VERMONT YANKEE
NUCLEAR POWER CORPORATION

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FVY 88-42
Warren P. Murphy

Vice President and
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May 24, 1988

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Office of Nuclear Reactor Regulation
Dr. T.E. Murley, Director

Dear Sir:

In accordance with a recent verbal request from your staff, I have enclosed, for your information, a copy of our "Report on Containment Safety at Vermont Yankee", dated April 29, 1988. We are not requesting your review of this document.

This report was generated by our Public Relations Department to summarize and describe the current status of all our Containment Improvement/ Severe Accident initiative items for the State of Vermont. It is not a technical report and therefore does not represent a definitive follow-up effort to the "Vermont Yankee Containment Safety Study", dated August 1986, which was previously reviewed by your staff. As described in our March 1, 1988 letter to your staff, Vermont Yankee will await the NRC's pending formal guidance prior to resolving any other severe accident issues.

If you have further questions, please do not hesitate to contact me.

Very truly yours,

[signature] for

Warren P. Murphy
Vice President and
Manager of Operations

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REPORT ON CONTAINMENT SAFETY AT VERMONT YANKEE

April 29, 1988

Vermont Yankee Nuclear Power Corporation

INTRODUCTION

This report gives a comprehensive review of the status of containment safety at the Vermont Yankee nuclear power plant in Vernon. The starting point is the Containment Safety Study conducted by Vermont Yankee in 1986. Each issue or recommendation covered in that study, the several reviews of that study, the studies done at other plants, and, finally, any recommendation from any creditable source, has been carefully evaluated and acted upon. The evaluation has been done by a Containment Safety Task Force made up of engineers and operators with not only theoretical expertise in nuclear power plants but also detailed, current technical and operational knowledge of the Vermont Yankee plant. The evaluation has been done in a thorough and highly disciplined manner. The report tracks a recommendation or issue through to a schedule for implementation if a change was evaluated to be beneficial. This report summarizes all major activity on issues bearing on containment safety at Vermont Yankee which have occurred over the last two years.

I. BACKGROUND

On June 30, 1986, Vermont Governor Madeleine Kunin asked the Vermont Yankee Nuclear Power Corporation to conduct a containment safety study of the Vernon generating station. The Governor requested that the study be done quickly, and it was ultimately agreed that the study would be completed in sixty days. Vermont Yankee immediately acted upon her request and informed the Nuclear Regulatory Commission that it would transmit to the federal agency a study which would include a design review of the Vermont Yankee containment, a specific evaluation of the probability of a Vermont Yankee containment failure under severe accident scenarios involving core melt, and a review of the current status and possible improvements to the containment in the areas of hydrogen control, containment sprays, pressure relief, core debris control and emergency procedures (see J. G. Weigand letter to Harold Denton, June 30, 1986).

Vermont Yankee also promised the NRC to continue its active participation in the "Industry Degraded Core Rulemaking" (IDCOR) group and Boiling Water Reactor Owners Group (BWROG), particularly those activities that address reactor containment issues, so that it could benefit from the latest developments in technological research.

At a meeting in Montpelier, Vermont Yankee officials informed both Governor Kunin and the NRC on how it would go about conducting the sixty-day study. The first task would be to document and describe the Mark I's design and operational features as used in the Reactor Safety Study (WASH-1400). Vermont Yankee would then document and describe the Vernon plant's Mark I design and operational features as originally built, and to tabulate all design and operational modifications, affecting containment capability, made to it between the plant's original design and current status . Finally the study would document and describe Vermont Yankee design and operational differences from the Mark I plant used in the Reactor Safety Study. Another task would be to evaluate the differences in design and operation between the Mark I containment analyzed in WASH-1400 and the current Vermont Yankee containment, and then to estimate the Vernon plant's specific conditional failure probability. Finally, the sixty-day study would examine areas of containment safety concern, then recently identified in discussions between the nuclear industry and the NRC in a Bethesda, Maryland, meeting on June 16, 1986. Company officials noted that, for each "concern," the specific application to Vermont Yankee would be examined and any practical and beneficial design modifications to the Vernon containment would be considered.

On July 17, 1986, Vermont Yankee officials announced the names of four outside engineering groups which were participating in the sixty-day study: Yankee Atomic Electric Company, General

Electric Company, Delian Corporation, and Fauske and Associates, Inc. Company officials pointed out that this team would bring two important areas of expertise to the containment safety study -- knowledge of the specific design and operational features of the Vernon plant, and knowledge of severe accident phenomena and resulting containment performance. Yankee Atomic engineers had worked with Vermont Yankee engineers throughout the original construction and subsequent operation of the Vernon plant. The General Electric Company had been responsible for the original plant design and also provided engineering services to Vermont Yankee during its operation. The Delian Corporation brought specific expertise in systems reliability analysis and in probabilistic risk assessment to the study team. Fauske and Associates were recognized experts in reactor safety phenomenological analyses and incorporation of these analyses into comprehensive plant evaluation models. (Later, other experts would join the engineering and scientific team: Risk Management Associates and the firm of Pickard, Lowe and Garrick.) The product of this joint study venture, company officials announced, would be submitted to the NRC for its review and evaluation.

Even before completing the study, Vermont Yankee announced on August 13, 1986, that it would incorporate three modifications at the Vernon plant which would enhance the plant's containment safety. The changes involved implementing new safety procedures in two areas: maintain the safety of the plant should all AC electrical power be lost; and, involving the cross-connection of the plant's fire protection system to supply cooling water to the containment's sprays. Also, a guideline for venting the containment in the case of abnormal pressure build-up was developed. Vermont Yankee officials pointed out that these procedural and guideline modifications could be implemented relatively quickly because they did not require a lengthy engineering review and analysis and because they were immediately apparent as a safety enhancement.

Vermont Yankee said that it would introduce these safety changes at the Vernon plant with the assistance of the consulting firm of Advanced Science and Technology Associates, Inc. (ASTA) of Solana Beach, California. ASTA provided management, training and engineering services to the nuclear industry and government agencies. ASTA's efforts would cost Vermont Yankee about $60,000 and would take about thirty days to complete. Company officials pointed out that to do the job itself would take six times as long.

On the morning of September 2, 1986, Vermont Yankee announced it had finished its containment safety study and had submitted it to the NRC for evaluation. A copy of the study was also sent to the State of Vermont. Vermont Yankee president J. Gary Weigand addressed a gathering of reporters at company headquarters in Brattleboro, informing them that the sixty-day study concluded the Vernon plant was "much safer than previously characterized." The study determined that the conditional failure probability of the Vernon plant was once every 500,000 years. Mr. Weigand noted that this corresponded to a 7% conditional failure probability in the unlikely event of a serious accident leading to core melt. The Vermont Yankee president said that, although the study showed that Vermont Yankee's containment had an extremely low probability of failure in a core melt scenario, the likelihood of a serious accident leading to core melt was about once every 300,000 years. (This meant the likelihood of an accident leading to core melt and then to containment failure was once every half-million years.)

Vermont Yankee's containment safety study attributed the superiority of the Vernon containment to the containment referred to in the WASH-1400 study to five factors: the ratio of the containment size to the reactor size is much larger at Vermont Yankee than the referenced plant; the ratio of the size of the emergency pumps to the reactor size is much larger than the referenced plant; the Vernon plant has a plant-unique flexibility in its cooling water systems; the Vernon plant has a special electrical power source from the nearby Vernon hyrdostation; and, Vermont

Yankee has made modifications and upgrades to its containment since the WASH-1400 study was first issued.

The containment safety study not only calculated Vermont Yankee's own conditional failure probability but also produced recommendations for procedural and design modifications to improve the Vernon plant's containment. These would have to be submitted to intensive engineering and design analyses. Among others, these included (besides the previously announced changes): a procedure for restoration of AC electrical power following a station blackout; a repair procedure for the restoration of the Vernon hydroelectrical station's tie line to the Vermont Yankee plant; a procedure for conserving and switching DC power following a station blackout; a procedure for manual reactor depressurization following a station blackout; a procedure to align the diesel-powered fire pump for reactor vessel injection following a station blackout; a procedure to control power and reactor vessel water level following an "anticipated transient without scram" (ATWS) event; an upgrade of the Emergency Operating Procedures (EOP) based on the guidance provided in Revision #4 to the Emergency Procedure Guidelines developed by the Boiling Water Reactor Owners Group (BWROG); operator guidance and training on the response of the residual heat removal system (RHR) pumps to high suppression pool temperatures; a containment-torus vent path; an upgrade of the valve operators for containment spray and reactor vessel injection capacity; a nitrogen supply system to the reactor's safety relief valves; and, continued service water system capability for post-accident operation.

In late October, 1986, the Nuclear Regulatory Commission responded to the Vermont Yankee containment safety study in a 26-page report. The NRC stated that Vermont Yankee did provide evidence showing the Vernon plant to be safer than previously characterized. The federal agency's evaluation noted that the Vernon containment is "more capable of performing its function during severe accidents than previous assessments of Mark I type containments would indicate." In a cover letter to the NRC evaluation, Robert Bernero (then head of the NRC's boiling water reactor licensing division) concluded that Vermont Yankee's estimated conditional failure probability for the Vernon containment could be considered reasonable, based on the NRC staff's experience with other BWR probabilistic risk asssessments (PRA's). The report did find that the Vermont Yankee sixty-day study did not include an analysis of uncertainties in its methodology, computer codes and engineering judgment. The NRC said that safety enhancements to the Vernon containment discussed in the Vermont Yankee study were "consistent with the type of improvements considered by the [NRC] staff." The NRC agreed with Vermont Yankee that future analyses should be performed to test the feasibility and effectiveness of implementing these enhancements. The NRC said that with "modest improvements" to the containment the likelihood of containment failure could be reduced even more.

Meanwhile, Governor Kunin had asked for a "second opinion" on Vermont Yankee's containment safety, and hired Peter R. Davis of PRD Consulting in Idaho to review the Vermont Yankee study. On October 30, 1986, Peter Davis submitted his review to the Department of Public Service. Davis said that he considered the Vermont Yankee study "to present a reasonable estimate of containment failure probabilities from severe accidents which could be initiated from internal events only." Davis further stated, "Although the [Vermont Yankee study] does not provide any uncertainty analysis, and this is considered a major deficiency..., based on selected sensitivity studies and comparisons performed as part of this review, the [Vermont Yankee study's] probability results for internal events appear to be generally consistent with present knowledge regarding severe accident behavior and within the range of large uncertainty associated with such behavior."

Peter Davis offered his own recommendations to improve containment safety. His suggestions, as well as recommendations on containment modifications from NRC and industry sources and the Vermont Yankee Containment Safety Study itself, were then submitted to be analyzed for implementation by a group of Vermont Yankee and Yankee Atomic engineers. The group, known as the Vermont Yankee Containment Task Force, began its deliberations in March, 1987. Before considering the Task Force's mission and methodology, it is beneficial to review the context in which the Task Force operated, especially with regard to NRC analyses, industry studies, and other nuclear utilities addressing their containment safety program.

II. NRC STUDIES

In 1985 the Nuclear Regulatory Commission issued the Severe Accident Policy Statement which outlined the NRC approach in assessing the risk to the public from severe reactor accidents. This policy statement concluded that the risk of current reactors was low and that no immediate action was necessary to modify nuclear units, but the NRC suggested that research be continued to examine possible issues related to severe accidents. The results of this research would be evaluated to see if any mandated modifications might be needed.

Since the initial Reactor Risk Assessment known as WASH-1400 was completed in 1975, the risk assessment techniques utilized in its preparation have been widely applied in subsequent plant Probabilistic Risk Assessments by groups in standardizing and verifying assessment techniques. Most significantly, these assessment techniques are the basis for a very large scale effort now in progress to prepare the replacement for WASH-1400. This replacement will be the Reactor Risk Reference Document (NUREG-1150). NUREG-1150, in addition to reflecting the current state of knowledge, will provide quantitative ranges of uncertainty of its results and will identify important "issues" that should be considered for research and analysis. These issues generally apply to phenomena which have potential for substantial reductions in risk or uncertainty. NUREG-1150, the Reactor Risk Reference Document, will analyze the risks associated with five basic types of US commercial reactors by performing a detailed assessment of five surrogate plants. These assessments are being performed by the NRC research staff and the national laboratories (Brookhaven, Sandia and Battelle).

This document, now in draft form and under review, has provided the source of extensive news media coverage and public debate. Because the material in NUREG-1150 has become a source of some public concern, it is important that it be understood by those associated with the operation of nuclear power plants and persons in position of responsibility for public policy. The draft results of this study so far suggest that Mark I boiling water reactors represent a low risk to the public as compared to other types of US nuclear plants and naturally occurring hazards, and are within the safety goals published by the NRC in 1986.

In order to understand NUREG-1150, it is necessary to understand the fundamental difference between a risk assessment like the NUREG and an engineering analysis. In an engineering analysis, universally accepted codes and standards are applied to determine if a particular structure meets the required margin of safety. In a risk assessment, the failure of the structure is "forced" to occur. The probability of this forced occurrence is then determined by the event probabilities of individual mechanisms which are seen as causing the postulated forced occurrence. Thus, only two meaningful results of risk assessment are provided. First, the probability of the failure, which together with the consequences, quantify risk, and, secondly, the identification of potentially important mechanisms for this failure, which then become candidates for additional review. Simply stated, these risk assessments start with the failure as a postulated basis and do not form a basis for a conclusion as to whether or not failure will occur. This underlying concept that failure is assumed, which is unique to risk assessment as opposed to an engineering analysis, can make the result very misleading if the concept is not understood.

As part of the methodology used in the risk analysis of containment safety in NUREG-1150, the term "conditional containment failure probability" was defined. This term has a narrow meaning and is not at all the probability that the containment will fail. In fact "conditional containment failure probability" can increase as a result of plant modifications which cause the actual containment failure probability to decrease. Although this "conditional containment failure probability" does have meaning to those performing risk assessments, the term has very little value as an independent measure of nuclear plant containment safety.

While there are many types of results and methods of displaying them, the display provided in the draft NUREG which most clearly gives an indication of the safety of a containment is that which shows the risk to an individual within one mile of the plant. This is an integrated result of all factors which lead to the ultimate failure of the containment and produce a significant radioactive release. Utilizing this measure, the Peach Bottom plant, which is the surrogate for Vermont Yankee, is found to be the safest.

Since this NUREG-1150 risk assessment requires the assignment of probabilities to events that have never happened, one of the useful results is the identification of events which are particularly harmful, regardless of the probability. These events can be the subject of further analysis to investigate potential risk reduction measures.

Two such areas were identified and have been the subject of considerable review. The first was the ultimate failure strength of the Mark I containment. The second was the attack of molten reactor fuel on the steel containment. The results of these reviews have shown that the concern over these events could be substantially reduced owing to a greater strength than assumed for the containment and the lack of sufficient energy in the molten fuel to reach and damage the containment wall. Probabilistic risk assessments will identify other mechanisms of failure because of, as discussed earlier, the nature of these assessments. As events or mechanisms which contribute to "Conditional Containment Failure Probability" are eliminated, this probability may increase or decrease.

Many other NRC efforts are in progress relating to containment performance. Owing to the comprehensive nature of NUREG-1150, these efforts have been or will be encompassed by this document. To date, however, there is no quantitative assessment which indicates that BWR Mark I plants represent a disproportionate or unacceptable share of the risk to the public as compared to other reactor plants or other types of risks.

III. BERNERO CONCERNS

While the NRC was drafting the NUREG, Robert Bernero made known his five "concerns" which he felt should be addressed with fairly simple modifications initiated by utilities operating Mark I BWR plants. Vermont Yankee acted on each of these concerns:

1. COMBUSTIBLE GAS CONTROL - PREVENTION OF HYDROGEN-CAUSED EXPLOSION.

INITIATIVE: During operation, the Vermont Yankee containment remains inerted with nitrogen. This removes the potential for hydrogen and oxygen buildup to an explosive concentration. Vermont Yankee's license allows it to remain de-inerted for brief periods at startup and at shutdown. This provides plant workers a safe environment within the containment structure for conducting safety inspections or operating equipment. Historically, this has led to the containment being de-inerted for only 1.1% of the time.

2. CONTAINMENT SPRAY - THE ABILITY TO PROVIDE AT LEAST TWO WATER SUPPLIES FOR CONTAINMENT SPRAY: ONE OF WHICH TO BE FUNCTIONAL DURING STATION BLACKOUT.

INITIATIVE: Vermont Yankee has two backup water supplies for containment spray. One of these, the fire water system, uses an independent diesel engine to provide water when electrical power is lost. Although Vermont Yankee maintains the ability to pump water in the event electrical power is lost, certain valves would require manual operation. Vermont Yankee conducted the design work to provide control room operation of these valves through the utilization of a third, installed diesel generator. The implementation of this modification will be pursued on a priority schedule.

