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

ACTION

HELTEMES

MEMORANDUM FOR: Edward L. Jordan, Chairman
Committee to Review Generic Requirements

FROM: Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

SUBJECT: CRGR REVIEW OF SUPPLEMENT 2 TO GENERIC LETTER 88-20, INDIVIDUAL PLANT EXAMINATIONS

The staff has completed its recommendations from the Containment Performance Improvement (CPI) Program for BWR plants with Mark II and Mark III containments and PWR plants with ice condenser and dry containments. The purpose of this memorandum is to request CRGR review of these recommendations included in the attached proposed Commission paper.

By way of background, Generic Letter No. 88-20 was issued on November 23, 1988 which requested that all licensees perform an Individual Plant Examination (IPE) for their plant(s). This letter indicated that licensees should not make major changes to plant containment systems as a result of the IPE until the findings of the CPI Program were available and could be considered in the IPE. On August 29, 1989, Supplement 1 to Generic Letter No. 88-20 was issued which announced the availability of NUREG-1335, "Individual Plant Examination: Submittal Guidance," and formally started the IPE process. This supplement also contained, per Commission direction, recommendations from the Mark I CPI Program to be considered by licensees with Mark I containments as part of their IPEs.

The staff has now completed recommendations from the CPI Program for the other containment types. The staff has not found any containment improvements that would be recommended on a generic basis. However, several potential improvements were found that the staff believes warrant further consideration on a plant-specific basis as part of the IPE. The staff will recommend to the Commission that the list of these potential improvements be forwarded to licensees in a supplement to the IPE Generic Letter for consideration during the IPE process. This recommendation is consistent with Commission direction for the recommended Mark I improvements.

Detailed technical information and insights have also resulted from the CPI Program which may be useful to licensees during the conduct of their IPE and as part of the Accident Management Program. This information will be included in technical reports to be prepared over the next few months which should be available with the actual issuance of the supplement to Generic Letter 88-20. It is important to notify licensees, many of which have already started their IPEs, of these findings in a timely manner so that they can be considered as part of the IPE process.

The staff has previously prepared and provided a burden analysis in accordance with 10 CFR 50.54(f) for the original generic letter (Ltr. V. Stello to the Commissioners, "SECY-88-205 Generic Letter for the Implementation of the Severe Accident Policy Statement," dated 9/20/88). The staff also responded to Section IV.B of the CRGR charter (Ltr. B. Sheron to E. Jordan, "Supplementary Information for the CRGR Review of the Generic Letter for the Initiation of the Severe Accident Policy Statement," dated April 15, 1988).

In accordance with CRGR operating procedures, we are enclosing 15 copies of the proposed Commission paper with the proposed Generic Letter No. 88-20 supplement. Completion of the CRGR review is requested by January 24, 1990. For further information on this subject, please contact William Beckner (2-3975) of my staff.

Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

Enclosure: Proposed Commission Paper

For: The Commissioners

From: James M. Taylor
Executive Director for Operations

Subject: RECOMMENDATIONS OF CONTAINMENT PERFORMANCE IMPROVEMENT PROGRAM FOR PLANTS WITH MARK II, MARK III, ICE CONDENSER, AND DRY CONTAINMENTS

Purpose: To present staff recommendations and plans for the Containment Performance Improvement (CPI) program for plants with Mark II, Mark III, ice condenser, and dry containments.

Summary: The Containment Performance Improvement (CPI) program is one of the main elements of the integrated approach to closure of severe accident issues. It was assumed in the integration plan, SECY-88-147, that the CPI program could be completed before utilities complete their Individual Plant Examinations (IPEs) so that the results of the CPI program could be incorporated into the IPEs. The staff has already presented its recommendations with regard to BWR Mark I containments and is currently implementing these recommendations consistent with Commission direction. This paper presents staff recommendations and plans for the BWR Mark II and Mark III containment types and the PWR ice condenser and dry containment types.

The technical work has progressed to the point that major conclusions and recommendations can be made at this time. It is essential that these major conclusions be provided to licensees at an early date so that they can be considered in the IPEs which are currently in progress. Remaining work still to be completed involves documentation of detailed findings supporting the major conclusions and insights that

Contact: William Beckner, RES
492-3975

may be useful to licensees in performing the IPEs and to staff during the reviews of the IPEs.

