigue effects of cyclic loads due to system temperature and pressure changes.

- Passive mechanical components associated with safety-related systems are designed to include consideration of the potential effects of age-related phenomena such as corrosion, erosion, and

thermal cycling fatigue. Nevertheless, these components are subject to periodic inspections and maintenance.

- Many active mechanical components associated with safety-related systems are expected to wear out. Therefore, these components are periodically inspected and maintained or replaced under the In-Service Inspection/Testing and Maintenance Programs.

- Electrical components which would be required to function in a harsh environment during a design basis event are monitored and maintained under the Environmental Qualification (EQ) Program. Other safety-related electrical components, not included in the EQ Program, are monitored and maintained under the Maintenance Program.

- Plant structures were designed in accordance with applicable codes and standards at the time of construction and are subject to periodic inspections and maintenance.

- Routine inspection and testing of the Mark I Containment have not indicated any deterioration in its structural integrity. Using good maintenance practices, such as corrosion prevention, concrete surface repair, and protective coating upkeep, the structural integrity of the Containment System can be ensured well beyond a full 40-year licensing period. A comprehensive analytical study in 1986 validated the effectiveness of the system.

On this basis, it can be concluded that the proposed license amendment would not adversely affect the public health and safety.

TABLE 3-1

Comparison of Annual LERs for Vermont Yankee
and an Average U.S. Reactor

Year	Number of LERs	
	Vermont Yankee	Average Industry Reactor
1981	37	53
1982	26	54
1983	34	57
1984	24	26
1985	13	31
1986	16	27
1987	19	26
1988	15	22

Source: NUREG-1272, Volume 2, No. 1

TABLE 3-2

Comparison of Annual Automatic Scrams for
Vermont Yankee and an Average U.S. Reactor

Year	Number of Automatic Scrams	
	Vermont Yankee	Average Industry Reactor
1980	2	7.4
1981	3	6.2
1982	2	6.1
1983	3	4.9
1984	2	4.5
1985	1	4.3
1986	2	3.9
1987	3	2.7
1988	3	2.1

Source: INPO, 1989

TABLE 3-3

Summary of Vermont Yankee Historical SALP Scores

Assessment Period	Operations	Radiological Controls	Maintenance	Surveillance	Emergency Preparedness	Fire Protection	Security	Outage Management	Quality Programs	Licensing	Training
07/81 - 06/82	1	1	1	1	2	1	1	1	N	1	N
07/82 - 04/83	2	1	1	1	N	1	1	2	N	1	N
05/83 - 10/84	1	2	2	1	1	2	1	1	2	1	N
11/84 - 10/85	1	2	1	1	2	N	2	1	2	1	N
11/85 - 12/86	1	2	2	1	2	N	1	1	2	1	1
01/87 - 06/88	1	2	2	1	2	N	1	N	2	1	1