3. CONTAINMENT VENTING - PREVENTION OF CONTAINMENT OVERPRESSURIZATION BY WETWELL VENTING.

INITIATIVE: Vermont Yankee has developed guidelines and trained personnel on the use of existing plant piping to vent the containment. This method removes gases through the wetwell and subsequently provides a vent path to the 318-foot stack. Vermont Yankee previously completed a conceptual design that would provide additional venting capabilities during a total loss of AC electrical power. Venting is an ongoing industry issue in which Vermont Yankee is playing an active role.

4. CORE DEBRIS - USE OF BARRIERS TO PREVENT A MOLTEN CORE FROM PENETRATING THE CONTAINMENT.

INITIATIVE: The use of barriers to prevent a molten core from penetrating the containment steel has been fully analyzed. Vermont Yankee has a similar size drywell and reactor vessel as the Peach Bottom plant analyzed in the WASH-1400 report, yet has less than half the fuel. Based on the size of Vermont Yankee's core and the geometry and size of its containment, Vermont Yankee concluded that the molten core would not reach the containment wall.

5. SEVERE ACCIDENT PROCEDURES - IMPLEMENTATION OF REVISION 4 OF THE EMERGENCY PROCEDURE GUIDELINES.

INITIATIVE: Vermont Yankee developed procedures and trained operators in all applicable areas of severe accident mitigation. Included were such procedures as Restoration of Electrical Power, Operation of Vital Electrical Equipment, Use of Backup Containment Sprays, and Containment Venting Guidelines. Revision #4 of the Emergency Procedure Guidelines has been submitted to the NRC, and, when approved, will be incorporated in the Vermont Yankee emergency procedures.

IV. INDUSTRY STUDIES

In addition to the work being performed as part of NUREG-1150 principally by the NRC research division and the national laboratories, the nuclear industry has sponsored several related activities. The chief effort was undertaken by the Industry Degraded Core Rulemaking (IDCOR) group. The major areas addressed by this group were the quantification of the radiological aspects of reactor accidents as well as the development of a standardized methodology that could be utilized in the performance of plant specific risk assessments. As far as the quantification of radiological hazards, there is a consensus of agreement with IDCOR that these hazards have been overestimated in past assessments. Specific computer codes used to predict these results are, however, subjects of ongoing review with the national laboratories. The IDCOR plant risk evaluation methodology has also been basically accepted but the use of specific computer codes to predict some relevant phenomena is still being reviewed. These two IDCOR activities provide fundamental elements necessary before there can be an NRC program of performing individual risk assessments for all plants.

A smaller but more focused segment of the nuclear industry comprised of owners of GE boiling water reactors has specifically addressed the Mark I safety question. This group (BWROG) utilized the existing probabilistic risk assessments for Mark I plants as well as the current knowledge of plant and containment performance. Specific events or mechanisms which were identified as potential major contributors to risk were reviewed as to their validity and the impact of various modifications to eliminate or mitigate them regardless of their validity.

The results of the BWROG efforts substantiated the Vermont Yankee analysis results and came to the conclusion that there were no major modifications that should be mandated. The owners group provides another opinion supporting the general consensus that the BWR Mark I does not stand out as an "outlier" (i.e., representing a larger than expected risk level) and, thus, there are no major modifications that are required presently or in the foreseeable future.

V. PILGRIM AND SHOREHAM

The Pilgrim plant in Massachusetts has a GE boiling water reactor with the Mark I containment. Pilgrim officials have reviewed many of the same issues as have been considered at Vermont Yankee. The initiatives undertaken by the Pilgrim staff to make plant modifications are directed toward being responsive to draft or preliminary NRC positions on BWR containments. One of the major plant modifications was the addition of piping from the torus vent line to bypass the low pressure filtration system (Standby Gas Treatment System). This allows gas at containment design pressure to be exhausted to the plant's stack. This system has been installed with the exception of one valve which would actually connect this new piping to the containment. This final step is pending NRC approval. The prospects for this approval and the methodology for obtaining it are not clear.

The Pilgrim plant apparently has no current plans to install a core debris barrier. Since Pilgrim has access to the same assessment and research information as Vermont Yankee, Vermont Yankee officials presume Pilgrim's decision not to proceed with this modification would be parallel to Vermont Yankee's decision on a core debris barrier (see Chapter Eleven). Almost all other modifications currently planned at Pilgrim have been or will be accomplished at Vermont Yankee, including expanded functions of the diesel-powered fire pump to supply reactor pressure vessel injection and containment spray, and provisions for an additional self-contained diesel engine.

The other BWR plant at which a major modification has been planned is Shoreham in New York. Considerable analysis has been accomplished to study the effectiveness of various types of containment vents. While Vermont Yankee cannot determine the technical basis for their particular choice, Shoreham officials have apparently opted to install a very large filter (120' x 40'). This activity is at such a preliminary state that very little, if any, information would be applicable to Vermont Yankee.

VI. CONTAINMENT TASK FORCE

The Vermont Yankee Containment Task Force (made up of engineers and operators from Vermont Yankee and engineers from the Yankee Atomic Electric Company, Nuclear Services Division) was created as part of an aggressive program to collect and resolve issues associated with the Vermont Yankee's plant response to severe accidents. The Task Force collected and then carefully evaluated recommendations for containment modifications from the Vermont Yankee Containment Safety Study, the ASTA report, industry and NRC studies, Peter Davis's review and endeavors by other nuclear utilities. The Task Force characterized the initially unresolved Containment Safety Study recommendations by four basic attributes that affect: public safety, personnel safety, plant capacity factor, and required resources. Each of these attributes was further refined by its own qualifiers, such as installation, testing, effect on events and systems, and costs.

The Task Force decided that a formal process was needed to evaluate the containment issues. The evaluation was to be based on: what attributes should be considered when assessing the possible impacts of resolving an issue; how are the impacts assessed (ranging from individual judgment to mathematical models); and, how are the different impacts aggregated to determine an over-all impact. The Task Force noted that a selection of a process depended on several factors: the technological sophistication of the issues; the number of issues; required accuracy; required reproducibility; required defensibility; required documentation; availability of formal "tools"; schedule; and, the individuals participating in the evaluation process.

The process used by the Task Force was developed during a three-month period. The impact on each attribute (i.e., public safety, personnel safety, plant capacity factor, and required resources) was quantitatively described by a value from -10 to +10. A negative value indicated an adverse impact; a positive value, a beneficial impact. A -10 indicated an adverse impact ten times greater than a -1 value; a 0 value indicated no discernible impact. This "dimensionless" scale was selected by the Task Force because of its usefulness. It allowed both positive and negative impacts to be clearly noted. It allowed reasonable discrimination in the relative impacts of different issues. A dimensionless scale was found acceptable because the ranking is performed on a relative basis, not an absolute basis. An issue cannot be eliminated solely on the basis of its ranking. Reasons for early elimination, however, included: over-all negative impact on public safety; adequately addressed by another issue; or, not relevant to Vermont Yankee.

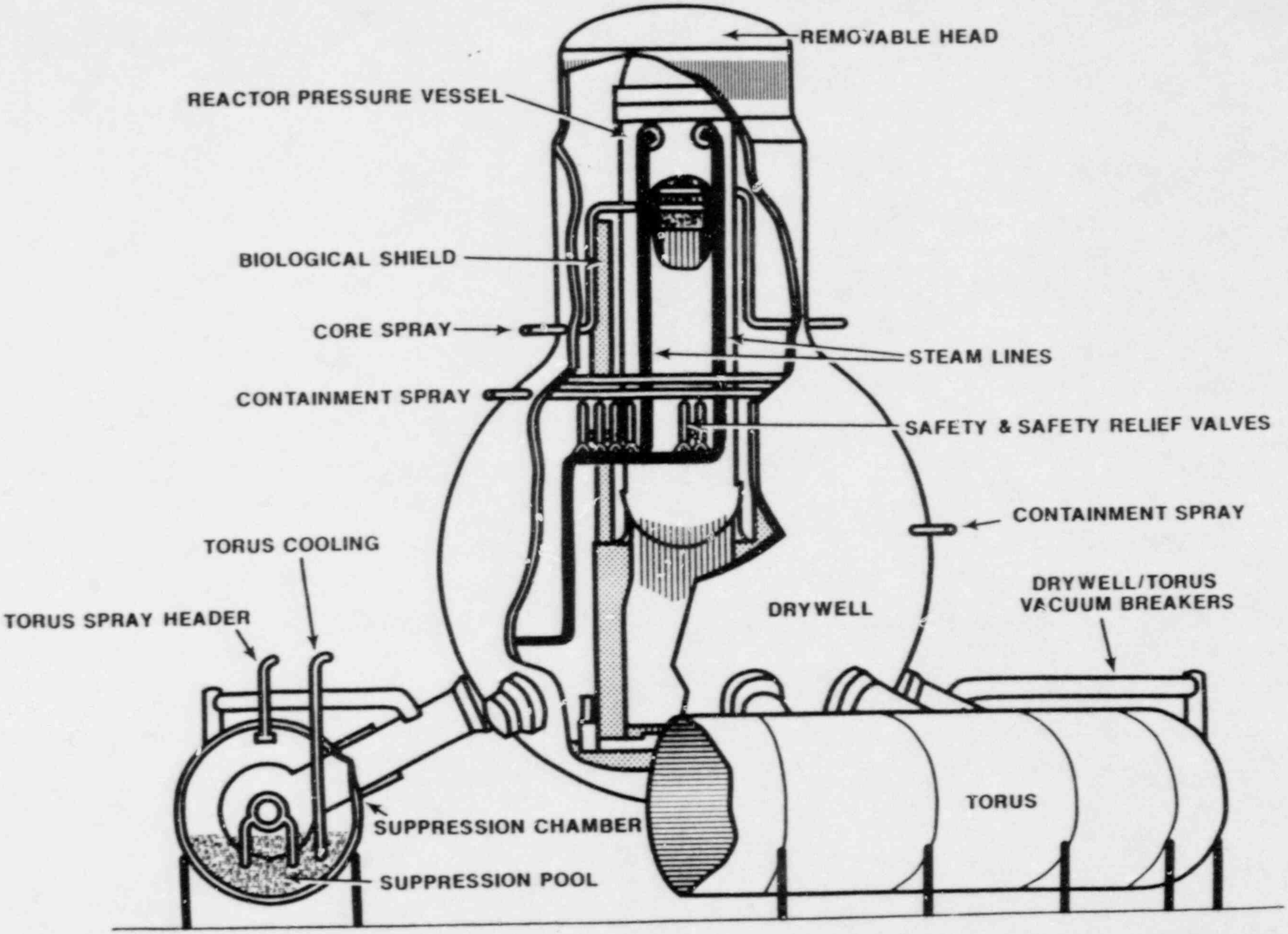
The Task Force scored its assessments on the basis of a roundtable discussion (facilitated by structured attribute evaluations sheets), an averaging of individual member's scores, and consideration of evaluations of issues scored earlier. This continuous peer appraisal process proved to be very effective. The Task Force took about twelve months to perform its mission. It closed out thirty-seven containment issues. The Task Force's conclusions and Vermont Yankee management's responses are the focus of the following pages.

VII. CONCLUSION

A reader of this report should use the Vermont Yankee Containment Study as a companion guide to understand the context of the thirty-seven items addressed by the Containment Task Force. Also helpful as interpretative documents are NRC studies and drafts on Mark I safety (i.e., WASH-1400 and NUREG-1150), a delineation of the so-called "Bernero concerns," and various industry analyses of containment capability (i.e., IDCOR and the Boiling Water Reactor Owners Group's Severe Accident Containment Integrity report [SACI/BWROG]).

As with all technologies, it is essential that those associated with nuclear power plants --in any way-- maintain a dynamic perspective. There will continue to be areas of technical disagreement among individuals and among regulators, laboratories, consultants and utilities. In most areas, a technical consensus will ultimately be reached. Many investigations or studies are currently being conducted, but in most cases these investigations will raise new questions or uncertainties at the same time they are providing answers. The new questions or uncertainties are predictably less important. What this means for Vermont Yankee is that, while we have many issues to continue to investigate, the major areas have all been covered and the technical evidence is that Vermont Yankee is a very safe plant that will not require major modifications.

VERMONT YANKEE PRIMARY CONTAINMENT



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CHAPTER ONE

REDUCTION OF MAIN STEAM LINE ISOLATION

(Reference: Peter Davis's review, p. 7.5, 7.C.2)

Peter Davis, in the report of his review of the Containment Safety Study, recommended that two courses of action be taken to enhance containment safety as affected by main steam line isolation. The Task Force, in reviewing his recommendations, recognized that previous efforts had already reduced the frequency of the automatic closing of the reactor's four main steam lines, on non-emergency transients, by changing the licensed set points of certain isolation valve signals which initiate the closing of these lines. The Task Force also reviewed Vermont Yankee's procedures which permit reactor operators to reopen these lines as soon as they determine that no reactor system has a significant problem and that it is appropriate to reopen them. The Task Force found that the ability of operators to reopen main steam isolation valves had already been developed and proceduralized. In other words, the two basic recommendations made by Peter Davis were implemented previously by Vermont Yankee. These earlier safety improvements were not specifically discussed in the Containment Safety Study and probably were not known to Peter Davis.

There are four main steam lines or pipes leading from the reactor to the turbine-generator and condenser. Each steam line has two primary containment isolation valves on it, completely redundant and independent from each other, which are used to close the lines, thus isolating the reactor and the containment. All of these eight valves automatically close when they receive certain signals. For example, if there is a signal of low reactor water level or low main steam line pressure, this might indicate that a significant reactor leak has occurred, and the valves would shut the lines automatically. The automatic signal to shut the steam line valves, however, does not necessarily always indicate a major problem. For example, a signal of low reactor water level may actually indicate a malfunctioning minor component in the plant's feedwater system, and not a major steam line leak. In the latter example, it may not be beneficial for the valves to shut automatically because the reactor is then isolated or closed off unnecessarily from the plant's condenser. The condenser serves as the normal heat sink or heat absorber for the reactor and also as a mechanism to remove reactor pressure. When the reactor is isolated, the containment heat sink (the torus) must take over and handle the reactor's heat.

In weighing the pros and cons of the above recommendations, the Vermont Yankee Task Force saw two important advantages in favor of the recommendations. The Task Force concluded that implementation of the recommendations would improve containment safety by reducing unnecessary challenges to containment systems (e.g., the safety relief valves, the pressure-suppression pool.). The Task Force also concluded the reactor operators' flexibility would be significantly improved by being able to call upon a variety of systems throughout the plant to deal with emergencies, rather than being confined to depending on the containment systems to handle reactor heat and pressure.

The Task Force discussed the disadvantages of the proposals, but concluded that these negative points did not outweigh the positive results of making such changes. One disadvantage considered was that operators might make a mistake in deciding to reopen the main steam line isolation valves. The Task Force decided, however, that this scenario was implausible and highly unlikely, since the Plant Emergency Operating Procedures are always followed. The conditions under which the main steam isolation valves automatically shut have been determined by elaborate studies to produce a high degree of assurance that plant safety will be maintained. Changes must be made with caution.

Vermont Yankee previously obtained NRC approval to reduce the frequency of the main steam line valve isolations. These changes included changing the set points of certain signals that cause the main steam line valves to close automatically. The set point for isolating the valves on a high flow signal was raised by approximately twenty per cent. This was done to avoid unnecessary main steam line valve isolation during certain surveillance procedures. The set point for isolating the main steam lines on a low reactor pressure signal was decreased to avoid an unnecessary isolation should the reactor scram (or automatically shut down). Vermont Yankee had previously implemented another change in accordance with NRC-approved emergency procedure guidelines. This was to provide operators with a clear method to reopen a main steam isolation valve should it close automatically unnecessarily.

There are also industry efforts underway to improve containment safety in the area of main steam line valve isolation. Vermont Yankee is involved in such initiatives as a member of the Boiling Water Reactor Owners Group (BWROG) in evaluating actions to reduce the frequency of unnecessary automatic shutdowns or scrams. The industry, through the BWROG, has also evaluated and justified items to reduce unnecessary main steam valve isolation. One important item that BWROG is pursuing is to eliminate such automatic isolation from a high radiation signal. This proposal is now with the NRC for review and approval. Vermont Yankee has produced two proposals itself including a plant specific evaluation endorsing the BWROG evaluation that would delete the high radiation signal that currently causes the valves to close unnecessarily. This will shortly be submitted to the NRC for approval. The second proposal from Vermont Yankee is to reduce the surveillance frequency for main steam isolation valve "stroke" testing (i.e., closing and opening the valves to determine their operability), since this testing places the plant in a condition more vulnerable to inadvertant isolations. This proposal is in draft form and is waiting for internal review and final approval. The Task Force recommended that Vermont Yankee continue to evaluate potential changes in main steam line isolation valve closure signals and surveillance methods and frequencies. If new findings result from this review, Vermont

Yankee should submit changes to the NRC for approval, following internal assessment and approval. Vermont Yankee management concurred that no other actions were necessary to conclude this recommendation.