The staff has found no improvements for these containment types that would warrant generic implementation for all containments of a given type. However, a number of insights and potential improvements have been identified that the staff recommends be explicitly considered in a plant-specific manner as part of the IPE process. In addition, detailed technical information and insights have been developed that may be useful to licensees during the IPE process and the upcoming accident management program.

The staff recommends that information on insights and potential improvements be forwarded to all licensees as a supplement to the IPE generic letter. In addition, the staff recommends that the technical details in support of the major conclusions and insights which will also be documented in upcoming technical reports be made available to licensees as background information for their IPE and accident management programs. These reports should be completed in the same time frame as the issuance of this supplement to the IPE Generic Letter 88-20.

Background: The Containment Performance Improvement (CPI) program is one of the main elements of the integrated approach to closure of severe accident issues, as indicated in the staff's "Integration Plan for Closure of Severe Accident Issues" (SECY-88-147). Other main elements include (1) the Individual Plant Examination (IPE) effort, (2) improved plant operations, (3) the severe accident research program, (4) examination of external events, and (5) a program on accident management. The CPI effort is based on the premise that there may be generic severe accident challenges to each containment type that should be assessed to determine whether additional regulatory guidance or requirements are warranted. In contrast, the purpose of the IPE program is to identify vulnerabilities that are unique to plants (e.g., system capacities and dimensions, valve alignments, and procedures) and that would not be found unless each plant were individually examined. It was also assumed in the integration plan that the CPI program could be completed before utilities complete their IPEs so that the results of the CPI program could be incorporated into the IPEs.

The staff has presented its recommendations with regard to BWR Mark I containments in SECY-89-017. The staff is proceeding to implement the hardened vent for Mark I plants as directed by the Commission. Other improvements recommended in SECY-89-017 have been forwarded to Mark I licensees in Supplement 1 to Generic Letter 88-20 dated August 29, 1989 to be considered as part of the IPE as directed by the Commission.

This paper contains the staff plans and recommendations for the BWR Mark II and Mark III containment types and the PWR ice condenser and dry containment types.

Discussion: The staff has made use of the latest results from the NUREG-1150 program, other available PRAs, and research being performed under the accident management program and elsewhere to identify significant containment challenges and to evaluate potential improvements. The findings of the CPI program discussed below do not represent major new information, but are rather a compilation and evaluation of a significant number of PRAs and severe accident research performed over the last few years. Enclosure 1 is a bibliography of major reports reviewed by the CPI program. While the focus of the CPI program has been on containment performance and accident mitigation, as with the Mark I CPI program, insights have also been obtained in the areas of accident prevention and accident management.

Specific vulnerabilities and improvements have been evaluated to determine if they are generically applicable, if they should undergo further investigation in the plant-specific IPE program or if they are not worthwhile. This approach is consistent with Commission direction concerning the Mark I improvements. The staff has not identified any recommended generic improvements that would be applicable to all containments of a given type. However, a number of insights and potential improvements have been identified that the staff recommends be explicitly considered in a plant-specific manner as part of the IPE process. In addition, detailed technical information and insights have been developed that may be useful to licensees during the IPE process and the upcoming accident management program.

The staff recommends that information on insights and potential improvements be forwarded to all licensees as a supplement to the IPE generic letter. In addition, the staff recommends that the technical details in support of the major conclusions and insights which will also be documented in upcoming technical reports be made available to licensees as background information for their IPE and accident management programs. These reports should be completed in the same time frame as the issuance of the supplement to the IPE generic letter.

BWR Mark II Containments

There are nine BWRs with Mark II containments located at six sites. Figure 1 shows the general arrangement of a Mark II containment. The geometry of the reactor pedestal support and downcomer location has a major impact on the performance of the containment if the reactor vessel fails in a severe accident. Three major variations exist, as shown in Figure 2. No Mark II plant was reviewed in the NUREG-1150 studies. However, five PRAs of varying detail, including the ongoing NRC LaSalle study, have been performed for BWRs with Mark II containments.