Source: NUREG-1214, Revision 4, October 1988

Vermont Yankee Cumulative Capacity Factor

Figure 3-1

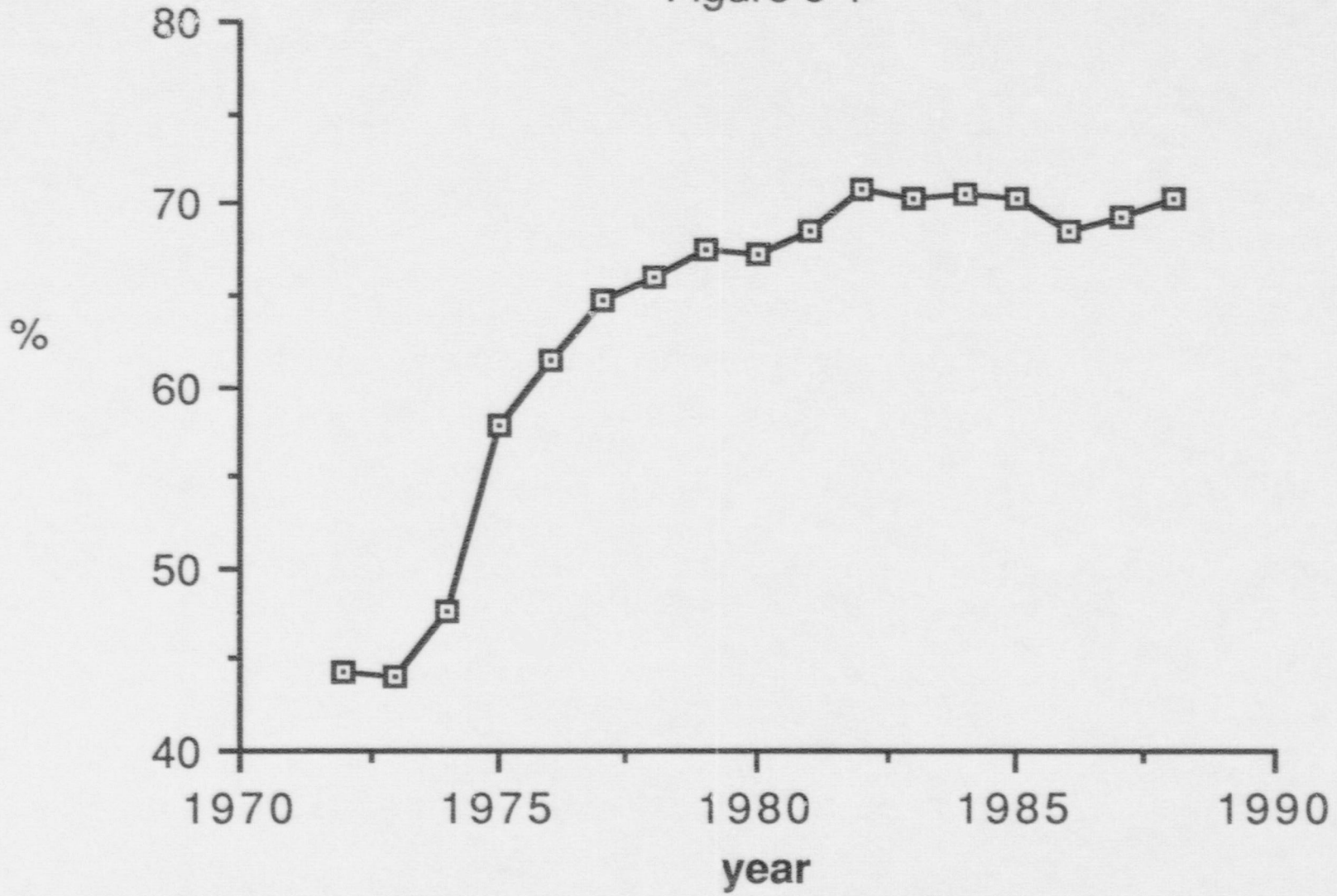
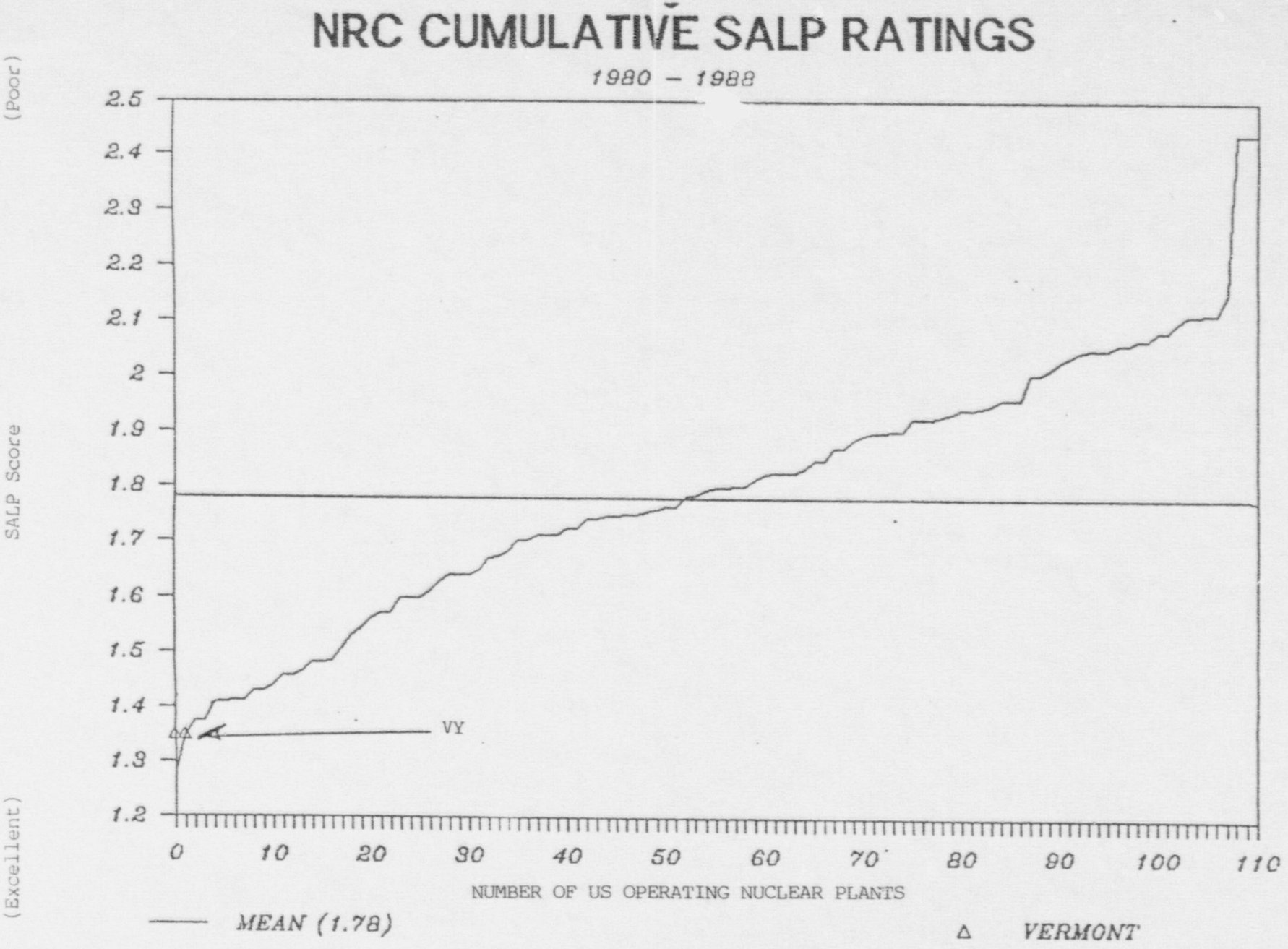


Figure 3-2


NRC CUMULATIVE SALP RATINGS
1980 – 1988
(Poor)
SALP Score
(Excellent)
2.5
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
VY
0
10
20
30
40
50
60
70
80
90
100
110
NUMBER OF US OPERATING NUCLEAR PLANTS
MEAN (1.78)
VERMONT

4.0 ENVIRONMENTAL ASSESSMENT

4.1 Introduction

The purpose of this section is to provide an assessment that demonstrates that the environment will not be adversely affected by the proposed amendment to the plant's operating license. This assessment principally considered the findings of the plant's Final Environmental Impact Statement (1972)[1], Environmental Report (1970)[4], Supplemental Environmental Report (1971)[5], Final Safety Analysis Report (1982)[3], as well as other studies and data accumulated over the past 16 years of operation. Four criteria, as defined below, were used to assess the findings and data cited above. Essentially, these four criteria have been the basis for the determinations made by other licensees that have already applied for and subsequently been granted a similar amendment.

- Environmental control/monitoring systems and programs meet applicable regulatory criteria and show evidence of continual appropriate enhancement as well as effectiveness through present and future years of operation.

- The rate of discharge or generation of radiological and nonradiological effluents, solid wastes, and occupational exposures are projected to remain well within the bounds of the Final Environmental Impact Statement[1] and applicable regulatory criteria and permits, or where appropriate, the upper limits established through typical plant operation over recent years.

- The increase in cumulative effects of applicable parameters are projected to be inconsequential.

- The off-site exposures that result from a design basis accident continue to meet the criteria of 10CFR100 through the proposed amendment term.