CHAPTER TWO

PROCEDURES AND TRAINING FOR CROSS-CONNECTING DIESEL-POWERED FIRE PUMP TO THE RHR SYSTEM

(References: Containment Safety Study, p. 149, 5.7.3(1), p. 83, 4.5.2, p. 143, 5.6.5.3.1.C, p. 179, 6.2(5); ASTA, p. 8, V.C.2)

The Vermont Yankee Containment Safety Study and ASTA recommended a review of the plant emergency procedures be undertaken to ensure that adequate instructions be available to operators to enable them to cross-connect the diesel-powered fire pump to the residual heat removal system. This procedure, which was revised at Vermont Yankee, enhances containment safety by providing yet another back-up to the containment spray system, and core cooling systems.

The above recommendation must be viewed in the context of a sustained station blackout scenario which degrades to a severe accident. This scenario assumes that the Vernon plant totally loses its AC electrical power sources. This means that no power is available from any of three off-site sources, including the Vernon hydro station, and also from the two on-site diesel generators. The diesel generators produce three-megawatts of electrical power and are completely redundant and independent from each other. Under these extremely adverse and highly unlikely conditions, only battery power is assumed to remain. The high power necessary for electrical pump operation is unavailable. Therefore, the normal low pressure cooling systems needed to reduce the consequences of an accident are unusable. During such a loss of power, the residual heat removal system can be brought into operation for cooling using the available high-capacity diesel-powered fire pump.

This pump is presently installed at the cooling water intake structure of the Vermont Yankee plant site. The pump is a self-contained, diesel-powered machine used as a back-up source of water for the plant's fire protection system, drawing water directly from the Connecticut River. It is a back-up pump to the electrically powered fire pump. In addition to its use in the fire protection system, through existing valves and piping the diesel-powered fire pump can be lined up to draw river water which it then supplies to the residual heat removal system in order to provide low pressure core cooling and containment spray. Since the diesel-powered fire pump is self contained and because the piping configuration necessary for cross-connecting it to the residual heat removal system can be set up manually, its availability is present even during station blackout scenarios. The volume of diesel fuel supply on site ensures cooling capability for several days. Not only does the capability inherent in the existing equipment offer the immediate advantage of an additional means of core cooling and containment spray, but also through its use, core damage can be prevented while workers are restoring the normal electrical power, thus restoring the normal cooling equipment needed for a stable cold shutdown of the reactor.

The ability to use the diesel-powered fire pump for emergency core cooling and containment spray has been available and generally understood for several years. The Vermont Yankee Containment Safety Study and the ASTA report recommended that emergency procedures be reviewed to ensure that adequate guidance be provided to plant control room operators for ready use of the pump during accident conditions in which the plant may be under the highly unlikely condition of a station blackout.

The Containment Task Force concluded that procedural guidance for plant operators would not only provide clear direction during a station blackout emergency, but would also ensure consistent operator response, thereby increasing over-all plant safety. To have such a procedure is, in effect, to have yet another safety system for the plant. A procedure requires that actions, as well as consequences, be pre-reviewed and approved to bring about a consistent and methodical--and therefore safer--approach to setting up this alternate means of core and containment cooling. Procedures further allow emergency response personnel to anticipate actions and pre-plan subsequent actions. Training covers all procedures ensuring that operating personnel are continually refreshed in knowing what precise steps to take to line up the diesel-powered fire pump. This proceduralized capability is an important improvement in protecting the reactor core and containment structure.

The Containment Task Force did take into account the disadvantages of giving additional, very detailed procedural guidance to plant operators. According to the Task Force, additional procedural guidance might restrict operators' flexibility in responding to emergency conditions. A "cook book" approach to emergency response could divert attention from the actual emergency by requiring strict adherence to procedures, which become unnecessarily complicated and restrictive. But the Task Force decided that only moderate changes were needed in existing emergency operating procedures. The procedures already address the need and means to cross-connect the diesel-powered fire pump to the residual heat removal system and are now upgraded to be sufficiently clear and specific.

The procedures were enhanced and no further study is considered necessary by the Containment Task Force. Vermont Yankee approved this disposition of the recommendation.

CHAPTER THREE

REPAIR OF THE VERNON TIE LINE

(References: Containment Safety Study,
p.149, 5.7.3(3); p.121, 5.3.5.1.2;
p.179, 6.2(2))

The Containment Safety Study recommended implementing plant procedures which would spell out how plant personnel could repair the Vernon hydroelectric station tie line, if it should be knocked out during a severe storm. The Task Force considered how these procedures might improve the reliability of the tie line.

The Vernon hydroelectric station tie line is a dedicated line that connects the Vermont Yankee plant and the Vernon hydro-station. It can provide enough power to run either one of the plant's emergency electrical distribution systems. Any one of the distribution systems can operate the safety equipment that would be needed to prevent or mitigate a plant accident. Getting power from the tie line would only be necessary if the plant, for some reason, lost both of its independent diesel-generators and was not able to get power from any of the three lines coming off the New England Power Grid. The Vernon hydro station tie line can be placed in operation directly from the Vermont Yankee control room.

Vermont Yankee has a unique advantage in its close proximity to the Vernon hydroelectric generating station. The Vernon hydroelectric plant is a ten-unit station located one-half mile south of the Vermont Yankee boundary line. It is connected to Vermont Yankee by a dedicated 4160-volt transmission line (i.e., "tie line"). The line runs above ground until it reaches the plant boundary fence. It then runs underground to the Vermont Yankee plant's emergency electrical buses. This one, 3,300 KVA line is enough to supply all emergency power loads needed to safely shut down the plant.

Although much of the Vernon tie line is underground, the exposed portion could be vulnerable to severe weather conditions (e.g., hurricanes, ice and snow storms, etc.). The close proximity of this reliable source of AC power, however, means that, even in spite of storm damage, the tie line could be quickly restored to provide needed electricity to Vermont Yankee to stop accident sequences. Restoration could either be accomplished through repair to the line or, failing that, through the installation of temporary cables. While repair or restoration efforts are taking place, additional accident mitigation could be gained through conserving Vermont Yankee's own DC power (i.e., normal battery power). DC power would serve to keep vital instrumentation and certain safety system valves operable.

The Task Force considered the advantages to implementing these procedures: plant personnel directly under Vermont Yankee control would be trained in tie line repair techniques and they would have repair materials readily available. These efforts would be intended to improve the over-all reliability of the tie line. Also, the Task Force looked at disadvantages to implementing these procedures. Establishing a formal procedure which is well within the skills of the average qualified plant electrician could detract from other priorities. Attention would be diverted to a fairly routine task in place of continued emphasis on the more complex maintenance skills that are required to operate the plant safely and efficiently. An evaluation showed that repair of this type of power line is routine work for all utilities and they have materials strategically stockpiled and line crews available on short notice. Also, the Task Force noted that many resources and materials are easily and readily available from several nearby electrical utilities. Considering possible accident scenarios, the Task Force concurred that there would be plenty of time to obtain the necessary repairmen and materials from outside the plant, instead of having to call on Vermont Yankee electricians. The Vermont Yankee Task Force noted too that almost half of the tie line is buried and is not subject to severe weather conditions. The Task Force reviewed a study which estimated the cost of burying the rest of the tie line would be about $500,000.

The Task Force reviewed the skills of Vermont Yankee's qualified electricians and those of electricians from nearby utilities and decided that neither more procedures nor more training for Vermont Yankee electricians is warranted in preparation for this relatively routine task. The Task Force also reasoned that because of its location, historical severe weather patterns and the line's reliability, there was no compensating benefit to the cost of burying the remainder of the tie line. Vermont Yankee, however, has started a program (since the Task Force looked into this matter) to "walk-down" the tie-line portion that is above ground to identify and remove any foliage or other obstacle which could damage the tie line during severe weather. The Task Force ended its investigation by concluding that no further action was necessary. Vermont Yankee management concurred in this recommendation.

CHAPTER FOUR

EXTENDING AVAILABILITY OF AC AND DC POWER SOURCES

(Reference: Containment Safety Study,
p.121, 5.3.5.1.2; p.179, 6.2 (1); p.149,
5.7.3 (2); p.121, 5.3.5.2; p.83, 4.5.2;
p.179, 6.2 (3); p.143, 5.6.5.3.1 a)

One of the recommendations coming from the Vermont Yankee Containment Safety Study was to put in practice strategies for coping with station blackout scenarios. This includes restoring AC power and the conservation of DC power supplies. The recommendation specified that such procedures should entail shedding non-essential DC electrical loads, the identification of alternative DC supplies and the methods for restoration of the transmission line from the Vernon hydroelectric station, as well as all other possible power sources.

One dominant sequence leading to core melt and a threat to containment integrity is the loss of all AC power (or station blackout). Station blackout renders much of the normal safety equipment inoperable for core cooling. As a result, over a period of hours, heat buildup leads to core damage and, if prolonged, to containment failure. But if AC power can be restored before core melting begins, then such an accident can be prevented with no adverse consequences. High among the strategies for coping with station blackout is the development of procedures for active restoration of AC power from either on-site or off-site sources. Until such time as AC power is restored, any action to conserve DC power on-site greatly improves plant safety margins. Because no automatic DC load shedding exists, benefits can be gained through specific procedural guidance for DC load management. While such conservation measures are beneficial, it should be kept in mind that the restoration of AC power is still paramount. Therefore. the identification of the most accessible on-site or off-site power source and the procedural strategies for its quick restoration will minimize the time that the plant will be using DC power supplies.

The Task Force considered all possible advantages to implementing this recommendation. They saw that a proceduralized strategy for coping with station blackout ensuring specific actions would be taken to restore AC power and conserve DC power would be beneficial. Procedural guidance would help guarantee consistent plant personnel response and would prepare personnel to deal with a wide variety of adverse situations. On the negative side, the Task Force considered that procedural guidance might limit the flexibility of personnel if all contingencies were not taken into account. Procedures might also misdirect efforts from those activities of a higher priority.

The Task Force concluded that the Containment Safety Study's recommendation was to a great extent implemented by recent changes to existing emergency procedures. The Task Force concluded that the recently added "Appendix A" to emergency operating procedures (OT 3122) provided sufficient guidance for both DC load shedding and the restoration of AC power sources. The Task Force decided that, in spite of some noted disadvantages, these procedures gave the necessary guidance for plant personnel to deal with severe accident situations. Therefore, the Task Force determined that this recommendation could be closed out. Vermont Yankee management concurred.

CHAPTER FIVE

GUIDANCE TO RELIEVE REACTOR PRESSURE DURING STATION BLACKOUT

(Reference: Containment Safety
Study, p.179, 6.2 (2))

The 1986 Containment Study recommended that Vermont Yankee develop procedural guidance for depressurizing the reactor vessel during a station blackout. This would be an anticipatory action to remove energy from the reactor vessel prior to the time it would otherwise be required. Early pressure reduction would lessen potential further degradation of containment safety margins.

On each of the plant's four main steam lines is a safety relief valve. The purpose of these four valves is to make sure the reactor vessel is not over-pressurized. Each valve automatically opens when the reactor vessel pressure reaches a pre-determined set point. This pressure (in the form of steam) is relieved and transferred to the torus (or pressure suppression chamber) in the plant's primary containment. There it is condensed into water, thus dissipating pressure. These valves can also be remotely opened by the operators by an electric signal which uses DC power to operate a solenoid valve. Such valves allow compressed nitrogen to flow to a "pilot" valve that, in turn, opens the safety relief valve. The reason this valve is operated through the use of nitrogen is to prevent gas exhausted from the pilot valve from diluting the nitrogen-inerted atmosphere which is in the primary containment. (The primary containment has a nitrogen atmosphere to prevent fires and explosions.) A 15,000-gallon liquid nitrogen tank is located on the Vermont Yankee plant site. This nearby nitrogen supply assures long-term operation of the safety relief valves even during station blackout. In addition to the nitrogen actuation, plant personnel can also call on the plant's air system to manually open valves should the nitrogen supply be lost. While the use of air dilutes the nitrogen, its small volume would have little effect on nitrogen concentration.

Under certain severe accident conditions in which rapid pressurization of the reactor vessel is postulated, the manual operation of the relief valves would allow steam to be exhausted to the suppression chamber (earlier than if the valves are allowed to operate automatically) where it would be condensed into water. As steam is sent to the torus relieving pressure, cooling water can be injected into the reactor core through either of two steam-driven high-pressure pumps or the low pressure diesel fire pump.

In circumstances in which reactor pressure slowly increases, the manual operation of the safety relief valves increases plant safety. Under these conditions, if the reactor pressure were below a point necessary for the operation of the steam-driven cooling pumps, but higher than that which could be overcome with low-pressure cooling injection pumps, the relief valves could be manually opened to reduce pressure. Once vessel pressure can be lowered far enough, the low-pressure cooling pumps could be started. Under station blackout, for example, with the normal cooling pumps (residual heat removal system and core spray pumps) not available, the relatively low-pressure diesel-powered fire pump could be used to inject cooling water into the reactor vessel to prevent core damage and stop any threat to containment integrity.

The Vermont Yankee Task Force considered the advantages to this recommendation and observed that procedures for use of the safety relief valves to "blow down" the reactor vessel (i.e., send reactor steam to the torus) during station blackout would allow operators to follow a pre-planned program for vessel depressurization. Not only would procedural guidance provide for timely operator actions, but would also make the consequences and effects of these actions well understood in advance. The only disadvantage of this recommendation was that a detailed procedure was seen as a possible detriment to operator discretion in employing better suited alternative action. But the latter was concluded by the Task Force to be a minor concern.

Vermont Yankee has implemented this recommendation by including it in the plant emergency procedure OE 3104 ("Torus temperature and level control"). No further action is required.

CHAPTER SIX

STATION BATTERY COMMON MODE FAILURE

(Reference: Reactor Risk Reference Document, NUREG-1150 Appendix E, Table E.11, Item P1, p. E-46)

The recommendation was made that maintenance and surveillance testing be controlled to prevent the possibility of common mode failure in the two station batteries. Also, testing and preventative maintenance should not cause both station battery sub-systems to be out of service during plant operation at the same time.

The station battery system consists of two trains, each capable of supplying the plant's necessary emergency systems with sufficient electrical power to stabilize the plant in the event of an extended station blackout. In a station blackout (i.e., no off-site power available and total loss of diesel generators), one of the two station battery trains would be required to operate the emergency systems. In NUREG 1150 (for the evaluated plant, Peach Bottom), DC power common-mode failure (i.e., both battery trains failing simultaneously) is a significant contributor to core damage sequences. Current surveillance procedures at Vermont Yankee already preclude a large part of the concern. These procedures require that each of the station battery trains be removed from service only during refueling outages.

Common mode failure can be simply defined as one action, or one component failing, causing two or more systems or equipments to be inoperative. The Task Force recognized the obvious advantages of this recommendation. It would ensure that only one of the redundant battery trains be taken out of service at a time and that the out-of-service train be fully restored prior to taking the redundant train out of service. These actions would help eliminate common mode failure which could possibly disable both station battery trains at the same time. The Task Force looked for disadvantages in this recommendation and, after careful consideration, found none.

The Task Force concluded that Vermont Yankee's current testing practices do not allow the redundant station battery trains to be out of service simultaneously. The only surveillance that requires the batteries to be out of service occurs during a refueling outage; testing is not performed during power operation. Any maintenance which would be required during power operation and would remove a battery train from service would also require the plant to immediately take steps to be shut down and be in "cold" shutdown within 24 hours. Since current battery testing practices do not require the batteries to be taken out of service during full power operation, and further do not allow both trains to be out of service simultaneously at any time, the Task Force determined that no procedure changes were needed in this area.

This recommendation raises a wider issue which is the need to minimize the times when multiple safety systems are out of service. An initial evaluation showed that current procedures and training provide assurance that this issue is not a major concern to Vermont Yankee. Vermont Yankee will evaluate the need for providing additional guidance to the operating crew to control the removal of multiple safety systems from service simultaneously when performing testing or maintenance. This effort will be completed by start-up from the next refueling outage.

CHAPTER SEVEN

RECHARGING THE STATION BATTERIES FROM THE UNINTERRUPTIBLE POWER SUPPLY

(References: ASTA IV.1, p.6; Containment Safety Study, Appendix G p. D-16,2.4; Draft SACI/BWROG, p.24)

Recommendations were made to develop the capability of providing alternate power sources from from the Vernon plant's uninterruptible power supply to recharge the 125-volt station batteries.

The Vermont Yankee plant is equipped with two independent 125-volt station batteries. These batteries are maintained fully charged by chargers supplied from a normal power bus. The batteries are capable of supplyiing power to a variety of emergency cooling systems in the highly unlikely event that all off-site and on-site AC electrical power is lost. If such power losses do occur and there is a severe accident, then high pressure cooling pumps would be needed. The high-pressure systems required are the high-pressure cooling injection system (HPCI) or the reactor core cooling isolation system (RCIC). The pumps in these systems are steam driven and therefore very little electrical power is needed for the high pressure injection of cooling water to the reactor vessel. The station batteries provide this power for instruments, controls and valve operation.