Based on PRA insights, Mark II containment vulnerabilities and potential improvements that have been investigated are similar to those investigated for the Mark I containments. Mark I improvements, other than the hardened vent which are contained in the supplement to the IPE generic letter, are being investigated under the IPE for Mark I plants. It is appropriate that Mark II licensees also investigate these same improvements on a plant-specific basis under the IPE since they may also be generally applicable to these plants. However, less definitive conclusions have been reached regarding the need for improved venting of Mark II containments. The primary benefit from venting remains the same for Mark II plants as for Mark I plants (i.e., the prevention of core melt for loss of decay heat removal (TW) sequences). However, some additional considerations come into play for Mark II plants. Some Mark II plants may already have the capability to vent through a hardened pipe. In addition, due to the larger volume of Mark II containments, the time available for operator recovery actions during a TW sequence may be longer. Thus the likelihood that venting will be required is expected to be less in a Mark II plant compared with a plant with a Mark I containment. Because of these reasons, the risk reduction to be gained from improvements to the vent system for Mark II plants is expected to be less than for Mark I plants.

For less probable cases in which venting is initiated after core melt has occurred, the incremental benefit of scrubbing of fission products by the suppression pool during venting at a Mark II cannot be assured to the same degree as in Mark I plants. This is because molten core material on the floor of the Mark II containment may fail downcomers or drain lines and result in suppression pool bypass. Therefore, the net benefits of venting may be less for plants with Mark II containments.

Because of the varying hardware and procedures at Mark II plants and the apparent reduced benefits of venting in Mark II plants compared to Mark I plants, the staff recommends that venting be evaluated as part of the IPE process for each Mark II plant using plant-specific hardware and procedures in order to determine how best to maximize the benefit from venting and minimize potential downsides. In addition the staff also recommends investigation of other potential means of improving the reliability of suppression pool cooling systems as an alternate to venting.

BWR Mark III Containments

There are four operating BWRs with Mark III containments located at four sites. The Mark III containment is approximately five times the volume of the Mark I containment and 65% to 85% of the volume of a large dry PWR containment. The containment design pressure is 15 psig (25% of a Mark I, 30% of a large dry). Unlike Mark I and II containments, the Mark III containment is not inerted and has igniters for hydrogen control. Figure 3 shows the general arrangement of a Mark III containment. The only PRA performed on a BWR with a Mark III containment is for Grand Gulf as part of the NUREG-1150 studies.

The low core melt frequency (on the order of 10^{-6}) estimated by the NUREG-1150 studies is primarily due to the fact that Grand Gulf is a modern BWR design with a diversity of ways to provide water to the core. Thus, Grand Gulf uses a motor driven High Pressure Core Spray with a dedicated diesel generator which improves the reliability of this system for mitigation of transients and small LOCA events. In addition, Grand Gulf has a number of low pressure coolant injection systems. Thus, Grand Gulf already has a number of diverse systems such as those studied for other BWR plants (e.g. diverse alternative supplies of water to the reactor vessel). At least one such system (fire water connection) was implemented by the licensee as a direct result of the NUREG-1150 (first draft) studies.

Based on PRA insights, potential plant improvements that have been investigated are again similar to those investigated for Mark I plants and thus should also be investigated on a plant-specific basis as part of the IPE for Mark III plants. Because of the relatively large volume of the Mark III containment, the need for venting is believed to be less likely than for either the Mark I or Mark II containments. In addition, some Mark III plants may already have the capability to vent through a hardened system. Thus improvements to the vent system have not been recommended on a generic basis for Mark III containments because of less potential for risk reduction relative to Mark I or Mark II plants, but could be considered as part of the IPE. The major additional potential improvement considered for Mark III containments is the result of the fact that Mark III plants make use of igniters to control hydrogen following a severe accident. A potential vulnerability for Mark III plants involves station blackout, during which the igniters would be inoperable. Under these conditions, a detonable mixture of hydrogen could develop which could be ignited upon restoration of power. Thus the staff recommends that the benefit of backup power to the hydrogen igniters be evaluated on a plant-specific basis as part of the IPE.