In addition to this introduction, this chapter is divided into four additional sections. In Section 4.2, the following systems and programs for environmental control and monitoring are described: Waste Disposal System, ALARA Program, Area and Process Radiation Monitoring Systems, Environmental Radiation Monitoring Program, and Nonradiological Surveillance Program. Throughout each description, any refurbishment or upgrading and data obtained since the plant's startup are highlighted.

Section 4.3 presents an assessment of the environmental effects of plant operation during the proposed amendment term. In addition, the plant's historical data in each area of assessment is compared with the performance of the industry's average BWR (as defined by the NRC or INPO) and the recent trends of such data are discussed as well. For comparison and to establish long-term trends, moving average data for a five-year period are used to levelize actions such as mandatory retrofitting, major repairs, or unanticipated outages which are beyond the scope of normal operations at any power plant. This five-year period for compiling the moving averages is the same period as the proposed amendment, which allows for easier comparisons and projections.

In Section 4.4, the off-site exposures from releases during postulated accidents are considered. This environmental effect was previously evaluated in the plant FSAR[3] where the results were found to be within the limits set forth in 10CFR100. Through references and a projection of future populations within 50 miles of the plant, it is shown that the FSAR evaluation will remain valid and 10CFR100 criteria met in future years, including the term of the proposed amendment.

Finally, Section 4.5 presents the summary and conclusions of this assessment.

4.2 Systems and Programs for Environmental Control and Monitoring

4.2.1 Environmental Control Systems and Programs

4.2.1.1 Waste Disposal System

The Waste Disposal System is described in Section 9 of the FSAR[3]. This system receives, contains, adequately treats, and safely disposes of all radioactive wastes. The basic processes used are natural decay of radioactive isotopes, filtration to remove particulate matter, dewatering by means of centrifuges to reduce the volume and mobility of wet waste, filtration of gases by charcoal and HEPA filters, dilution of low activity liquid and gaseous discharges, and compaction of dry active waste. The system consists of liquid and gas storage tanks, centrifuges, pumps, compressors, heat exchangers, filters, instruments, piping, and valves, as described in the FSAR.

4.2.1.2 As Low as Reasonably Achievable (ALARA) Program

In accordance with 10CFR20.1(c) and the plant Technical Specifications, Vermont Yankee has established an ALARA Program.

The purpose of this program is to maintain occupational radiation exposures "As Low As Reasonably Achievable." The program assures that ALARA is considered in all aspects of plant design, operation, maintenance, and inspection. For instance, all workers are advised that they are responsible to ensure that their work practices will maintain their exposures ALARA. To increase employees' awareness of their exposure to radiation, all monitored employees receive an annual statement of their radiation exposure.

Vermont Yankee's Radiation Protection Policy or ALARA Program requires that an estimate of the total dose be provided for all Radiation Work Permits (RWPs). If the estimate is less than one person-rem, the ALARA controls are established by the person initiating the RWP. If the estimated total dose is at least one person-rem but less than 10 person-rem, the job receives an ALARA review by the Plant Health Physicist. All jobs estimated at 10 person-rem or

greater require a review by the Plant Health Physicist and the Plant ALARA Committee prior to the job being initiated. Moreover, the policy also addresses materials control in the Reactor System. Consideration must be given to the use of low cobalt or cobalt-free alloys when replacing existing components or designing new components.

A Plant ALARA Committee is also required under the policy and is composed of personnel from the various Vermont Yankee departments (e.g., Maintenance, Operations). The chairman of the committee is the Plant Manager with the Plant Health Physicist also being a permanent member. The committee meets quarterly and prior to refueling outages to assess the effectiveness of exposure control methods in keeping personnel exposures ALARA. Furthermore, the committee assists in developing ALARA policy and procedures and monitors the implementation of ALARA measures.

The plant's program is assessed after each outage by an ALARA report that the Plant Health Physicist is required to generate. The report lists exposures incurred on major jobs and summarizes the ALARA lessons learned for future use. The report allows the ALARA Committee to identify ALARA-related inadequacies in designs or procedures used for equipment installation, operation, surveillance, and maintenance. The results of these post-job critiques provide knowledge that can be used to improve future designs and reduce exposures on the same or similar jobs in the future. Similarly, Vermont Yankee also sets an annual plant exposure goal based on the outage report and input from each plant department. Current exposure is periodically reviewed by management to identify adverse trends, thus assuring timely, corrective action, when necessary.

Vermont Yankee's long-term commitment to ALARA is evidenced by the programs continued review and adjustment based on lessons learned and new technology. For example, during the 1985-1986 recirculation piping replacement project, an "ALARA Coordinator" was appointed from the Chemistry and Health Physics Department. The Coordinator along with an augmented staff of ALARA engineers, worked to ensure all phases of the project were reviewed for ALARA concerns. Due to the success of the "ALARA Coordinator" in helping

to reduce exposures during this project, management subsequently approved the appointment of a full-time coordinator who is responsible to implement and improve the plant ALARA program.

New technologies, such as chemical decontamination, have been found by the plant to be an effective ALARA tool. Also, through its involvement with the BWRs Owners' Group Chemistry Program, Vermont Yankee will be able to implement, in a timely fashion, improvements to the Chemistry Program, which should further help to minimize dose rates. Finally, in future years of operation, Vermont Yankee will continue to apply advanced technologies, such as robotics, when available and appropriate to reduce personnel exposure.

4.2.2 Environmental Monitoring Systems and Programs

4.2.2.1 Area and Process Radiation Monitoring System

The Area Radiation Monitoring System is described in Section 7 of the FSAR[3]. This system monitors radiation levels associated with process systems and areas at various locations inside and outside of the Reactor Building. It is designed for use during normal operation or postulated accident situations and includes equipment for detecting, computing, indicating, and alarming. Periodic testing and inspection of the system assures its functional readiness throughout the plant's license term.

A number of radiation monitors and monitoring systems are also provided on process liquid and gas lines that may serve as discharge routes for radioactive materials. The monitors include the following:

Main Steam line Radiation Monitoring System
Off-Gas Radiation Monitoring System
Plant Stack Radiation Monitoring System
Process Liquid Radiation Monitors
Reactor Building Ventilation Radiation Monitoring System

Each of these systems is periodically calibrated and inspected to assure accurate functional performance.