The 125-volt station batteries also provides electricity to remotely operate the depressurization system which will depressurize the reactor vessel enabling the use of low pressure pumps such as the diesel-powered fire pump to provide cooling water to the core. It should also be noted that the station batteries have another important safety role: they are the normal supply of electricity to the instrumentation and control components of the plant's two emegency diesel generators. The continued operation of the 125-volt station batteries allows the operation of the diesel generators, the high pressure cooling injection system, the reactor core cooling isolation system, the automatic depressurization system and other essential safety system instrumentation during severe accidents.

During normal operation, the Vernon plant's internal power is supplied by the main turbine-generator through the facility's auxiliary transformer. Power is distributed initially on two main buses (Bus 1 and Bus 2), then divided among numerous smaller busses. Should the main transformer become unavailable for any reason, electrical power is supplied from off-site sources by "backfeeding" power either through the main transformer or through the two station startup transfomers. On-site electrical loads are divided into two categories: "essential" and "non-essential" power. This classification is made based on the function of the equipment being served. The essential loads are supplied from two independent and redundant subsystems designated as Bus 3 and Bus 4. During a loss of off-site power, these busses are automatically isolated from the non-essential loads. Essential loads will then receive power from the two on-site, independent diesel generators. Either Bus 3 or Bus 4 can also be connected to the Vernon hydroelectric station as an alternate source of power. Essential bus loads are further distributed from Bus 3 and Bus 4 to Bus 8 and Bus 9. Among the essential loads supplied by Bus 8 and Bus 9 are the battery chargers for the uninterruptible power supply (UPS battery units). The uninterruptible power supply consists of two independent equipment trains, each composed of a battery charger, a large capacity battery and an inverter. The uninterruptible power supply is normally fed AC power and its output is AC power. However, if the AC supply is interrupted then associated batteries supply the power so that the output AC is never interrupted. The battery chargers "rectify" incoming AC power to maintain the charge of the batteries; battery power then is inverted or transformed into AC power which supplies Bus 89A or 89B. Bus 89A and 89B supply the critical low pressure injection valves (LPCI) and isolation valves for the recirculation system. Alternatively, should either UPS become unavailable, power to the 89A or 89B busses can be provided through a tie from Bus 8 or Bus 9. Figure 7-1 shows the electrical system discussed above in a simplified form.

Under a station blackout in which all off-site power is lost, and with a concurrent loss of the plant's two independent diesel generators, AC electrical power to Bus 89A and Bus 89B would remain available from the uninterruptible power supply. Under these conditions, the Task Force noted from the recommendation that greater flexibility would be gained if procedures were in place to feed back power from either the 89A or the 89B busses to other busses which could supply electricity to equipment necessary for accident mitigation. In this situation, guidance would be necessary for load shedding in order to minimize the AC load. Unneeded equipment powered from the busses to be energized would be shut off. The most notable advantage would be the ability to remotely open the isolation valves for the containment spray system. Actuating these valves during a station blackout would allow water to be pumped into the primary containment using a diesel-powered pump. During a severe accident in which molten core material melts through the vessel onto the base of the primary containment, core "quenching" or cooling could be accomplished with drywell (primary containment) spray. With such quenching, the molten core would become solidified and any threat to melting through the primary containment would be removed. Under another scenario in which containment pressure gradually increases, drywell sprays could be used to condense the steam released from the vessel. This would decrease containment pressure and remove the potential for a challenge to the containment.

The modification required would be to provide electric control circuits for circuit breakers and to develop procedures. The Vermont Yankee Task Force considered the advantages of making such a modification. The Task Force noted that use of the UPS to provide charging capability to the station batteries would allow the extension of station battery life, thereby increasing the capability of the high pressure cooling injection system, the reactor core cooling isolation system, the automatic depressurization system and certain safety related instrumentation and controls needed for the startup of the plant's two emergency diesel generators. The advantage of procedural guidance for performing this action was noted by the Task Force to be ensuring that plant personnel would have definitive, reviewed steps to take to use existing plant capability to keep safety systems operable.

The disadvantage of the modification was centered on the fact that the UPS is the only source of AC power during a station blackout. As such, its use and conservation would be essential to mitigating the effects of an accident. Additional loads on this source could impair other recovery efforts. Further, procedures were judged to be impractical in that they would either be too restrictive in not considering the wide range of conditions possible, or they would be too cumbersome because of trying to cover the wide range of conditions. Finally, training specialists indicate these procedures might distract plant personnel from training on more important scenarios. This type of procedure would fall to low on the training priority list to justify detailed frequent training on it. The Task Force noted that during an accident, the Engineering Staff (as prescribed in Vermont Yankee's Emergency Plan) will be available to determine the need and appropriateness for actions to establish power to alternate busses. The determination of which loads to shed would be a part of any engineering review.

The Task Force agreed that a preferred source of emergency charging power for the station batteries would be an independent diesel generator and that a separate recommendation covered in Chapter 19 provides such a source. An auxiliary diesel, known as the "John Deere Diesel" is presently on the Vermont Yankee plant site. Its primary use is to supply certain auxiliary electrical loads not associated with plant operation. Since this generator is not included in the Vernon plant's original design, it is considerd available during a postulated station blackout. A plant modification to allow the "John Deere" to be used as an alternate power source for charging the station batteries is preferable to any modification either to procedures or plant equipment associated with the uninterruptible power supplies in order not to degrade AC emergency power reliability.

The Containment Task Force concurred with the recommendation that a plant modification be developed to use the "John Deere" as an alternate AC power source to the station battery chargers. Vermont Yankee management concurred and a design change has been developed which will provide the capability for the John Deere diesel to supply power to critical equipment (such as the containment spray valves and to the station batteries) allowing them to continue to be available. This modification will improve Vermont Yankee's capability for mitigating a severe accident. Extending the capacity of the station batteries will also increase the availability of vital safety-related equipment, including the diesel generators, the high pressure cooling water injection system, the reactor cooling water isolation system and the automatic depressurization system. All these systems can either prevent a severe accident or mitigate the consequences of one. Through the implementation of the normal Vermont Yankee design change procedures which require training on modification plant personnel will be trained to use the John Deere in severe accidents. The implementation of the design change, as well as the implementing procedures, has been approved by management and scheduled for completion prior to the startup from the 1989 refueling outage.

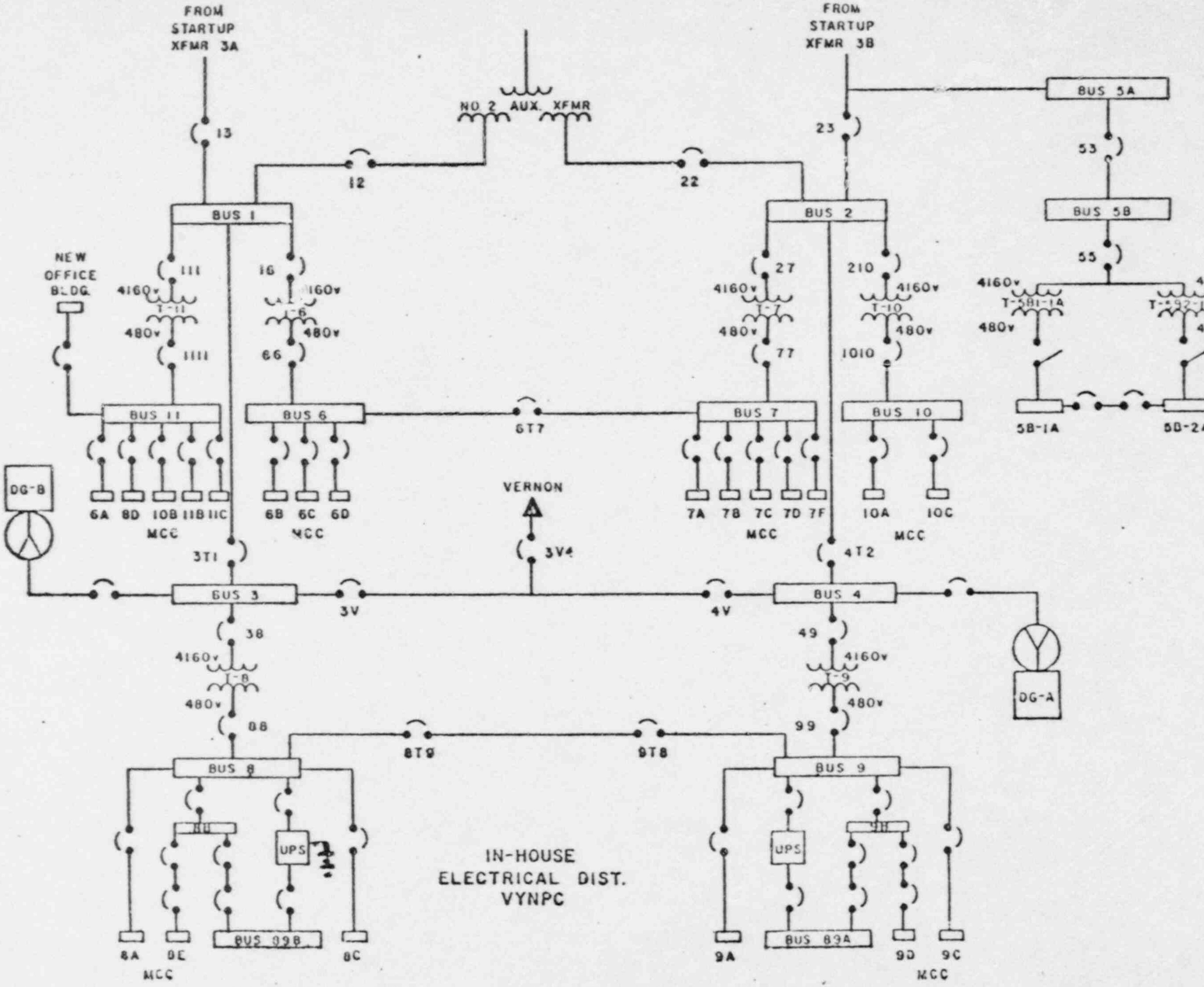
FROM STARTUP XFMR 3A
FROM STARTUP XFMR 3B
NO 2 AUX. XFMR
13
12
22
23
BUS 5A
53
BUS 5B
55
BUS 1
BUS 2
NEW OFFICE BLDG
111
16
27
210
4160v
T-11
T-6
T-7
T-10
480v
1111
66
77
1010
T-5B1-1A
T-5B2-1A
BUS 11
BUS 6
6T7
BUS 7
BUS 10
5B-1A
5B-2A
6A
8D
10B
11B
11C
6B
6C
6D
7A
7B
7C
7D
7F
10A
10C
MCC
DG-B
VERNON
3V4
3T1
4T2
BUS 3
3V
4V
BUS 4
38
49
T-8
T-9
88
99
DG-A
8T9
9T8
BUS 8
BUS 9
UPS
IN-HOUSE
ELECTRICAL DIST.
VYNPC
BUS 89B
BUS 89A
8A
8E
8C
9A
9D
9C

Figure 7-1

CHAPTER EIGHT

VENTING THE CONTAINMENT

(References: NRC letter to VY, October 24, 1986; Containment Safety Study various; Draft SACI/BWROG, p.45; Draft NUREG-1150, Appendix E, p.3, M4, M2, M5; ASTA, III.C.3, pg.4)

The Task Force considered a recommendation to provide a vent path from the torus which is capable of operation during severe accident conditions. This recommendation also considered procedure improvements that could be developed to better define and facilitate the venting option.

Venting is the intentional release of gases from the primary containment (i.e., the steel structure surrounding the reactor vessel). It would be done to control the pressure inside the containment in order to keep it intact. Also, venting could prevent the reactor core from melting because the core depends on containment equipment to keep it cool. If the core melts, fission products would be released inside the containment. Venting would release some of these fission products to the atmosphere, but most would stay inside the containment in the water if gases are vented first through the containment's pressure suppression pool (torus).

The Vermont Yankee Task Force considered those events for which venting might be required; which events containment pressure control might be possible through other means (e.g., the drywell or primary containment spray); what would be the appropriate time to vent for each event; what would be the required vent size for each event; and, what vent paths already exist at Vermont Yankee. The Task Force also looked at how vent valves could be operated in the absence of AC power and what procedures would be required. The Task Force considered where the various vent paths would discharge and what type of release to the atmosphere would result for each event and each vent path. The Task Force finally investigated if the development of additional vent paths were justified for Vermont Yankee.

The Task Force observed that venting could prevent containment failure for certain accidents. Depending on the accident sequence, venting can prevent core melting or mitigate the consequence of a core melt. But the Task Force saw serious disadvantages to venting. There could be unnecessary radioactive releases because containment pressure could be relieved by other means such as the drywell (containment) spray. Also, plant personnel may be able to recover from an accident sooner than expected, thus making a venting release unnecessary. The Vermont Yankee Task Force noted that venting could involve earlier releases than a containment leak. The Task Force observed that venting could also cause a "harsh" environment in the reactor building which surrounds the containment. This could hamper recovering from an accident due to damaging equipment and/or hindering repair efforts. Finally, it was pointed out that the choice of an inappropriate vent path could bypass the "scrubbing" action of the torus water. This could lead to significantly higher radiological releases than a containment leak that involves scrubbing.

The Task Force determined that torus venting can be an effective means to prevent containment failure for a certain class of low probability events. These are events when something abnormal occurs and the plant loses the ability to remove containment heat. Venting for these kinds of events preserves core cooling by preserving containment integrity. With the core adequately cooled, there would not be significant fission products released out the vent. For these kinds of events, venting would not be required until relatively late (about ten hours) into the event. The Task Force noted that Vermont Yankee has identified over thirty potential vent paths. The Task Force concluded that, given the available time for operator action and the identified vent paths, Vermont Yankee would be able to vent successfully. For other classes of events, venting is one option for mitigating accidents. These are events where the core melts. However, though venting may help mitigate these accidents, there is still the potential for unnecessary or premature release through the improper use of a vent. Although much industry work has been aimed at defining the conditions of "proper venting," the Task Force noted, the only conclusion thus far has been that the conditions are very plant-specific. The benefits of venting depend on the plant-specific accident sequences. And the effectiveness of venting depends on plant-specific equipment and procedures to operate that equipment.

Vermont Yankee sees venting as an appropriate strategy for preventing core melt (but no significant radioactive releases would be involved in this type of venting). For those events where core melting would occur, venting would involve radiaoctive releases. The Task Force noted that, although it recognizes venting as an option, Vermont Yankee has pursued other alternatives for mitigating the consequnces of such accidents. Vermont Yankee has identified drywell spray as an alternative with the same advantage of containment pressure control. Moreover, drywell spray has the additonal advantages of core debris cooling and drywell cooling, yet does not involve radioactive releases to the atmosphere. For these reasons, Vermont Yankee will continue work on assuring that the drywell spray will be effective under severe accident conditions.

The Task Force concluded that current industry knowledge on venting and vent paths does not justify the development of an additional torus vent path. However, the Task Force recommended that Vermont Yankee pursue a conceptual design and cost estimate for a hardened vent line to the plant stack. This would then be available to evaluate when Vermont Yankee's specific design features are considered using the methods to be approved under the NRC's Severe Accident Policy Statement. Vermont Yankee sees that, given the plant-specific aspects of venting and the possible need for filters shown by industry analyses, further studies should only be done within the context of implementing the NRC's severe accident policy using NRC approved methods.

Certain venting procedures will be developed as part of incorporation of the Emergency Procedure Guidelines, Rev. 4, following NRC approval. If additional procedural guidance on venting is required, it will be identified by the NRC-required Individual Plant Evaluation.

Management concurs in the approach recommended by the Task Force and recognizes that the venting issue must be actively pursued by Vermont Yankee.

CHAPTER NINE

FURTHER STUDIES OF DRYWELL SPRAY

(Reference: NRC letter to VY, October 24, 1986, Section 2.2.2; ASTA, V.C.1., p.8; Draft SACI/BWROG, p.45)

The recommendation was made to perform further studies of drywell (i.e., primary containment) spray performance under reduced water flow conditions.

The drywell spray at the Vernon plant can be activated through various means: torus (pressure suppression pool) water pumped by the residual heat removal (RHR) pumps, river water pumped by the residual heat removal service water pumps, and river water pumped by the diesel-powered fire pump. Design calculations for the drywell spray were based on the residual heat removal system's pumping capacity. The RHR service water pumps and the diesel-powered fire pumps have a smaller capacity than the regular RHR pumps. The Task Force looked at how this reduced pumping capacity would affect the performance of the drywell spray. The important features of the drywell spray performance under accident conditions were, as assessed by the Task Force, the following: the injection flow rate through the drywell spray nozzels (this determines the total amount of water injected as drywell spray; water acts to cool the containment atmosphere, to cool any core debris and to "scrub" or filter fission products in the drywell); and, the spray droplet size (along with the water flow rate, the size determines the rate at which some fission products are removed from the drywell atmosphere). The Task Force concluded that further studies in this area would not be beneficial, since the drywell, under these conditions, would cause "fission product scrubbing" even without ensuring a specific spray path flow. A number of technical studies have shown a high level of fission product scrubbing regardless of the conditions in the containment. The disadvantage seen was that further studies of drywell spray performance would require major engineering resources that would be much better employed on more promising safety initiatives.