4.2.2.2 Environmental Radiation Monitoring Program

The Environmental Radiological Surveillance Program is described in Section 2.6 of the FSAR. This program was established prior to the start of plant operation. The radiological environmental surveillance program is designed to demonstrate the adequacy of safeguards inherent in station design and the effectiveness of the station's process radiation monitoring and area radiation monitoring systems to measure the controlled releases of low level radioactive materials. Emphasis is placed on control at the source, with follow-up and confirmation by environmental surveillance. This is accomplished by continuously measuring radiation levels and airborne radioactivity levels and periodically measuring amounts of radioactivity in samples at various locations surrounding the plant.

Several types of sample media used correspond to the possible exposure pathways. These are direct radiation, inhalation, and ingestion via waterborne or airborne pathways. Direct radiation is measured continuously by Thermoluminescent Dosimeters (TLDs). Airborne radioactivity is collected continuously by passing air through a fiber filter in series with a charcoal absorption media. The filter collects particulate radioactivity, and the charcoal collects radioiodine. Waterborne radioactivity levels are monitored by taking river water and groundwater samples, as well as shoreline sediment samples. Ingested radioactivity is collected by obtaining samples of vegetation, milk, silage, and fish.

The measurements are made within an area that is divided into two zones. Zone 1 is an area that is considered to be within the potential influence of the plant. Zone 2 is an area not considered to be influenced by the plant. The measurements in Zone 1 are compared to the measurements in Zone 2, as well as to other applicable environmental data, in order to differentiate between the effects of plant operation and the effects of natural background or other causes. To ensure that the program continues to

include those locations whose environmental samples are most likely to show plant related radioactivity, a land use census is conducted annually. Changes in milk sampling locations may be required following the census based on relative potential doses or dose commitments and the availability of samples.

4.2.2.3 Nonradiological Surveillance Program

A National Pollutant Discharge Elimination System (NPDES) permit to discharge effluents into the Connecticut River by Vermont Yankee is issued through the Vermont Agency of Natural Resources. Discharges occur from condenser cooling water, heating boiler blowdown, water purification systems, radioactive waste treatment systems, and storm water. Specific effluent limitations and monitoring requirements are established for each parameter at each discharge point. These are based on Title III and IV of the Federal Clean Water Act in accordance with 40 CFR Parts 122-125 and 423, the Vermont Water Pollution Control Act 10 V.S.A., Chapter 47, Vermont water pollution control permit regulations, and the Vermont water quality standards.

Biological investigations, which began in 1967 in the vicinity of Vermont Yankee, were used to support, in 1978, a 316(a) and 316(b) demonstration[2] under the Clean Water Act. These studies (six years of preoperational and four years of operational), demonstrated that the protection and propagation of the balanced, indigenous communities of shellfish, fish, and wildlife in and on the Connecticut River in the Vermont Yankee vicinity would be assured.

NPDES permits issued to Vermont Yankee every five years have contained requirements for the continued monitoring of the environment to ensure its protection. Studies to date have not identified any additional concerns with relation to the discharge to the Connecticut River. These studies have been reduced in scope as information documents the continued absence of harm. A provision of the permit has required the establishment of an Environmental Advisory Committee (EAC). This committee is comprised of representatives of the Vermont Department of Environmental Conservation, the Vermont Department of Fish and Wildlife, the New Hampshire Fish and Game Department, the New

Hampshire Water Supply and Pollution Control Division, the Massachusetts Division of Water Pollution Control, the Massachusetts Division of Fisheries and Wildlife, the Coordinator of the Connecticut River Anadromous Fish Program, the U.S. Fish and Wildlife Service, and the Environmental Scientist of the Vermont Yankee Nuclear Power Corporation. Changes to the monitoring programs at Vermont Yankee are made through the Advisory Committee, who receive yearly progress reports and proposals for upcoming studies.

4.3 Assessment of Environmental Impact During Normal Operations

4.3.1 Radiological

4.3.1.1 Occupational Radiation Exposure

Vermont Yankee's occupational exposure trend and comparative magnitude with the industry average BWR based on exposures in terms of annual person-rem per five-year moving average period is summarized in Table 4-1. In comparison with the industry average BWR, Vermont Yankee's occupational exposures have, overall, been significantly less. As can be seen, the aggressive implementation of the plant's ALARA Program has resulted in a distinct reduction in exposures over the most recent five-year period.

Table 4-2 presents the historical annual occupational exposure and plant outage status along with an adjustment for one time only projects. For the purposes of projecting future occupational exposures, it is more conservative to use only those values in Table 4-2 associated with the years subsequent to 1979, since fewer personnel were monitored beforehand. With the adjustment of exposures for special one-time-only projects, and the elimination of values for the nonrefueling outage years of 1982 and 1988, the plant has a base occupational exposure of about 700 person-rem/yr. For years with no refueling outage, the experience of 1982 and 1988 indicates that a base occupational exposure of 200 person-rem/yr can be conservatively expected.

Given Vermont Yankee's current trend of decreasing occupational exposure and consistently high SALP ratings in the area of Refueling and

Outage Management, it is expected that the base occupational exposures established above will serve as an upper limit in future years of normal operation. During the proposed amendment term, it is anticipated that Vermont Yankee will continue to operate in an approximately 18-month fuel cycle mode (see Section 4.3.1.4), which means that there will be four refueling outages over that period. Using the average annual exposures of 700 and 200 person-rem for years with and without typical refueling outages, respectively, it is estimated that the total occupational exposure during the proposed amendment term will be about 3,000 person-rem. This averages to about 600 person- rem/year. This projection is consistent with the plant's recent five-year average occupational exposure levels (as shown in Table 4-1) and is in accordance with 10CFR20 and Regulatory Guide 8.8.

4.3.1.2 Off-Site Radiation Exposure

The proposed amendment to extend the operating life of the plant by five years and three months will have no significant impact on the capability of the plant to maintain routine releases of radioactive materials (liquids and gases) to the environment "As Low As Reasonably Achievable" (ALARA) in accordance with 10CFR20.1(c) and 10CFR50, Appendix I. This conclusion is based on a review of the design bases of the Radwaste System as described in Section 9 of the FSAR[3], the calculation of annual doses to individuals and population groups over the last twelve years of plant operation as reported to NRC in Semiannual Effluent Release Reports, and an assessment of trends of effluent releases during that 12-year period.

Consistent with the 10CFR20 ALARA requirement, the NRC in 1975 issued 10CFR50, Appendix I, which established radioactive design dose objectives for liquid and gaseous (including iodine/particulate radionuclides) effluents. In 1976, a design evaluation of the Radwaste System was performed to demonstrate that the as-built design was capable of meeting the design dose objectives of 10CFR, Appendix I. This information was submitted to the NRC under the title, "Supplemental Information for the Purposes of Evaluation of 10CFR Part 50, Appendix I," on June 2, 1976 with two amendments, which were submitted August 31, 1976 and October 20, 1976, respectively. Table 4-3 provides a

comparison of Appendix I requirements, the 1976 design evaluation limits, and consolidated plant operating data.

For the plant's liquid effluent, the design evaluation determined that the annual whole body dose to the maximum individual due to radioactive materials contained therein should not exceed 2.2×10^{-2} mrem, or approximately 0.7% of the Appendix I design bases for showing compliance with the "ALARA" criteria. A review of the actual performance of the plant to control and limit liquid effluent over the period since 1976 indicates that the maximum individual dose averages no more than 5.0×10^{-4} mrem per year for those years when liquid releases have actually taken place. This represents only 0.017% of the ALARA objective doses. The effluent release data over this period also show that there have been zero liquid releases for the past seven years and no liquid releases in nine of the past 12 years. From this extended operating experience, the plant has clearly and consistently demonstrated its ability to hold up, process, and reuse waste water to a degree that has not necessitated the routine release of significant radioactive liquid waste.

The 1976 Appendix I design evaluation also determined that the gaseous Radwaste System was capable of limiting routine effluent releases, including anticipated operational occurrences, to within ALARA design objectives. The design evaluation determined that the annual whole body dose to the potentially maximum exposed individual should not exceed 1.2 mrem. Based on recorded noble gas effluents over the last 12 years, the calculated maximum exposed individual received, on average, only 0.32 mrem per year, or approximately 6% of the ALARA dose objective of 5 mrem per year, and only 27% of the design evaluation estimate of 1.2 mrem per year. Along with the above noted individual doses, the 50-mile estimated population dose due to noble gases released from the plant over the last 12 years has been calculated to be approximately 3.6 person-rem per year. For the estimated 1.4 million persons within 50 miles, the plant's contribution to the total population dose in comparison to that from background radiation is insignificant.

In addition to noble gases, the 1976 design evaluation of the gaseous Radwaste System estimated that the maximum organ dose due to the release of iodines and particulates in gaseous effluents should not exceed 3.8 mrem per year, or approximately 25% of the Appendix I dose criteria of 15 mrem per year to any organ. Dose calculations based on the actual iodine and particulate releases over the last twelve years indicates that the average maximum annual organ dose is only 0.32 mrem per year. This represents just 2% of the Appendix I ALARA dose criteria and only about 8% of the design evaluation estimate. Similar to the population doses calculated from the release of the noble gases, the 12-year estimated average population dose from iodine and particulates has been calculated to be 0.46 person-rem per year. This also represents an insignificant fraction of the total man-rem exposure the same 50-mile population receives each year from background.

Based on the design and performance history of the Radwaste System, it is confidently expected that through the term of this proposed amendment that off-site radiation exposures will remain well within the plant's ALARA criteria. It is important to note that, in 1985, these ALARA criteria were formally incorporated into the plant's operating Technical Specifications. Furthermore, the plant's contribution to the local population dose within a 50-mile radius is expected to remain insignificant in comparison to that from background radiations.

4.3.1.3 Solid Waste Generation

The volume of solid waste generated at Vermont Yankee has historically been among the lowest in the nuclear industry. Table 4-4 presents a comparison of the annual solid waste generation for Vermont Yankee and the average industry BWR. These values show that compared to the average BWR, Vermont Yankee has historically generated significantly less solid waste and has also followed the industry's long-term trend of reducing volume. Table 4-5 presents the five-year moving average of solid waste generated at the Vermont Yankee plant. During the future years of plant operation, including the proposed amendment term, continued emphasis on lower solid waste generation is expected to at least maintain if not improve the most recent

values stated in Table 4-5. Thus, the maximum solid waste volume over the entire amendment term should be on the order of about 2,000 cubic meters which averages to only 400 cubic meters per year, which is consistent with the plant's recent performance.

4.3.1.4 Uranium Fuel Cycle

The Vermont Yankee reactor contains 368 fuel bundles. Until recently, the plant has operated in a twelve-to-fourteen month fuel cycle mode. The availability of advanced - but proven and widely used - fuel designs has allowed Vermont Yankee to implement an 18-month fuel cycle mode of operation, thereby reducing the demand for fissile uranium by its more efficient utilization in the reactor core.

The additional five years of reactor operation that is sought under this proposal amendment will obviously increase the total fissile uranium required over the plant's operating lifetime. A reasonable assumption is that the plant will continue to operate the 18-month fuel cycle mode cited above through the end of the proposed amendment term. The better utilization of fissile uranium allowed through this extended fuel cycle operation means that, in relative terms, the cumulative increase will be proportionally smaller than any other five-year period to date. In absolute terms, the increased requirement for uranium will have only a marginal, if any, environmental impact which is completely justified by the cost-benefit assessment presented in Section 2.0.

4.3.1.5 Spent Fuel

The environmental studies performed before the startup of Vermont Yankee in 1972 projected that the plant would generate about 3,500 spent fuel bundles over a 40-year operating life. At this point in time, it has been estimated the plant will generate a total of 3,545 spent fuel bundles, which includes those generated during the proposed amendment term. Thus, this proposed amendment would have no impact of any consequence on the spent fuel projections made prior to commercial operations.