The Containment Task Force affirmed that, for Vermont Yankee, the drywell spray is a very effective means of mitigating the consequences of a core melt accident. The Task Force listed the main challenges to containment integrity in a severe accident: high pressure from steam generated by any core debris in contact with water; high pressure from noncondensible gases generated by the core coming into contact with the concrete in the containment structure; high temperature of the drywell atmosphere from hot molten core debris; and, melt-through of the drywell steel by molten core debris. The Task Force then noted how the drywell spray helps to mitigate each of these challenges: the drywell spray condenses steam generated by core decay heat; the drywell spray helps "quench" core debris to limit core-concrete interactions and noncondensible gas production; the drywell spray cools the drywell atmosphere; and, the drywell spray helps prevent a melt-through of the drywell steel by quenching molten core debris and limiting its spread. All of these benefits can help prevent containment failure. However, even if containment failure did occur, the drywell spray would still play an important role in limiting radioactive releases to the outside atmosphere by scrubbing or filtering fission products. Because of these benefits, the Task Force noted that Vermont Yankee has already begun engineering efforts to assure drywell spray capability under severe accident conditions which is covered in Chapter Ten. Vermont Yankee management concurred in closing this item.

CHAPTER TEN

DRYWELL SPRAY VALVE OPERABILITY DURING STATION BLACKOUT

(Reference: Containment Safety Study, p. 119, 5.3.5.1.1, p.179, 6.2(2); Draft SACI/BWROG, p.45; Draft NUREG-1150, Appendix E, p.3, M4)

During a station blackout, the residual heat removal system (RHR) and the service water system which supplies cooling water from the river either directly to the plant's auxiliary equipment or indirectly through the turbine and reactor buildings' closed cooling water systems have pumps and valves which would not function because of the loss of AC electrical power. The drywell spray, however, is still operable using the diesel-powered fire pump, if the appropriate valves can be operated. During a station blackout, these valves can be operated manually. The recommendation is to upgrade these valves through the use of an alternate power supply to allow their remote operation.

The Task Force observed that, even though the local, manual operation of these valves would probably be successful since the drywell spray would not be required until several hours after a severe accident, modification to allow their remote operation would improve the chances of successful drywell spray. The disadvantage would be that remote operation requires electrical power and this modification would add equipment to allow a completely independent diesel generator to be tied via operator action to a station bus. In spite of the latter, the Task Force affirmed Vermont Yankee's acceptance of the recommendation.

If a loss of off-site power were to occur, Vermont Yankee has two separate means of obtaining electrical power. These means are the on-site diesel generators (three megawatts each) and the Vernon hydroelectric station. Even if both of these sources were to incredibly fail, plant personnel would most likely be successful in manually operating the appropriate valves to allow the drywell spray to be aligned with the diesel-powered fire pump. Because of the importance of the drywell spray as a means to mitigate severe accidents, Vermont Yankee has begun work on a design change to allow remote operation of the necessary valves. The design change puts in place permanent electrical connections for a diesel-powered generator not only to operate these valves but also to charge the station batteries. This will allow either low pressure reactor injection or drywell spray water to be available for a total station blackout. This modification will further make available other important safety equipment through extending the availability of the station batteries (i.e., high pressure cooling water injection system, reactor core isolation cooling system and automatic depressurization system would be operable and water could be added to the reactor vessel.) This modification will be completed prior to the plant's start-up from the 1989 refueling outage.

CHAPTER ELEVEN

CORE DEBRIS BARRIERS

(Reference: NRC letter to VY, October 24, 1986,
Section 2.2.4, Draft NUREG-1150,
Appendix E, M3)

A recommendation from the NRC letter of October 1986 was that installation of a core debris barrier be evaluated. One postulated way the containment could fail would be by a melt-through of the drywell steel by molten core debris (i.e., the reactor core having melted through the vessel and fallen to the containment floor in a molten mass). For this to happen, the following sequence of events must take place. First, all the low and high pressure core cooling systems must be totally inoperable. This requires that many separate, independent cooling systems (any one of which could keep the core cool) would simultaneously fail. Also, many contingency sources of either power or water - Vernon tie line, diesel-powered fire pump, "John Deere" diesel, would be unavailable. Since there is no makeup water to the reactor, the core will eventually melt. The molten core must then slump to the lower portion of the reactor vessel and melt through. The molten core must then migrate through the under vessel reactor components and structural steel to reach the concrete drywell floor. The core debris must then travel across the drywell floor and come into contact with the drywell steel wall. Finally, the core debris must then be hot enough to heat the drywell steel so that it melts through and causes an opening such that the drywell atmosphere can be released. The Task Force considered several recommendations to halt the preceeding sequence, and specifically in this case the suggestion that, assuming the core melts through the vessel, a barrier on the drywell floor could prevent molten core debris from reaching the drywell steel wall.

The advantage to a core debris barrier would be that it could potentially help prevent the loss of the containment's integrity by blocking the migration of the molten core mass to its boundary. An apparent advantage, on first examination, is that this would be a simple, relatively inexpensive modification.

The disadvantages include that on further evaluation, in order to provide complete protection of the drywell, it would be very expensive to install (the NRC's NUREG-1150 shows the estimated cost of a core debris barrier to be over 100 times the estimated public safety benefit). Currently, there is no general consensus to the value of having localized barriers since it is not clear what the composition of the debris will be. It would also involve significant radiation exposure to the workers installing the structure because of the confined work area and the high radiation levels in that portion of the drywell where the barrier would have to be placed. It would also make all future work in the drywell more confined and therefore increase radiation exposure. Quality assurance is a greater problem in work done in restricted areas which could create a safety concern. The Task Force noted that the benefits of a core debris barrier depend on the likelihood of molten core debris ever reaching the drywell steel wall. Analyses aimed at quantifying this likelihood have been performed by NRC contractors in support of the draft NUREG-1150 ("Reactor Risk Reference Document"), and by industry contractors as part of the Industry Degraded Core Rulemaking (IDCOR) program. These studies entailed an assumed sequence of events leading to core melt, analytical models used to calculate the temperature, composition and amount of core debris released from the reactor vessel, and analytical models used to calculate heat transfer from the core debris.

Because of differences in assumptions and analytical models, NRC and industry contractors calculate widely different results. Even among NRC contractors, there is no consensus as to the advantages of a core debris barrier. Some experts have suggested that a barrier would be rapidly eroded by the molten core and would not be effective in preventing a drywell melt-through. Expert opinion currently holds that there are no refractory materials available to use in construction of a barrier that can withstand the thermal shock of a molten core without cracking to a degree that they lose their integrity.

The only consensus between NRC and industry experts is that water (from the drywell spray) is a very effective means to mitigate a core melt accident. Industry analysts believe that water would stop the spread of molten core and prevent containment failure. Some NRC analysts do not agree, but they believe that water would be effective in scrubbing radioactive fission products inside the containment.

The effectiveness of water in preventing a drywell melt-through was demonstrated through recent experiments by industry representatives. These results were presented at the NRC-Mark I Containment Workshop in Baltimore, Maryland in February, 1988. The experiments show that the heat transfer from core debris to water is dominated by mechanisms which had not been previously considered. The measured heat transfer was much greater than that used in either NRC or IDCOR models. Higher heat transfer would tend to limit the spread of core debris and would reduce the amount of heat which is available to heat up the drywell steel wall.

Additionally, specific features of Vermont Yankee reduce the plant's vulnerability to this problem. The Vermont Yankee core is much smaller than the reference plant considered in WASH-1400 but the containment is almost the same size. This means that the molten core does not spread as far or as deep. Also, the drywell vent pipes are less vulnerable to attack by the molten core than the reference plant. The conclusion is that Vermont Yankee cannot justify a core debris barrier.

The Task Force stated its support of a company position not to install a core debris barrier in the imediate future. This position considers both the costs of installing a core debris barrier and also the lack of consensus among technical experts regarding its usefulness.

CHAPTER TWELVE

SAMPLING THE TORUS FOR RADIOACTIVITY

(Reference: Containment Safety Study,
p. 143, 5.6.5.3.1.E;
Appendix E 1.1.8, p. E8)

During certain severe accident scenarios, water is injected into either the reactor vessel or to the primary containment. Water to the reactor vessel provides a make-up supply for water that is lost because of boiling. Water to the containment is used for drywell sprays to provide steam condensation (this results in pressure suppression of the containment). Regardless of the injection path of the water, the water itself eventually falls into the suppression pool (i.e., the torus which is the containment's "wet well"). A maximum water level in the suppression pool, however, is necessary for two reasons: to prevent flooding of the vacuum breakers that connect to the drywell (this could result in excessive differential pressure between the drywell and the suppression pool; as a result, containment integrity could be threatened); and, to avoid the increased hydrodynamic loading of the submerged components within the pool (increased loading on the submerged components would alter their response during a pressure release from the primary containment, leading to a possible suppression pool rupture). The normal methods for lowering suppression pool water level are either to provide a flow path to the radioactive waste processing facility by means of pumps in the residual heat removal system, or to use valves installed on the bottom of the suppression pool to drain water to the reactor building's sumps where it can later be pumped to the radioactive waste processing facility.

When the water from the torus reaches the radioactive waste facility, it is processed to remove radioactive isotopes and other contaminants and then is transferred to the condensate storage tank where it can later be used for vessel make-up water. The condensate storage tank has a 500,000-gallon capacity. It is located outside the reactor building within a concrete dike.

During the development of the plant's emergency operation procedures, additional methods were identified to enable the use of the high pressure cooling injection system (HPCI) and the reactor core isolation cooling system (RCIC) for suppression pool level control. Under these conditions, excess water is pumped directly into the condensate storage tank. The HPCI and RCIC systems each use pumps powered by the reactor steam. They are operated through the manipulation of DC-powered controls. As such, these systems remain operable during a station blackout in which all AC power sources are lost.

In the event of a massive fuel failure, the water within the suppresssion pool may become highly contaminated, so much so that its transfer to the condensate storage tank may result in an uncontrolled release of radioactivity to the atmosphere. Although the release of suppression pool water to the condensate storage tank is only permitted if there is no indication of a massive fuel failure, the Vermont Yankee Containment Safety Study recommended that sampling be performed prior to the water's discharge to ensure that radioactive levels are within requirements. The Task Force observed that the main advantage to this sampling procedure was that it would help prevent a release of radioactivity into the atmosphere. The disadvantages identified were that sampling of the torus may result in delays which could increase the possibility of containment damage. Also, if radioactivity is high near the sampling points, increased personnel exposure could result.

The Task Force concluded that the intent of this recommendation has been met by Revision 2 to Emergency Procedure OE 3104. This procedure requires checking for indications of gross or massive fuel failure before pumping water to the condensate storage tank. This can be accomplished while still providing for maximum personnel safety. The Task Force therefore considered the recommendation closed out and Vermont Yankee management concurred.

CHAPTER THIRTEEN

TRAINING TO VENT

(Reference: ASTA III.C.4, p. 4)

The Containment Task Force looked at the recommendation from ASTA that Vermont Yankee should provide training to emergency response personnel on the use of the containment venting guideline.

The Vermont Yankee containment is designed, tested and operated so that it will be capable of coping with severe threats to its integrity. For certain severe accidents having the potential of containment failure, controlled venting not only preserves the containment's structure but also prevents a significant release of radioactivity to the atmosphere. The Vermont Yankee Containment Safety Study recommended that analysis be performed to ensure an understanding of the positive and negative impacts of containment pressure control by venting through the pressure suppression pool (torus). As a result, a formal guideline was created to provide the pre-planning on the decision to vent the containment. Vermont Yankee determined that the Vernon plant has at least 32 different vent paths. Each path has been looked at to determine its appropriate use, and the potential adverse consequences of its use. A guideline was prepared, in lieu of a procedure, because the topic of containment venting involves scenarios beyond the design basis of the plant (i.e., accidents not credible to the plant's designers given the safety systems installed). As such, the approval of a procedure for containment venting can not be subjected to the conventional review given to normal plant procedures. The guideline allows the engineering and management staff in the Vernon plant's Technical Support Center (a control center established when the plant has an emergency) to evaluate venting and to transmit this information to control room operators. A subsequent recommendation resulting from a review of the venting guideline was that training should be set up to instruct personnel on the principles which the venting guideline is based. This is to ensure that Technical Support Center people, control room operators, and the Operations Support Center (another emergency center) all have an understanding on how the venting guideline should be executed.

The Task Force observed that a disadvantage to the over-all recommendation was that additional training on unrealistic accident scenarios (i.e., those that go beyond the designer's conception) could be unnecessarily burdensome to plant personnel. On the other hand, the Vermont Yankee Task Force concurred that an awareness of the available means for containment venting would allow plant personnel to decide expeditiously on the need for and the best means of venting. Pre-planning would help ensure that all involved personnel would be able to select the best vent path, knowing full well the consequences. Because of the recommendation's acceptance, Vermont Yankee personnel have received comprehensive training on all aspects of the containment venting guidelines. The training was composed of lectures and scenario practice sessions through the control room simulator. This training will become a regular item in the training syllabus for Technical Support Center managers. It is recognized that containment venting involves very complex technical issues. Many of these have not been fully resolved. Venting also involves difficult political issues which are likely to cover more than one state.

CHAPTER FOURTEEN

REDUCE INERTING TIME

(Reference: Containment Safety Study, p. 113, Sec. 5.2.2.1;
NRC letter to VY, October 24,1986, Sec.
2.2.1)

The 1986 Vermont Yankee Containment Safety Study recommended that Vermont Yankee reduce the time limit for "inerting" the primary containment during operations start-up and shut-down procedures from 24 hours to 12 hours.

The Vernon plant's containment atmosphere is "inerted" with nitrogen gas during normal operation. This reduces the potential for hydrogen burn in the containment if a severe accident were to occur. For some accident sequences, hydrogen gas would result from a chemical reaction between the fuel cladding (i.e., the zircalloy metal that encases the fuel pellets) and the reactor steam inside the vessel. Hydrogen gas can burn if the concentration of hydrogen and oxygen is high enough. But if no oxygen is present (i.e., if there is an "inerted," nitrogen atmosphere), the hydrogen will not burn. Because it takes a certain amount of time to inert the containment by adding nitrogen and removing oxygen, the Vermont Yankee Technical Specifications (i.e., those rules and procedures by which Vermont Yankee must operate the plant under NRC authority) allow 24 hours during start-up and shut-down of the reactor to accomplish this task. The recommendation was to reduce that specified time by half.

The Task Force considered this recommendation and saw that, if a severe accident were to happen while the containment is not inerted, there would be the potential for the containment to be damaged when the hydrogen burned. The Task Force, however, noted that, as long as the containment contains nitrogen, plant personnel access to the drywell to perform needed inspections and maintenance would be greatly hampered. Reducing the allowable de-inert time could result in workers' rushing, with a greater potential for errors in maintenance or inspection activities. Placing the plant in "cold" shutdown in order to perform these routine maintenance activities would require the plant to go through an additional cold shutdown and heat-up cycle. This cycle is undesirable from a safety standpoint due to the operating transients as well as a reactor vessel thermal cycle viewpoint.

The original license for the Vermont Yankee plant did not include an inerted containment atmosphere. Vermont Yankee, however, adopted, with NRC approval, the 24-hour de-inert time. With this time limit, the Vernon plant operates with the containment fully inerted for about 99% of the time. Reducing this time limit to 12 hours represents only a small increase in the over-all picture (the increase would be about 0.5%). The Task Force concluded that this small benefit is more than offset by the increased potential for errors in important inspection and maintenance activities and in increased plant transients. These activities need to be performed with the containment de-inerted. Accordingly, Vermont Yankee does not intend to reduce the Technical Specification time for inerting the containment. The Vernon plant will, however, minimize the actual de-inert time, which is always less than or equal to the Technical Specification limit. This will be done through administrative procedures. De-inert time will indeed be minimized, but not at the expense of compromising inspection and maintenance activities. This procedural change in the form of a caution to minimize de-inert time will be added to the appropriate procedures prior to the start-up from the 1989 refueling outage. Vermont Yankee management concurs in this disposition.

CHAPTER FIFTEEN

TRAINING TO KEEP EMERGENCY PUMPS OPERATING

(Reference: Containment Safety Study, p. 180, 6.2(1); p. 84, 4.5.3)

The Vermont Yankee Containment Study recommended that the plant provide additional guidance and training on the response of low pressure pumps to high suppression pool (torus) temperature. This guidance should indentify areas of concern for long-term pump operability and short-term survivability.