The plant's spent fuel pool currently has a licensed capacity to meet operational needs only through 1995 (without maintaining full-core reserve discharge capability). Vermont Yankee's strategy for dealing with this issue is twofold. First, Vermont Yankee will continue to explore environmentally and technically safe options for on-site expansion of spent fuel storage capacity. Second, Vermont Yankee Nuclear Power Corporation has a contract with the U.S. Department of Energy for the removal from the plant site and disposal of spent fuel. This situation, and Vermont Yankee's strategy for dealing with it, is similar to that of other licensees which have previously been granted an identical amendment.

4.3.2 Nonradiological

4.3.2.1 Thermal and Ecological Effects of the Circulating Water System

The operation of Vermont Yankee's Condenser Cooling Water System can be through three modes which determine the volume of water and the amount of heat discharged to the river. To comply with the thermal requirements for discharge under the NPDES permit (see Section 4.2.2.3), the condenser cooling water may be either discharged directly to the Connecticut River (open cycle) or recirculated and passed through mechanical draft cooling towers and a spray pond for temperature reduction prior to discharge to the river (closed or hybrid cycle). The potential environmental effects of the Circulating Water System include: (1) those of the thermal plume created by the heated water discharge to the river, (2) impingement of fish on the cooling water intake screens, and (3) entrainment of organisms (phytoplankton and zooplankton) within the cooling water stream.

The NPDES permit requires that discharge to the Connecticut River be such that the Vermont water quality standards are met, and further, that such discharges are not adverse to human health and safety, the environment in the vicinity of Vernon, and fish and other wildlife, including their value as fish and game or their habitat and ecology. To this end, in-stream biologically

based temperature criteria have been established. The State of Vermont bases its decision to issue an NPDES permit on the following conclusions:

1. The as-built design of the Cooling Water System reflects the best technology available to minimize: (a) fish impingement on the intake screens and (b) entrainment of organisms in the cooling water passing through the condenser. Also, the location and the physical characteristics of the thermal plume should not interfere with the normal migratory pathways of the indigenous or anadromous species inhabiting the river.

2. The plant has operated since 1973 without any observable impact to fish due to thermal effects. Therefore, the existing thermal limits and control program ensure the protection and propagation of a balanced indigenous community of fish and wildlife.

3. Accordingly, the as-built design of the Circulating Water System and the thermal limits imposed through the NPDES permit assure satisfaction of the technology requirements of the Clean Water Act and of the State of Vermont water quality standards.

It is expected that the basis for the State of Vermont decision will remain throughout the present license term as well as the proposed amendment term. In short, the environmental effect of the Circulating Water System is, and will remain, stable given the controlled nature of the Connecticut River and the fixed design of the Circulating Water System. Vermont Yankee will continue to monitor the effects of the Circulating Water System in accordance with its NPDES permit, which is renewed every five years.

4.3.2.2 Protection of Historic Properties

In accordance with the requirements of 36CFR, Part 800, Protection of Historic Properties, Vermont Yankee has reviewed the associated findings in the FER[4] and the current historical site listings of the Vermont Division of Historic Preservation, the New Hampshire Division of Historical Resources

and the Massachusetts Historical Commission. In addition, to assure a complete review, a representative of the Vernon Historians, Inc. was consulted to gain a local perspective.

The closest historic place to the plant is the Governor Hunt House, located adjacent to the plant. Consistent with its pledge at the time of plant construction, Vermont Yankee has restored the property and has continued to preserve and maintain it as well as allow for public visitation as part of its information center. Other historic places - all at a distance of about five to seven miles to the plant - are Union Station and Creamery Covered Bridge in Brattleboro, Vermont; Main Street Historic District and King Phillip's Hill in Northfield, Massachusetts and Todd Block in Hinsdale, New Hampshire, at a closer distance of two miles. Over 16 years of operation, there is no known evidence of the deterioration of these or any other sites as a result of Vermont Yankee's operation.

Based on physical separation, as well as the plant's exceptional operating record, it is concluded that Vermont Yankee's operation through the proposed amendment term will cause no detrimental impact on any known historic place.

4.4 Exposure From Releases During Postulated Accidents

The off-site exposure from releases due to postulated accidents has been previously evaluated in the plant's FSAR[3]. The results are acceptable when compared to the criteria defined in 10CFR100. This type of evaluation is a function of four parameters: (1) the types of accidents postulated, (2) the radioactivity release calculated for each accident, (3) the assumed meteorological conditions, and (4) population distribution versus distance from the plant. On the basis of the safety assessment in Section 3, it can be concluded that neither the types of accidents or the calculated radioactivity releases will change through the proposed amendment term. Furthermore, the site's meteorology as defined in the FSAR, is essentially constant and consideration herein is therefore unwarranted. Thus, the one parameter which is dependent on the proposed license amendment is the

population size and distribution. It is also important to note that there is no expectation of significant land use changes during the amendment term that would affect off-site dose calculations.

The population size and distribution in the vicinity of the plant has been reviewed several times since the construction permit was issued: the original FSAR in 1969,[22] ER in 1971,[5] revised FSAR in 1982,[3] and in late 1986, a special projection study for the purposes of this proposed amendment term.[7] This study ran projections through 2012. The potential for additional changes in population through the first two months of 2013 is considered to be insignificant. Table 4-6 presents a summary of the population size and distributions stated in these studies with specific delineation of low population zone (LPZ). The plant exclusion area will remain uninhabited through the proposed amendment term. For perspective, the exclusion area and LPZ boundaries are outlined below:

- Exclusion Area: The exclusion area for the Vermont Yankee site includes the entire 125-acre land area owned by Vermont Yankee surrounding the plant and a narrow strip of land between the Connecticut River and the east boundary of the plant properly to which Vermont Yankee has perpetual rights and easements from the New England Power Company. In addition, the Connecticut River water area between Vernon Dam and the northern Vermont Yankee properly line is included in the exclusion area since it will be a controlled access region during an accident condition. The means of controlling access on the river and evacuating it if necessary have been worked out with the State of New Hampshire officials who will coordinate control activities over the river. The minimum distance from the Reactor Building to the boundary of the exclusion zone is 910 feet in a westerly direction.

  The activities within the exclusion area are those pertaining to normal plant operations only. Passage on the Connecticut River to Vernon Pond is possible during normal plant operation. No part of the exclusion area owned by the plant will be sold, and no

structure will be located within it except those owned by Vermont Yankee Nuclear Power Corporation or related companies and used in conjunction with normal utility functions. No residences will be permitted on the site.

- LPZ: The low population zone for the Vermont Yankee Nuclear Power Station is the area included within a five-mile radius of the site. This land area was selected because it meets the requirements of 10CFR100 with respect to proximity to the nearest population center.

As presented in Table 4-6, the population within an aggregate 50-mile radius of the plant is projected to remain essentially unchanged for the term of the proposed amendment and also remain well within the ER[5] and FSAR[3,22] projections. For the area within a five- and ten-mile radius of the plant, the population projections for the proposed amendment term fall essentially within the middle of the most distant projections from the original and revised FSAR (year 2000) and ER (year 2010). In other words, if the median of the three previous population projections for the area within a ten-mile radius of the plant is used as a benchmark, then the more recent projections[7] for the proposed amendment term show no significant change. Likewise, from an absolute comparison, there is only insignificant growth projected over the amendment term for this same area. Of the three previous studies, only the revised FSAR and ER provided projections for the area between a 10- and 50-mile radius of the plant. The comparisons in Table 4-6 indicate that the projected populations through 2012 for this area will fall within the upper bound estimated by the ER in 1971 and, subsequently, the FSAR in 1982.

The major population centers (with populations of 25,000 or more) currently within 50 miles of Vermont Yankee are Northampton, Massachusetts (1980 population 29,286), about 30 miles to the south; and Amherst, Massachusetts (1980 population 33,210), at about 28 miles south. Accordingly, 28 miles is currently the Population Center Distance (PCD). However, population projections indicate that the town of Keene, New Hampshire (12

miles NE) will approach a population of 25,000 in approximately the year 2000. The 2012 projected population for Keene, New Hampshire is 29,566. Accordingly, the PCD will become 12 miles in approximately the year 2000. Federal regulation 10CFR100.11(a)(3) provides that the PCD be at least 1 1/3 times the distance from the reactor to the outer boundary of the LPZ. The town of Keene, New Hampshire at 12 miles northeast will satisfy this rule as the projected PCD in the year 2000, thus requiring no change in the definition of the current LPZ now or during the requested license extension period. Finally, there is no expectation of significant land use changes during the amendment term that would affect off-site dose calculations.

It is clear that none of the minor changes projected for the population distribution through 2012 will significantly impact the boundaries at which any accident analysis were previously calculated. The current exclusion area boundary, low population zone and nearest population center distance will continue to meet the requirements of 10CFR100.11(a)(3) amendment term. A comparison with other plants that have already been granted a similar amendment shows that Vermont Yankee will continue to be representative of a low population distribution through the year 2012. Accordingly, the proposed license amendment will not significantly impact previous conclusions on the potential environmental effect of off-site releases from postulated accidents.

4.5 Summary and Conclusions

The environmental effects of Vermont Yankee's continued operation through the proposed amendment term have been assessed. Comparison was made against several docketed environmental studies plus operational data using four criteria which were established (See Section 4.1) based on the applications for a similar amendment that other licensee's have submitted and subsequently gained NRC approval. The assessments have shown that the environmental effects of Vermont Yankee's operation through the proposed amendment term are expected to remain well within the limits set forth by the four criteria. Also, as expected, the plant's environmental effects appear to be independent of chronological age.

Vermont Yankee's systems and programs for environmental monitoring and control show that Vermont Yankee has established, maintained, and when appropriate, upgraded comprehensive environmental monitoring and control programs and systems which meet applicable regulatory criteria. In addition, the plant and other regulatory agencies have performed several surveillance type studies subsequent to the plant start-up, which support the absence of environmental impact as a result of plant operation.

The assessment of environmental impacts during normal plant operation was divided between radiological and nonradiological areas, with the following specific conclusions by topic:

- Occupational radiation exposure levels have been decreasing and, overall, have been significantly less than those from an industry average BWR. The ALARA program and continued excellence in refueling and outage management are expected to maintain these low occupational exposure levels through the proposed amendment term.

- Off-site radiation exposure from liquid and gaseous effluents have been significantly less than the applicable Appendix I criteria and are expected to remain at similar levels during future plant operation.

- Solid waste generation has historically been among the lowest in the nuclear industry and has followed the industry-wide trend of reduced volume. Solid waste generated during the amendment period is projected to be no more than that generated in recent years of operation.

- Uranium fuel cycle impact will be trivial as a result of operations during the proposed amendment term.

- o Spent fuel accumulation is expected to be consistent with projections made in preoperational assessments. Moreover, the plant has credible on-site options for dealing with future storage capacity requirements, as well as a firm contract with the U.S. DOE for the removal of spent fuel from the site.

- o Thermal and ecological effects of the Circulating Water System (CWS) are expected to be minimal through future years of operation. In cooperation with the Vermont Agency of Natural Resources, Vermont Yankee will continue to monitor and evaluate the impact of the CWS on the Connecticut River and meet all NPDES permit requirements

- o Protection of historic places is expected to continue in a manner that results in no degradation to such sites.

- o Off-site exposures from releases during postulated accidents were previously evaluated in the plant's FSAR. The only parameter used in these analyses which could change during future plant operation is the population distribution. The population near the plant is relatively low and is projected to remain virtually unchanged during future plant operation. Moreover, the effect of the projected changes from 2007 to 2012 would be negligible.

Based upon these analyses, it is Vermont Yankee's conclusion that there are no significant radiological or nonradiological impacts associated with the proposed action. Issuance by the NRC of the proposed license amendment will have no significant impact on the quality of the human environment.