The residual heat removal system (RHR) is a combination of several subsystems designed to remove decay heat from the reactor. Under accident conditions, this versatile system can be placed in a variety of configurations to provide core cooling (low pressure cooling water injection into the reactor), containment cooling (containment drywell spray), and torus cooling. The system is composed of two redundant trains, each equipped with two 1,000 horse power, single-stage centrifugal pumps. These pumps are capable of pumping 7,200 gallons of water per minute at a discharge head of 410 feet. Suction for the pumps can be drawn from the suppression pool, or from one loop of the reactor water recirculation system. This water then travels through one of two 57.5 million BTU/hr heat exchangers where it is cooled (cooling water is provided to the heat exchangers from the four RHR service water pumps -- two per train). The water is then returned to the suppression pool, or the reactor vessel or to the drywell sprays (primary containment). In order to maintain the reactor pressure at a level low enough for the low pressure systems to operate, the safety relief valves must be opened. This will release the steam in the reactor to the torus. The steam condenses as it exits piping below the surface of the torus water (i.e., the perforated "T-quencher" at the bottom of the suppression pool). In this way, cooling water can be injected while escaping steam is contained within the primary containment. Condensation of the steam in the torus prevents the containment from overpressurizing. The long-term utilization of the suppression pool for reactor vessel injection is a preferred source of cooling water because the continued use of any external source would eventually fill the suppression pool.

When there is a severe accident, in certain circumstances, the suppression pool would become too hot for use by the low pressure cooling water systems. Since in this alignment the RHR or core spray (CS) pumps would be exposed to high operating temperatures, the Containment Safety Study recommended that additional guidance and training be provided on the response of low pressure pumps to high suppression pool temperature. The Task Force concluded that procedural guidance and training would be advantageous in ensuring that operators would be fully aware of the problems associated with the operation of emergency core cooling pumps at high temperatures. The Vermont Yankee Task Force reviewed the operator training syllabus and concluded that pump performance under a variety of conditions is already included in the basic training for operators. Over-emphasis on high temperature operation, the Task Force observed, could result in a reluctance by operators to expose pumps to harsh conditions resulting from severe core accidents. Operators might shut off the pumps sooner than necessary. The high temperature effects on pump operation were evaluated by the Vermont Yankee Task Force to be only of primary concern to extended operation. Over a period of years the pumps will experience accelerated wear. In the short term (hours or several days), little adverse effect would be seen in the pumps. The Task Force concluded that the present training on high temperature effects on pumps is completely adequate. No further action is deemed necessary. Vermont Yankee management concurred.

CHAPTER SIXTEEN

SEALING THE DRYWELL HEAD

(Reference: SACI/BWROG, p. 46)

A location under certain high temperature conditions where the primary containment might leak appears to be the drywell head (i.e., the removable "cap" of the primary containment). Replacement of the current gasket material with a material which could withstand very high temperatures could eliminate this potential leak path. A stainless steel O-ring gasket replacement of one of the two tongue-in-groove rubber gaskets now in use would appear to serve this purpose.

Vermont Yankee's primary containment is a steel vessel which completely surrounds the reactor vessel. It is designed to hold all the sensible energy stored in the reactor vessel. In case of a major pipe break in the reactor system, the primary containment is designed to hold all of the radioactivity produced and prevent its release to the atmosphere. The primary containment's cover (i.e., the drywell "head") is a removable piece of equipment so that plant personnel can get to the reactor vessel in order to refuel it and inspect it. Since the head is removable, it is sealed during operations by a double O-ring gasket to prevent any drywell leakage. The gaskets are made of a rubber compound and are set in grooves in the primary containment's flange. The drywell head has "tongues" which push into the gaskets, creating an air-tight seal not only for normal pressure from the containment but also for "accident pressure" conditions. This seal is regularly tested for effectiveness by Vermont Yankee. But for severe accidents which involve core melt (i.e., accidents inconceivable to the plant's designers, given the facility's safety equipment), the Boiling Water Reactor Owners Group (BWROG) proposed the potential use of a stainless steel O-ring. Although the stainless steel gasket makes for a better seal in very high temperatures, it is not the resilient seal that the rubber gasket is (because of its flexibility and tongue-in-groove configuration). Also, because of movement resulting from thermal "growth" or expansion, the metal O-ring would have a higher potential for failure. This movement occurs at every reactor heat-up and cool-down. Leak-testing the rubber or steel O-rings can only be done during an outage. A metal O-ring could pass an initial test, but then potentially not hold during later plant operations because of thermal movement after reactor start-up.

The Vermont Yankee Task Force concluded that implementation of the BWROG's recommendation could reduce the potential for a leak in the drywell head gasket for those severe accidents involving core melt (i.e., those accidents with very high temperatures). On the other hand, the Task Force came to the view that implementing the change would increase the potential of primary containment leakage for far more probable events. The Task Force also recognized that the stainless steel O-ring is not without its problems: its lack of resiliency, its potential not to "seat" properly after a plant start-up, and the additonal stress it would put on the drywell flange because of its failure to seat properly. The Task Force also noted that the Vernon plant's drywell flange ring would have to be modified to accept the metal gasket. Because no other boiling water reactor has such a metal O-ring, Vermont Yankee would have to design and fabricate one, then modify the drywell head itself. This modification would be risky because it might not produce the intended result. Also, just to install it would require increased personnel radiation exposure and over the years additional radiation exposure could be expected.

In reaching a decision on this recommendation, the Task Force concluded that because Vermont Yankee will enhance containment spray capability, the need for a stainless steel gasket would be reduced even further. The drywell spray modification assures that high temperatures in the primary containment, resulting from a severe accident, will be prevented. The Task Force finished its assessment of the BWROG recommendation by affirming that current procedures ensure the current drywell head gasket will continue to receive thorough inspections and monitoring and that, should a problem with this piece of equipment arise, Vermont Yankee will address it immediately. Vermont Yankee management concurs.

CHAPTER SEVENTEEN

MAINTENANCE AND TESTING OF THE VERNON TIE LINE

(Reference: Containment Safety Study; VY Plant Manager memo to Vice President/Manager of Operations,12/3/86)

The recommendations are to incorporate maintenance and testing practices for the Vernon hydroelectric tie line into the Vermont Yankee preventive maintenance program. This would require conducting operational tests of the tie line.

The purpose of Vermont Yankee's electrical system is not only to provide economical power to Vermont and the region, but also to run equipment in the Vernon plant and to operate emergency equipment for the protection of the public. Vermont Yankee supplies electricity to the New England Power Grid through four lines "Keene," "Northfield," "Scobie," and "Coolidge." These lines can provide power in both directions: either to the Grid or to the Vermont Yankee plant. Any one of the four separate lines can supply Vermont Yankee with all its power needs, including the operation of emergency equipment. Vermont Yankee's own electrical distribution system is designed for the utmost reliability. Separation and redundancy are the hallmarks of the electrical system. Redundancy means every important safety system has a back-up. Separation ensures that a failure of one system will not affect the other. In case the four in-coming power lines should fail simultaneously, Vermont Yankee can call on either of two independent diesel generators (3-megawatt capacity each) to supply two independent emergency buses (either diesel can supply both electrical buses). If the power lines and the two diesel generators should all fail simultaneously, Vermont Yankee is in a unique position to receive the necessary electrical power from the nearby Vernon hydroelectric station.

The Vernon tie line is very reliable, but to ensure even more reliability, the Vermont Yankee Task Force endorsed the implementation of the recommendation which set up a preventive maintenance program to guarantee the line. This includes: periodic testing of equipment such as the switchgear and the transformer, inspecting the line regularly, and testing the line by operational test periodically. Further, the availability of the Vernon tie line was demonstrated at the last Vermont Yankee outage and will be demonstrated each succeeding refueling outage by aligning it to one of the safety busses and supplying it with the needed power. There are no further actions necessary to complete this recommendation. Vermont Yankee management concurs.

CHAPTER EIGHTEEN

REACTOR BUILDING SPRAY

(Reference: Draft NUREG-1150, Appendix E)

The Task Force considered a recommendation to install a spray system in the reactor building which would spray water throughout the structure.

If core damage and containment failure were to occur, radioactive fission products could be released from the containment into the reactor building. The reactor building, which surrounds the containment, can retain radioactivity and/or limit its release to the environment. This recommendation suggests adding a system to spray the reactor building. Such a "global" or sweeping spray could remove radioactivity from the reactor building's atmosphere, and thereby retain more of it inside the "secondary containment" (i.e., the reactor building). The Task Force considered the recommendation to mount the spray sparger surrounding the reactor building's hatchway, at the refueling floor level.

The Containment Task Force determined that the advantage to implementing this recommendation could be to reduce radioactive releases to the environment during certain accident sequences. It would not be effective in many accident sequences, and it would add additional complexity to the plant and to the control room. The Task Force determined that an installation of a reactor building spray would be extremely difficult and expensive. Moreover, the Task Force noted that the possibility for inadvertent activation of the system could be both a safety risk to plant personnel and an overall safety risk, albeit a small one. Many regular maintenance and inspection activities take place in the reactor building and many are on or in the proximity of energized electrical equipment. The Task Force noted that Vermont Yankee currently has sprays in certain locations of the reactor building for fire control. To add a global spray would be a major change in the fire suppression system, and the benefits of such a change appear to be very limited, since the effectiveness of the spray is heavily dependent on where the containment should fail during a severe accident.

A reactor building spray would be most effective, the Task Force concluded, for a drywell head (i.e., containment top) leak following a severe accident. This kind of failure would result in radioactive releases to the refueling floor. Earlier studies of the BWR Mark I containment performance assumed this would be a potential failure "mode." The most recent studies, however, of Mark I structural performance indicate that the torus air space is the most likely location for containment failure. These studies were performed by the Chicago Bridge and Iron Company, using the latest analytical methods. Containment leakage from the torus air space would involve the filtering of the radioactivity by the torus water. Furthermore, radioactive releases from the torus room of the reactor building would travel past large structures before reaching the locations which would be showered by a reactor building spray. There would be a substantial retention of radioactive fission products in the reactor building simply by their being deposited on plant structures and equipment.

The Task Force determined that no further action should be pursued. The Task Force noted that industry studies show the reactor building is effective in retaining radioactivity even without a global spray. Vermont Yankee management concurred in the recommended closeout of the recommendation.

CHAPTER NINETEEN

USING A DIESEL TO RUN A CRD PUMP

(Reference: Draft NUREG-1150, Appendix E)

The Vermont Yankee Task Force considered the recommendation that the plant use an existing low-capacity diesel generator to run the control rod drive (CRD) pumps during a station blackout accident condition at the Vernon facility.

During a station blackout event (defined in Chapter 4), reactor core cooling would be maintained by systems which are independent of AC electrical power. These systems depend on power from the plant's station batteries. But, if a station blackout were to last for a long time, these emergency core cooling systems could be lost because the station batteries might run down. The recommendation is that the plant run a CRD pump with an existing, low-capacity diesel generator for injecting cooling water into the reactor vessel to keep the core covered and, therefore, cool.

The Task Force considered that Vermont Yankee has a low-capacity diesel generator. A control rod drive pump requires more power to start than is available from the diesel generator. Accordingly, this scheme could not be implemented by Vermont Yankee with existing equipment. The addition of a new diesel generator for this function was evaluated to be impractical because of very limited benefit and the detrimental effect of the vastly more complex control and CRD pump power supplies that would result.

The Task Force noted, however, that Vermont Yankee is pursuing a design change to enhance the drywell spray for containment cooling. This modification is covered in detail in Chapter 10. This modification involves using the diesel generator for remote operation of appropriate valves to activate the drywell spray or supplying water to the reactor vessel with the diesel-powered fire pump. The modification also covers using the diesel generator to charge the station batteries. The Task Force concluded that this will prevent the batteries from running down during an extended station blackout and will assure the continued operation of the AC-independent emergency core cooling systems. The Task Force concluded that no further actions are necessary for this proposal, and Vermont Yankee management concurred.

CHAPTER TWENTY

DATA SETS FOR VENTING

(Reference: ASTA, Sec. III.C.2, p. 3)

As part of the Vermont Yankee Containment Safety Study, a venting guideline was created. This guideline is now used for training and would be used by the Technical Support Center (an emergency control center at the plant) if containment venting were required during an actual emergency. The Task Force reviewed the venting guideline which identifies over thirty vent paths at the Vernon generating station. The Task Force noted that the guideline is intended to aid the Technical Support Center staff by: determining the need and urgency to vent; identifying potential vent paths, given specific plant conditions; and, selecting the best vent paths for minimizing public risk. The recommendation is to create "data sets" to use along with the venting guideline. These data sets would be based on engineering analyses and would cover the following parameters: vent sizes to stop various rates of containment pressurization; vent sizes to establish various rates of containment depressurization; and, vent sizes to prevent containment pressurization for various reactor decay heat levels.

The Vermont Yankee Containment Task Force concluded that a possible benefit to having these data sets would be to furnish more information to the Technical Support Center for use with the venting guideline. On the other hand, the Task Force determined that these data sets would be extremely complicated and would require detailed engineering calculations for a multitude of possible plant configurations. The Task Force thought that these data sets would likely complicate an already difficult decision. The result may be that important decisions and actions would be significantly delayed to the point they would not be nearly as effective.

The Task Force reaffirmed Vermont Yankee's philosophy that it is vitally important to be prepared for severe accidents and to have correct guidance for the operators and the emergency team members to use during an accident. The Task Force pointed out, however, that such accidents offer very complicated conditions which are subject to large analytical uncertainties. Vermont Yankee's philosophy is to simplify guidance and provide flexibility for maximum effectiveness if complex situations can be expected to arise. The Task Force determined that the creation of detailed data sets for use with the venting guideline would be an unnecessary overcomplication. If venting were required, the general approach would be to start with the smallest controllable vent and progress to increased vent capacity as needed. The Task Force concluded that this recommendation would not aid Vermont Yankee in implementing this strategy. Vermont Yankee management concurred.

CHAPTER TWENTY-ONE

MANUAL OPERATION OF VENT VALVES

(Reference: ASTA, SEC. III.C.5)

The recommendation in the ASTA report is that Vermont Yankee buy the appropriate gas cylinders, tubing and fittings, which would be positioned for manual operation of valves that can be used for containment venting. Containment vent valves are normally remotely operated if electrical power is available. If a station blackout occurs, and AC power is not available, these valves can only be manually operated. Manual operation means using an air supply to open the valves, bypassing the electrical valve operators. Manual operation must be performed at a valve's location, however, since a portable air supply must be brought to the valves and connected.

The Task Force determined that these portable supplies could indeed be used if venting was required and the necessary electrical power was not available. But the Task Force also determined that venting the containment by local, manual valve operation would involve severe occupational health risks to workers under the most probably scenarios. The valves which would have to be manipulated are located in the reactor building. Use of a local air supply would require plant personnel to be near the valve being opened. Many of these valves discharge into the reactor building ducting which is not designed to withstand higher pressure venting loads. Failure of this ducting would expose plant workers to high-temperature steam and possibly to high radiation doses. The Task Force concluded that such actions should not be required to deal with severe accidents when there are other ways to cope with these circumstances.

The Task Force did consider an alternate approach to manual operation of the vent valves. This approach would require the acquisition of a portable diesel-driven air compressor. The air compressor could be tied into the plant's instrument air system during a station blackout and provide air to those valves that would need to be repositioned to vent the containment. This addition, in conjunction with the modification to be completed during the next refueling outage which provide the capability to tie in the "John Deere" diesel to a vital electrical bus would allow remote operation of the vent valves during station blackout scenarios. The Task Force considered this alternative and recommended the acquisition of a portable diesel-driven air compressor. No further action was believed necessary on this recommendation. Vermont Yankee management concurred with closing out this recommendation and committed to acquiring a portable air compressor by January 1, 1989.

CHAPTER TWENTY-TWO

CORE DEBRIS COOLING WITH DRYWELL SPRAY: ENHANCED PROCEDURES

(Reference: Containment Safety Study, p.153, 5.7.5)

The Containment Safety Study recommended that enhanced procedures be developed to provide a supply of water to the containment floor in the situation where the core has melted through the reactor pressure vessel. If the reactor core should melt through the bottom of the reactor vessel onto the floor of the primary containment, and also reach the steel wall of the containment, it could cause a breach of the containment. Water on the drywell floor will help stop the spread of the molten core mass to the steel wall. This water can be supplied from many diverse sources. The most likely source would be the drywell spray, used to reduce containment pressure and temperature.

The Vermont Yankee Containment Task Force's evaluation concluded that the drywell spray system is already in place at the Vernon facility and is a very reliable source of cooling water. The Task Force noted that present emergency operating procedures already instruct plant personnel to activate the drywell spray because of high drywell pressure and temperature. A minor revision to the current procedures would be all that is necessary to address the recommendation to enhance procedures to use the spray for molten core cooling, according to the Task Force. The Task Force, therefore, concluded that the recommendation should be accepted and a revision be incorporated into the plant's emergency operating procedures. Procedure OE3103 will be revised before the startup following the 1989 refueling outage. Vermont Yankee management concurred with this recommendation and the schedule for completion.

CHAPTER TWENTY-THREE

REVISING EMERGENCY PROCEDURES

(Reference: Containment Safety Study, pp. 83, 86,143, 144, 179; Appendix E)

The Containment Safety Study recommended the implementation of Revision #4 of the Emergency Procedure Guidelines which were developed by the Boiling Water Reactor Owners Group (BWROG). Vermont Yankee's present set of emergency operating procedures (EOP) was first developed in a joint effort with the BWROG. Vermont Yankee shaped these procedures to conform to the specific conditions of the Vernon plant. These procedures are referred to as "symptom-based" which means that the operator responds to the symptoms of a problem, not necessarily first determining the underlying cause. This gives operators greater flexibility and gets the operators out of an approach to plant problems that required the underlying cause of the problem to be identified before corrective action could be commenced. The procedures are detailed and an improvement over the former "event-based" approach which commenced by looking just for causes and not addressing the immediate problem.

Revision #4 to these emergency operating procedures would enhance current procedures even more. The Vermont Yankee Task Force considered, accordingly, the recommendation to incorporate Revision #4 at Vermont Yankee. Revision #4 addresses: primary containment atmosphere hydrogen control, reactor power control by varying reactor water level when a reactor scram is called for and the controls rods are unable to shut down the reactor (i.e., an "anticipated transient without scram" event). The Task Force determined that implementation would increase operator and management ability to deal with the most serious accidents. Under the Revision, there would be specific procedures to respond to even low-probability events. The only disadvantage the Task Force discovered was that implementation would require additional training to respond to highly unlikely scenarios at the expense of a minor dilution of training in other areas.

Revision #4 is currently under NRC review awaiting final approval. Vermont Yankee has completed a draft of its emergency operating procedures incorporating Revision #4 with Vermont Yankee-specific items. The Task Force noted that Vermont Yankee has committed to implement Revision #4 once the NRC approves it, and once all necessary training has been completed. NRC approval is expected in May, 1988. Implementation will require about eighteen months after the NRC approval. Revision #4 has also been recently reviewed by the BWROG to determine applicability for severe accident scenarios. The review indicated that the guidance given in Revision #4 is appropriate for severe accident sequences.

CHAPTER TWENTY-FOUR

SIMULATOR TRAINING FOR STATION BLACKOUT

(Reference: ASTA, Sec, IV.C)

The ASTA report recommended that operators receive specific station blackout training in the simulator. A long-term station blackout (or loss of all AC power) at the plant site is one event that may challenge the integrity of the primary containment. This challenge would be primarily because of the plant's inability to remove decay heat from the core and the primary containment. The inability to make up water to the primary cooling system would ultimately lead to the core's overheating and melting.

The Vermont Yankee Task Force investigated ways for the plant to be prepared for station blackout even though it is a very low probability event. The Task Force concluded that control room simulator training in station blackout procedures would enhance the operators' ability to cope with this sequence of events. Such training would give plant personnel a preview of station blackout in a real life setting. The Task Force noted, however, that the time devoted to this training would have to be substantial. The Task Force also determined that the simulator was not originally designed to replicate the station blackout scenario because it is greater than design basis accidents. Modifications would have to be made to the simulator's computer programs.

The Task Force decided that an upgrade should be made to the simulator to allow for full training on station blackout procedures. In the meantime, the operations staff and the Technical Support Center staff have had classroom training in station blackout procedures. The operations staff have also had simulator practice on many loss of AC power and loss of DC power scenarios.

The simulator software will be modified to permit realistic training in station blackout by the end of 1989. Vermont Yankee management concurs in this disposition of the recommendation.

CHAPTER TWENTY-FIVE

KEEPING THE CONTAINMENT INERT AFTER A SEVERE ACCIDENT

(Reference: Containment Safety Study, p. 113, 5.2.2.2)

The Containment Safety Study recommended that steps be evaluated that will prevent dilution of the containment's inert atmosphere after a severe accident. In the course of severe accidents which involve the reactor core overheating, a large amount of hydrogen gas can be generated by the reaction at extremely high temperatures of the zircalloy fuel cladding with steam. The hydrogen gas represents a potential energy source if it reacts with oxygen. To preclude this reaction, the primary containment's atmosphere is inerted with nitrogen, which displaces most of the oxygen in the drywell's atmosphere.

During normal plant operation, air (which contains 20 per cent oxygen) is not admitted to the primary containment and therefore oxygen concentration is less than 1 per cent. During severe accidents, the only significant source of oxygen is from the outside air which would enter the containment from the reactor building through vacuum breakers on check valves to the torus if the torus pressure should decrease to less than reactor building pressure. This would not normally be expected because the containment's nitrogen-filled atmosphere is initially almost 2 pounds above reactor building pressure. What would cause the containment pressure to decrease and be less than reactor building pressure would be the venting of the pressurized nitrogen atmosphere of the primary containment. The plant's emergency procedures indicate that this could only occur in very limited circumstances, where it would be very unlikely sufficient gases would be vented to reduce containment pressure to that of reactor building pressure. The reactor building to torus vacuum breakers, therefore, should never open under severe accident conditions.

The Task Force concluded that the introduction of oxygen could be a serious problem, but concluded that it is already taken care of by present design and operating procedures. The Task Force determined that Vermont Yankee already has an inerted primary containment which is monitored for hydrogen and oxygen concentrations even during severe accident conditions. Also, procedures are in place to limit oxygen introduction into the primary containment atmosphere. Moreover, the Task Force affirmed Vermont Yankee's commitment to implement Revision #4 to the Emergency Operating Procedure Guidelines when approved by the NRC. This will further enhance the operators' control of hydrogen and oxygen concentrations in containment under severe accident sequences.

The Task Force concluded that this recommendation could be closed out and management concurred.

CHAPTER TWENTY-SIX

ENSURING SERVICE WATER AVAILABIITY

(Reference: Containment Safety Study, p. 85, 4.5.6)

The Vermont Yankee Task Force considered the recommendation to review the service water system to identify the potential for common mode failure of the system because of bio-fouling. Biofouling is the clogging up of pipes or heat exchangers by small plants or animals that often grow and reproduce in the systems especially at elevated temperature conditions.

The service water system provides cooling water to various plant components to facilitate heat removal. The system draws water from the Connecticut River through filtration screens at the plant's intake structure. Water is then circulated by four, two-stage centrifugal pumps, each with a rated capacity of 3350 gallons per minute at 250 feet of head. The pumps are grouped in pairs to feed water into redundant 24-inch pipes that supply a common manifold on the east wall of the torus room. From this manifold, more pipes diverge to supply various components throughout the Vernon plant. One of the major cooling loads for the service water system is the residual heat removal system (RHR). Service water is drawn by four RHR service water pumps through two RHR heat exchangers to remove decay heat loads from the torus and/or reactor vessel. Individual components receiving cooling water generally have their own heat exchangers, but to ensure confinement of potential contamination, certain equipment is further isolated by another heat exchanger loop, known as the Reactor Building Closed Cooling Water System (RBCCW). In this system, service water is pumped to the second floor of the reactor building where it then makes four "passes" through either of the two RBCCW heat exchangers. After it leaves the heat exchangers, the water flows back down to the torus area toward the service water discharge header. The cooled water

(RBCCW) on the other side of the heat exchangers remains in a closed loop where it subsequently is used for cooling such components as the reactor water recirculation pumps, the control rod drive pumps and the fuel pool heat exchangers. Plant components that do not have a potential for releasing contamination by means of heat exchanger leakage are cooled directly by the service water system (e.g., the uninterruptible power supply, reactor building air coolers, etc.) All service water coming from plant components is eventually directed from the Vernon plant into a discharge header; the header empties into the plant's discharge structure downstream of the plant.

During emergencies, service water can be used to provide an inexhaustible supply of water for injection into the reactor vessel by means of the reactor's normal feedwater system. Through the service water system, water stored in a seismically-designed 1.6 million-gallon reservoir (located beneath the west cooling tower, known as the "deep basin") is an additional source of cooling water for a safe reactor shutdown. In emergencies, this water would be supplied by a gravity-flow from the deep basin to the RHR service water pumps, where it is pumped through the selected RHR heat exchanger, the diesel generator coolers and other auxiliary equipment needed for plant shutdown. After cooling these components, the service water can be returned to the cooling towers through a sparger and then cooled by the number one fan of the west cooling tower. The water then travels back to the deep basin where it is available for recirculation.

Given the extensive role of the service water system for heat removal, and its flexibility for providing alternate injection paths for reactor vessel make-up and cooling, the system has a pervasive influence on Vermont Yankee's ability to respond effectively to severe accidents. The Containment Safety Study observed that several nuclear units have experienced a common mode failure of service water-related systems owing to biological fouling. The Study recommended that Vermont Yankee examine the potential impact of bio-fouling to ensure that involved systems performed as they are designed to do.

The Task Force reviewed this recommendation and concluded that, although many plants have seen service water failure because of bio-fouling, this is a long-term problem which is apparent as a gradual degradation of system peformance over time. It is not a significant containment safety issue because it does not present a risk in accident scenarios. The Task Force noted that Vermont Yankee maintains a performance monitoring program to identify and correct any such degradation. Furthermore, the types of failures associated with bio-fouling are seen in small-bore pipes, not in the large-bore pipes associated with components needed for mitigating the consequences of an accident. The Task Force, therefore, concluded that this recommendation is adequately addressed by existing Vermont Yankee programs, and that no further action is required. Vermont Yankee management agreed with the evaluation of the Task Force.

CHAPTER TWENTY-SEVEN

TRAINING FOR USING THE FIRE PROTECTION SYSTEM FOR CONTAINMENT SPRAY

(Reference: ASTA, V.C.2)

The ASTA report recommended that training be conducted on lining-up and using the Fire Protection System for containment spray. Spraying water into the primary containment will eliminate or reduce the consequences of most postulated severe accident sequences. Sprays lower containment pressure and temperature, which both avoids any possibility of containment rupture and avoids severe environmental conditions for vulnerable containment equipment. Sprays aid in quenching and solidifying any molten core debris in the case of the extremely low probability accident scenario which results in the core melting through the reactor vessel and reaching the containment floor. Sprays scrub radioactivity from the containment's atmosphere.

In accident conditions that have been considered in the basic plant desi (i.e., "design basis" accidents), containment spray is accomplished using the residual heat removal system (RHR), with the torus water inventory as the primary source of water. During severe accident scenarios in which a total loss of AC electrical power is assumed, large electrical pumps would be unavailable. But the drywell spray could still be operated by establishing a water flow path from the Vernon plant's fire protection system. In this case, water would be drawn from the Connecticut River using the 2,500 gpm diesel-powered fire pump. Since the pump only requires electricity from a self-contained battery, it remains unaffected by a station blackout.

At the time the Vermont Yankee Containment Safety Study was written, operating procedures only provided guidance for use of the diesel-powered fire pump to inject make-up water into the reactor vessel. Although the drywell spray offered a similar configuration for linkage to the fire pump, there was no guidance for doing so.

In September, 1986, Advanced Science and Technology Associates, Inc. (ASTA) was hired by Vermont Yankee to study ways to improve the operators' ability to respond to accidents which could threaten containment integrity. Among the areas addressed was the cross-connection of the fire protection system to augment containment spray. During this effort, Appendix A to Emergency Procedure OE 3103 was prepared to give detailed steps for cross-connecting the fire system to one of the RHR "loops," for spraying either the drywell or the torus during a station blackout.

Within ASTA's final report was a recommendation that Vermont Yankee set up training to ensure that the techniques for cross-connecting the fire protection system were fully understood by operators. In November, 1986, this recommendation was implemented by completion of a lesson plan on the methods of cross-connection which then became a formal part of the operator training curriculum. During the review of ASTA's recommendation, the Task Force concluded that this training had been established and was sufficient for use of the revised Vermont Yankee procedure. The Task Force concluded that the recommendation had been addressed by the proceduralization of cross-connecting the fire protection system to the residual heat removal system. Further, training on the procedure has been incorporated in emergency procedures training and will continue as part of the over-all Emergency Operating Procedures training. Vermont Yankee management concurs that this closes out the recommendation.

CHAPTER TWENTY-EIGHT

IMPROVE CONTROL ROOM INDICATION OF STATION BATTERIES

(Reference: ASTA, IV.C.2, p. 6)

The ASTA recommendation was to install 125 VDC battery voltage indication in the main control room. During a station blackout, it is assumed the plant completely loses all AC electrical power. This means that no power is available from any of three off-site sources or the two on-site emergency diesel generators. Since no AC power is available, one way operators could mitigate the consequences of a severe accident would be by using DC power, which allows HPCI, RCIC, and auto depressurization systems to function. Under such conditions, batteries are extremely important. The Vernon plant is equipped with two independent-125-volt station batteries to supply DC power. The batteries are maintained at full power by a charger supplied from the essential power bus. The batteries are capable of supplying power to a variety of emergency cooling systems, should all AC power be lost. Among these cooling systems is the high pressure coolant injection system (HPCI). Its high-capacity pump is primarily powered by reactor steam; as such, it requires only minimal electrical power for its control and instrumentation. In addition to HPCI, the 125-volt batteries supply power needed to remotely operate the auto depresurrization system relief valves for the reactor vessel. This would enable the use of such low pressure pumps as the diesel-powered fire pump. Another important role of the batteries is that they supply control and instrumentation power to the two on-site emergency diesel generators. The last major system the 125 VDC powers is the reactor core isolation cooling (RCIC) system which is similar to the above mentioned HPCI system but has only a tenth the pumping capacity. When all their functions are considered, the two station batteries can effectively serve vital safety equipment needed for emergency core cooling.

The importance of DC electrical power sources during a station blackout, and the relatively low cost in monitoring these sources, seem to make this recommendation attractive. A control room monitor would allow operators to view constantly the condition of the batteries. The Task Force, however, saw disadvantages to the proposal. The Task Force concurred that the installation of extensive battery monitoring instrumentation would be a superfluous addition to already detailed control room panels. During an accident in which the station batteries would be relied upon, normal convention would likely require plant personnel to perform continuous monitoring at the station batteries themselves. If control room monitors were installed, however, local monitoring may not be performed and some incipient indications of battery failure might go undetected. The Task Force reviewed this recommendation and concluded that the potential for confusion caused by crowding of more instrumentation on the control panels poses a greater threat to plant safety during normal and abnormal operations than the small benefit that instrumentation would provide during a low-probability event requiring its use. The accuracy and flexibility of local monitoring would be far greater than remote indication. Consequently, control room readings would likely be disregarded when operators would be developing strategies for battery conservation. The Task Force determined then that no further action was necessary on the recommendation and Vermont Yankee management concurred.

CHAPTER TWENTY-NINE

DRYWELL COOLERS

(Reference: Peter Davis's review, p.7.5, 7.C.1)

One recommendation in the Peter Davis Review is that the drywell coolers be upgraded to reduce the likelihood of drywell failure due to high drywell temperature conditions. As part of the drywell heating, ventilation and air conditioning system (HVAC), Vermont Yankee has four drywell cooling units. These units operate by sending water through copper cooling tubes and circulating the drywell atmosphere around these tubes with fans.

The drywell of the Vermont Yankee plant is normally cooled by four reactor recirculation units (RRUs). Air flow from the drywell is recirculated through the RRUs, cooled by Reactor Building Closed Cooling Water (RBCCW), and directed through an air distribution network to various discharge points within the drywell. The heat flow path is from the recirculated air within the drywell, via the RRU to RBCCW, via the RWCCW heat exchanger to the service water system for ultimate discharge to the river.

Drywell heat removal during an accident is provided by other systems. These systems are associated with the Emergency Core Cooling System (ECCS). Also, this ECCS flow may be used as the source of water for the drywell sprays. This spray of water provides effective cooling of the drywell. The heat absorbed in the water is ultimately removed by the RHR heat exchangers, via the RHR service water and service water systems to the river. Accident analyses performed within the plant's design basis, as documented in Chapter 14 of the Vermont Yankee Final Safety Analysis Report (FSAR), show that drywell temperature is adequately controlled.

In reviewing the potential need for, and availability of drywell heat removal for severe accident sequences, two dominant sequences were identified. There are the Anticipated Transient Without Scram (ATWS) sequences, and sequences dominated by total loss of AC power (station blackout). In the former, there is significant energy release to the drywell early in the event which causes pressure increases which must be mitigated rapidly in order to prevent challenges to containment integrity. In the latter, there is a gradual pressure-temperature use in the drywell leading to the possibility of a later containment failure.