TABLE 4-1

Vermont Yankee vs. BWR Industry
Five-Year Occupational Exposure Averages

Five-Year Interval	Total Dose (Person Rem)		Average Dose Per Worker (Rem)	
	Vermont Yankee	BWRs	Vermont Yankee	BWRs
1974-1978	275	690	0.45	1.05
1975-1979	466	687	0.60	0.91
1976-1980	703	815	0.70	0.87
1977-1981	767	891	0.70	0.85
1978-1982	756	896	0.71	0.80
1979-1983	994	969	0.76	0.80
1980-1984	880	1,067	0.76	0.80
1981-1985	823	936	0.59 (b)	(c)
1982-1986	914	915 (a)	0.57 (b)	(c)
1983-1987	934	817 (a)	0.51 (b)	(c)
1984-1988	534	691 (a)	0.36 (b)	(c)

Source: "Occupational Radiation Exposure at Commercial Nuclear Power Reactors," NUREG-0713, Volume 6, 1984.

(a) INPO performance indicators for the U.S. Nuclear Utility Industry.
(b) Plant records.
(c) Not available.

TABLE 4-2

Adjustments to Cumulative Doses

Year	Cumulative Dose (Person-Rem)	Adjustments	Net	Detail of Adjustments for One-Time-Only Projects/Comments
1973	85	None Elected	85	
1974	216	None Elected	216	
1975	153	None Elected	153	
1976	411	None Elected	411	
1977	258	None Elected	258	
1978	339	None Elected	339	
1979	1170	487	682	Hanger Inspection - 337 Sparger and CRD Nozzle Inspection - 43 Torus Modifications - 108
1980	1338	632	706	Hanger Modifications - 273 Torus Modifications - 103 Clean-Up System Pipe Changeout - 256
1981	731	74	657	Special Maintenance - Scram Discharge Volume (SDV) - 74
1982	205	27	178	Seismic Modifications to SDV NO REFUELING
1983	1527	650	877	ISI of Recirc Piping - 201 Torus Modification and Piping Supports - 93 Recirc Pipe Weld Repairs - 337 SDV/HCU Modifications - 19
1984	603	20	583	E-Qual and Special Maintenance - 20
1985	1051	402	649	Special Maintenance. Start (approximately four months) of recirc pipe replacement project.

TABLE 4-2
(Continued)

Adjustments to Cumulative Doses

Year	Cumulative Dose (Person-Rem)	Adjustments	Net	Detail of Adjustments for One-Time-Only Projects/Comments
1986	11881	1109	79	Special Maintenance. End (approximately six months) of recirc pipe replacement project.
1987	303	None Elected		
1988	124	None Elected		

TABLE 4-3

Summary of Off-Site Appendix I Radiation
Exposure Limits and Actual Performance Data
(as mrem)

Parameter	Appendix I Limits	1976 Vermont Yankee Radwaste System Design Review Limit	Maximum Dose Received From Plant Since 1976
Liquid	≤3	2.2×10^{-2}	5.0×10^{-4}
Gaseous	≤5	1.2	0.32
Iodine and Particulates	≤15	3.8	0.32

TABLE 4-4

Comparison of Annual Volume of Solid Waste
Generated at Vermont Yankee and BWR Industry

Year	Vermont Yankee (cubic meters)	Average BWR* (cubic meters)
1973	186	N/A
1974	197	N/A
1975	308	N/A
1976	238	N/A
1977	258	N/A
1978	483	N/A
1979	272	N/A
1980	484	113
1981	438	937
1982	451	889
1983	415	852
1984	349	863
1985	542	797
1986	309	493
1987	223	459
1988	185	312

*Source: INPO, 1989

TABLE 4-5

Five-Year Moving Average of Annual Volume of Solid Waste Generated at Vermont Yankee

Five-Year Period	Average Annual Volume (cubic meters)
1973-1977	237
1974-1978	296
1975-1979	311
1976-1980	347
1977-1981	387
1987-1982	425
1979-1983	412
1980-1984	427
1981-1985	439
1982-1986	413
1983-1987	367
1984-1988	321

TABLE 4-6

Summary of Population Projections
for Vermont Yankee

Area (Mile)	Original FSAR (1969) 2000	Revised FSAR (1982) 2000	Current 2007	ER (1971) 2010	Current 2012	Difference Between (as %) Current 2012 and Orig. FSAR 2000	Current 2012 and Rev. FSAR 2000	Current 2012 and ER 2010	Current 2012 and 2007
0 - 5*	12,566	10,076	11,112	11,770	11,823	-5.9	+17.3	+0.4	+6.3
5 - 10	35,811	33,164	27,704	22,130	28,556	-20.2	-13.8	+29.0	+3.0
0 - 10	48,377	43,240	38,816	33,900	40,379	-16.5	-6.6	+19.1	+4.0
10 - 50	N/A	1,761,410	1,440,243	1,672,200	1,467,232	N/A	-12.2	-16.8	+1.9
0 - 50	N/A	1,804,650	1,479,059	1,706,100	1,507,611	N/A	-11.6	-16.4	+1.9

* Reflects Low Population Zone

5.0 REFERENCES

1. U.S. Atomic Energy Commission, "Final Environmental Statement Related to Operation of Vermont Yankee Nuclear Power Station," Docket No. 50-271, July 1972.

2. Vermont Yankee Nuclear Power Corporation, "316 Demonstration; Engineering, Hydrological, and Biological Information and Environmental Impact Statement," March 1978.

3. Vermont Yankee "Final Safety Analysis Report" (Revised) 1982. (Amended Annually)

4. Vermont Yankee "Environmental Report" (FER) September 1, 1970.

5. Vermont Yankee "Supplement to the Environmental Report (ER)," Volume I, dated December 21, 1971.

6. "Safety Evaluation Report" (SER), dated June 1, 1971.

7. Report, "Demographic Update of the Area Surrounding the Vermont Yankee Nuclear Power Station," HMM Associates, Inc., dated September 1986.

8. License No. DPR-28 (Docket No. 50-271).

9. ASME Boiler and Pressure Vessel Code, 1965 Section III, Including Winter 1965 Addendum.

10. Calculation No. VYC-378, "Vermont Yankee Reactor Cyclic Limits for Transient Events," dated October 16, 1985.

11. Letter, V. L. Rooney (NRC) to R. W. Capstick (VY), Docket No. 50-271, dated June 24, 1986, NVY 86-121.

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