Heat release to the drywell during ATWS events is assumed to be both rapid and continuous. Equivalent heat release, depending on power and water level assumptions, varies from a low of approximately 10% power to as much as 35% power. As currently configured, each RRU receives 112 gpm of cooling water at a maximum of 100°F. Discharge piping is designed for a maximum discharge temperature of 180°F, thus permitting a maximum temperature rise of 80°F. This equates to a heat removal capacity of approximately 18×10^6 btu/hr for four coolers. This is a very small percentage of the heat removal requirements for the drywell coolers to be effective during ATWS events.

Accordingly, the Task Force concluded that, as presently designed and configured, or as could reasonably be modified, the use of the RRUs would not appreciably improve the analyzed containment response during postulated ATWS events, and thus would not improve safety. Conversely, to augment the capacity of these units to the degree that would be required for them to be effective in ATWS events would necessitate redesign and major modification of the units, their air distribution system, the RBCCW system and the service water system. Because there are several alternatives for coping with this scenario including direct ability to handle ATWS via main steam isolation valve reopening and heat dispersal via the condenser, further consideration of RRU upgrade for this event was evaluated not to be warranted.

Under station blackout conditions (loss of all AC power), only non-AC powered equipment is available for accident mitigation. This precludes operation of the service water and RBCCW systems, and precludes fan operation of the RRUs and damper operation in the RRU discharge ducting. Accordingly, the Task Force concluded that RRU upgrade would not be of benefit in blackout scenarios.

The Vermont Yankee Task Force noted that the drywell coolers were designed only for normal operating conditions. Any upgrade of the coolers to encompass accident conditions would involve major design changes and equipment purchases. The new equipment would be much larger and difficult if not impossible to install in the available drywell space. There would be significant radiation exposure to workers during the installation and because of increased congestion a continuing inefficiency and extra radiation exposure to workers [illegible] future. Members of the Task Force pointed out that, even if installed, upgraded coolers would still be of little use during a station blackout event. The Task Force concluded that there are more efficient methods of cooling the drywell atmosphere following severe accidents -- primarily through the drywell spray. In recommending that Vermont Yankee not upgrade the coolers, the Task Force observed that the Vernon plant is pursuing a design change to upgrade the drywell spray system which was discussed in Chapter 10. This will improve the drywell cooling capability under postulated severe accident conditions. Vermont Yankee management concurs.

CHAPTER THIRTY

UPGRADING STANDBY LIQUID CONTROL

(Reference: Containment Safety Study, pp. 86 & 180, 4.5.8 & 6.2(4))

This recommendation was to be able to shutdown the reactor more rapidly when the control rods fail to complete a scram to lessen the energy release to the containment during ATWS conditions by upgrading the Standby Liquid Control System. If immediate reactor shutdown is required because of abnormal conditions, the Reactor Protection System (RPS) is activated. The RPS causes a rapid insertion of the neutron-absorbing control rods into the reactor core. This stops the nuclear reaction and causes reactor shutdown within seconds.

One type of postulated abnormal event is an "anticipated transient without scram" (ATWS). An ATWS is any transient event for which the RPS should produce a reactor scram but fails to do so. The RPS contains redundant components and is a very reliable system. No complete failure of the RPS has ever occurred at a boiling water reactor (BWR) plant. Nevertheless, Vermont Yankee is designed with a backup system for reactor shutdown. This system, called the Standby Liquid Control System (SLC), accomplishes reactor shutdown by injecting a chemical solution into the reactor which absorbs neutrons and achieves the same effect as control rod insertion. The recommendation was to upgrade the SLC system by increasing its rate of neutron absorption.

Increasing the rate of neutron absorption for the SLC system would allow faster reactor shutdown during ATWS events. For certain ATWS scenarios, steam produced in the reactor is discharged into the containment. Thus, faster shutdown of the reactor would reduce potential containment stress by reducing the amount of steam released to it. The Task Force determined that upgrading the SLC is a major and expensive modification. But the panel observed that Vermont Yankee has already implemented a design change as suggested by the Containment Safety Study and as required by the NRC's "ATWS Rule" (10 CFR 50.62) The change, implemented during the Vernon plant's 1987 refueling outage, involved doubling the number of neutron-absorbing boron atoms in the SLC injection solution. This will produce a reactor shutdown about twice as fast as the previous SLC system. The Task Force concluded no further action was necessary under this recommendation. Vermont Yankee management concurs that this recommendation is closed.

CHAPTER THIRTY-ONE

TRAINING TO REFILL THE CONDENSATE STORAGE TANK IN STATION BLACKOUT

(References: Containment Safety Study, p. 83, 4.5.2, p. 143, 5.6.5.3.1d, Appendix C, p. C-6; Draft SACI/BWROG, p. 46)

This recommendation from both the Vermont Yankee Containment Safety Study and the Boiling Water Reactor Owners Group proposed to provide procedural guidance to plant personnel on the various methods to refill the condensate storage tank (CST) should it be required during a station blackout.

In a station blackout scenario, no AC electric power would be available to supply power to the electric motor-driven pumps. In this event, the only emergency pumps that would be available to maintain core cooling would be the steam-driven pumps (i.e., either the high pressure coolant injection system [HPCI] or the reactor core isolation cooling system [RCIC]). These pumps do not rely on AC power but rather use power from the Vernon plant's station batteries (i.e., DC power) and steam from the reactor to perform their function. These pumps can draw water from the containment's suppression pool (torus) or from the 500,000-gallon condensate storage tank (CST). If water is drawn from the primary containment, it will be recirculated from the torus to the reactor and then back to the torus. The path from the CST, however, will allow the system to supply additional water inventory to that which may already be in the primary containment. There is no system that will automatically refill the CST once its 500,000 gallons are drained.

The Vermont Yankee Task Force determined that, in principle, there are always certain advantages to having procedures in place which outline actions that have been thoroughly reviewed prior to possible execution. On the other hand, the Task Force concluded that the effort to refill the condensate storage tank is a relatively trivial task. The Task Force noted there are a multitude of methods to provide water to the tank, involving simple actions. The Task Force concluded there is little to be gained in either creating procedures or training personnel in such methods. Finally, the Task Force saw that refilling the CST would not have to be done until several hours after station blackout occurred. During such emergencies, the Technical Support Center would be activated and be able to provide any needed instructions to go about refilling the tank. The Task Force concluded, therefore, that no action was required regarding this proposal. Vermont Yankee management agreed with this conclusion.

CHAPTER THIRTY-TWO

READILY ACQUIRING PORTABLE ELECTRIC GENERATORS

(Reference: ASTA, IV.C.3)

The ASTA study recommended that Vermont Yankee create a list of companies that could supply large portable electric generators on short notice. The Vermont Yankee Containment Safety Study identified the importance of restoring station AC electrical power following a station blackout. If AC power can be restored before the core begins to melt, sequences of events leading to containment failure can be terminated with no adverse consequences to the public. The restoration of AC power increases in importance as a station blackout sequence progresses. As the accident event lengthens, the plant's batteries begin to run down and the core cooling systems are threatened. Under these circumstances (assuming that off-site power can not be restored and the emergency diesel generators can not be operated) alternative AC power must be sought.

The intent of this recommendation was that an up-to-date vendor list should be developed which would allow quick acess to emergency power sources which would expedite the restoration of AC power. The Task Force determined that such a list would only be useful if it were current. Company resources would be needed to perform this effort and it would be of low probability that it would be used.

The Task Force concluded that there were already several ways Vermont Yankee had developed to quickly obtain a variety of emergency equipment. Federal agencies could not only supply the needed equipment but could also quickly deliver it. Commercial suppliers were identified through computer networks tied into Vermont Yankee's Purchasing Department which provide ready access to up-to-date vendor and inventory lists. The Purchasing Department is already part of Vermont Yankee Emergency Organization and is ready to acquire needed equipment at a moment's notice. A senior member of the Purchasing Department is stationed in the Recovery Center with an adjacent computer terminal and telephones to expeditiously procure emergency material, services and equipment. The Task Force, therefore, considered this recommendation accomplished and management concurred.

CHAPTER THIRTY-THREE

MAXIMIZING SERVICE WATER AVAILABILITY

(Reference: Containment Safety Study,
p. 85, 4.5.6, p. 180, 6.2(3))

The Task Force looked at the recommendation from the Containment Safety Study to review the capabilities of the service water system to ensure it is available for operation as long as possible following severe accidents.

The service water system has an important function during all modes of plant operation. It acts as the ultimate "heat sink" (or absorber) for all cooling services required by plant equipment. One of its important safety functions is to cool both emergency diesel generators. The diesel generators could not operate for very long without cooling water supplied from the service water system. If Vermont Yankee should lose all off-site AC power, both diesel generators would automatically start and supply all the power needed to shut down the plant safely. One of the important systems the diesels would supply electricity to would be the service water system.

The Task Force concurred that Vermont Yankee should use every measure to keep the service water system available during all modes of operation to maintain the plant in a safe condition. The Task Force agreed that having procedures which prescribe shedding non-essential loads following accidents will ensure that vital plant safety systems will be cooled. The Task Force concluded, however, that Vermont Yankee already has sufficient design features, operating procedures and operator training to accomplish the intent of the recommendation. Therefore, the Task Force said, no further action or additions are required. Vermont Yankee management concurred that this recommendation was sufficiently addressed and can be closed out.

CHAPTER THIRTY-FOUR

COPING WITHOUT THE START-UP TRANSFORMERS

(References: ASTA, IV.C.1., p.6; Containment Safety Study Appendix D, p. D-16, 2.4; SACI/BWROG, p. 46)

This recommendation is made to help reduce the time that the Vernon plant would be without electrical power. The recommendation is to create a procedure for "backfeeding" electrical power through the plant's MAIN transformer (including removing the main generator) when the start-up transformers are not functioning. This procedure would give plant personnel guidance on supplying a source of electrical power for the Vernon plant, especially during emergencies.

The Vermont Yankee plant not only provides power to the New England Power Grid but also to the plant itself. Each of the main power lines leaving Vermont Yankee to the New England network can be two-way streets (i.e., as soon as the Vernon plant stops sending power to the Grid over these lines, power can immediately be reversed and sent into Vermont Yankee from the network). Vermont Yankee's two start-up tansformers are the means by which power comes into the plant from off-site sources. If both transformers are out of service, an alternate path must be sought. The recommendation in question proposes that Vermont Yankee develop a procedure to "backfeed" both essential and non-essential plant loads through the main transformer to the auxiliary transformer. This task has been performed in the past, but only during refueling outages.

The advantages to the proposal, as analyzed by the Containment Task Force, are: provides a means to minimize the time off-site power is lost when the start-up transformers are out of service; provides written guidance to set up alternate means of supplying power for essential plant loads (especially during an emergency); and, protects plant personnel from electrical injury and/or plant equipment from damage by using a formal procedure. These advantages, according to the panel, outweighed any disadvantage. The Task Force concluded that the formal plant procedure in which resolved this recommendation was issued at Vermont Yankee last year. No further action is required and Vermont Yankee management concurs.

CHAPTER THIRTY-FIVE

INTERSERVICE AGREEMENT WITH THE NEW ENGLAND POWER SYSTEM

(Reference: ASTA, IV.C.3, p. 6)

One ASTA recommendation was to reevaluate and reconfirm service agreements with the Vernon hydroelectric station and the New England Power System with regard to station blackout scenarios.

The Vermont Yankee Containment Safety Study demonstrated that the Vernon hydroelectric station is a major additional safety factor that is essentially unique among nuclear plants. It is a back-up source of power to Vermont Yankee of very high reliabiity. The 10-unit hydrostation is located less than a mile from Vermont Yankee. A dedicated, normally energized line between the hydro plant and Vermont Yankee, can be connected directly to either of Vermont Yankee's emergency electrical busses by remote operation of circuit breakers from the control room. The capacity of the hydro plant is sufficient to meet emergency needs on either of the two busses. These busses supply power to large pumps which are important because they provide additional water to the reactor vessel, spray water to the drywell and torus, and provide residual heat removal from the torus or the reactor vessel.

In studies to determine how to mitigate a severe accident, several recommendations were made to address the survivability, maintenance and procedural use of the Vernon tie line. While these recommendations have been discussed elsewhere, see Chapters 17 and 3, their implementation is of less value if the hydrostation does not recognize the priority that should be given to Vermont Yankee during a scenario in which it loses all AC electrical power. The ASTA study recommended that interservice agreements be confirmed between Vermont Yankee and the owners and operators of the Vernon hydroelectric station.

An advantage to such agreements would be to ensure that any available power is supplied to the Vermont Yankee plant for coping with severe accidents. It is possible that an inexperienced operator at the hydro plant would fail to give Vermont Yankee top priority if there were major problems in the high voltage distribution system.

The Task Force came to the conclusion that during a severe accident, even without a formal contract, the hydro plant would give Vermont Yankee priority service. At present the need for emergency power to Vermont Yankee is clearly understood by the operators of the hydro plant and it is "informally agreed" that Vermont Yankee will receive priority service, but a formal agreement should be established. Negotiations are currently underway on such an agreement which is scheduled for completion by September 1, 1988. Management concurs that this item is closed out.

CHAPTER THIRTY-SIX

TRAINING TO PRESERVE STATION BATTERY LIFE AFTER SEVERE ACCIDENTS

(Reference: ASTA, IV.C.5)

The ASTA recommendation was for additional operator and maintenance personnel training with regard to extending the 125 VDC battery usable life during blackout conditions.

Station blackout is the loss of all AC power to both the essential and non-essential busses. Because many safety systems rely on AC power, an extended loss of AC power contributes to the potential of containment failure. For station blackout scenarios, the only electrical power sources considered available are those from batteries. Preservation of batteries, therefore, through load shedding and/or sharing becomes in these circumstances an extremely high priority. This was addressed as procedure changes in Chapter 4. Also equally important is to maintain the batteries to prevent damage during discharge and subsequent recharging from temporary AC sources.

In recognition of the importance of station batteries during severe accidents, changes to emergency operating procedures at Vermont Yankee were made to give additonal guidance to plant personnel in methods for extending the capability of DC power systems. The procedure changes were created by studying plant responses, determining the systems required for continued plant safety, identifying battery capacities, and developing a method to minimize and balance DC loads quickly to ensure the extended availability of needed systems. A recommendation resulting from the development and review of the procedure change was to provide additional training to plant operators; also a recommendation was made to instruct plant maintenance personnel on an understanding of battery cell monitoring, "jumpering" out of bad cells and the danger of battery cell polarity reversal.

The Task Force reviewed the training given to operators on the revised emergency procedures and concluded that instruction was initially provided in late 1986. Refresher training is routinely provided through the continuing program for operator qualification. The Task Force also noted that battery usage and care, as it applies to maintenance personnel, is well within the scope of work routinely performed. The Task Force determined, therefore, that procedures and training are in place and that no further action on this recommendation is required. Vermont Yankee management concurs with this conclusion and considers this recommendation closed out.

CHAPTER THIRTY-SEVEN

GAS SUPPLY TO THE SAFETY RELIEF VALVES

(References: Containment Safety Study, p. 85, 4.5.5.
p. 149, 5.7.3(3), P. 180, 6.2(2);
Draft NUREG-1150, Appendix E, M1)

This recommendation is to increase the ability of the relief valves to operate with a more reliable pneumatic gas supply system. Vermont Yankee uses a single, compressed-gas "header" to supply the gas required to operate the reactor's safety relief valves. Safety-related accumulators (i.e., storage units) are inside the containment to provide short-term gas supplies, another storage system (Cryogenic System), outside the containment, is for long-term supplies. Although these two independent systems can each supply enough gas to operate the safety relief valves, a recommendation was made to increase assurance that these systems would work even with a header break or leak, and that the Cryogenic supply source would be available in a loss-of-power accident (causing isolation of the nitrogen supply system).

Under accident conditions where high pressure cooling systems are not available, the safety relief valves are used to depressurize the reactor vessel. With a lower pressure in the rector vessel, low pressure cooling systems can be used. The safety relief valves use compressed gas to operate. Since there are four safety relief valves, a single header into the primary containment is used to supply them with compressed nitrogen gas. Included as an extra safety feature on the gas supply lines is an accumulator and a "check" valve. This arrangement provides additional gas in case of a break or leak in the gas supply header. Although this arrangement serves as a back up gas supply, its operation is generally categorized as "short term." To broaden the availability of the system, the Vermont Yankee Containment Safety Study considered the possibility of a back-up supply header for long term use. The Task Force determined that long-term availability could also be achieved by increasing the size of the accumulators. The Task Force determined that an additional header required another primary containment "penetration." An additional header would also be useless if the supply line failed. Other disadvantages include a significantly higher cost as well as increased radiation exposure to workers to install the back-up header. It was further determined that nitrogen is available from the bulk supply tank through manual operator actions. This has already been implemented in a procedure.

The Vermont Yankee Containment Task Force recommended that a conceptual design and cost estimate be pursued for increasing the accumulator size. This should be completed for consideration during the 1989 budget process. Vermont Yankee management concurs with this recommendation and will implement this enhancement to containment safety during the 1990 refueling outage.