PWR Ice Condenser Containments

There are ten reactors with ice condenser containments located at five sites (one still under construction and one deferred). The ice condenser containment houses a four-loop Westinghouse PWR, is typically about 1.2 million cubic feet in volume, and has a design pressure of 12-15 psig (see Figure 4). The second draft NUREG-1150 provides the most up-to-date insights into the important contributors to core damage and containment challenges facing the ice condenser plant. In using these results care must be taken, however, to ensure that they are representative of the other ice condenser containment plants. For instance, the loss of offsite power initiating event frequency is lower for Sequoyah than for other ice condenser plants because of the offsite grid reliability. Also, because of design differences, significant variation has been reported in calculations of the ultimate failure capability of the containments. Estimates have ranged from 60 psig for Sequoyah to 120 psig for Watts Bar.

The Sequoyah risk analysis indicates that containment bypass sequences dominate early fatality risk. Timing is a key factor in these sequences as is lack of any mitigating systems to scrub the release. The CPI program will not address this area further because there is a joint NRR/RES program on interfacing system LOCAs currently under way which is developing guidance and possible additional requirements for interfacing system LOCAs including those that could bypass the containment.

Direct containment heating (DCH) is a phenomenon that has a great deal of uncertainty associated with it. Risk assessments have varied considerably in their characterizations of its contribution to containment failure by overpressurization. Because of this uncertainty, research is being performed under the Severe Accident Research Program to reduce the uncertainty in risk due to DCH. In addition, the staff is investigating, as part of the accident management program, possible means to prevent or decrease the severity of DCH events. The principal strategy being investigated is that of full or partial depressurization of the reactor coolant system. The CPI program has made use of the ongoing accident management work on depressurization and evaluated the impact of depressurization on the ice condenser containment. An important finding is that depressurization to prevent DCH for ice condenser plants is not sufficient to prevent containment failure unless some means is also present to control the large amount of hydrogen that may be produced.

Containment failure resulting from uncontrolled hydrogen burns or detonations is a potentially important failure mode for ice condenser containments. This could occur in station blackout events if power to the hydrogen igniter system is lost, high concentrations of hydrogen are produced as a result of core degradation, and power is then restored at a later time. Therefore, the staff recommends that backup power provisions for the hydrogen igniters be investigated further as part of the IPE for ice condenser plants.

Other potential improvements for ice condenser containments include a number of procedural changes, in addition to depressurization, that should be considered under the accident management program.

PWR Dry Containments

There are 63 PWR plants with large dry containments located at 40 sites in the U. S. There are also seven PWR plants located at four sites that use subatmospheric containments. The containment volume and design pressure of a large dry containment are typically about 2.5 million cubic feet and 60 psig, respectively. The containment volume and the design pressure of a subatmospheric containment are about two-thirds of those of a large dry containment. Figure 5 shows the general arrangement of a large dry containment.

The second draft of NUREG-1150 indicates that, given a core melt, the conditional probability of early containment failure for a large dry containment is low. For the Surry plant, containment bypass was found to be the dominant contributor to risk. However, this area was not investigated further because of other, ongoing activities in this area. DCH was not important for the dry containments studied in the second draft of NUREG-1150. However, as noted previously, this is an area of large uncertainty and the importance of DCH to risk may vary for plants with dry containments other than those studied under NUREG-1150. Research is ongoing to reduce this uncertainty in risk due to DCH and depressurization to avoid DCH is being investigated as part of the accident management program.

Hydrogen combustion on a global basis is not believed to be a significant threat to large dry containments. However, less firm conclusions have been reached for the smaller subatmospheric containments. It may also be possible for detonable mixtures of hydrogen to build up in localized compartments of both types of dry containments and damage equipment. Hydrogen control for dry containments is being investigated as part of the accident management research program. In addition, the staff recommends that owners of dry containments examine locations of possible hydrogen evolution and evaluate the potential for damage to important equipment due to localized detonations as part of the IPE program.

Future Staff Actions:

Work is continuing under the CPI program to document the detailed findings and to conduct additional confirmatory research. These activities are expected to be completed in mid FY-1990 and will serve as insight and reference material that can be used by licensees in the conduct of their IPEs. Major conclusions discussed above are not expected to change, however, as a result of this effort.

Recommendations: It is recommended that the Commission approve issuance of the supplement to the IPE generic letter (Enclosure 7) which requests licensees to explicitly evaluate specific containment challenges and potential improvements discussed above as part of their IPEs. In addition, this generic letter will also reference the availability of technical reports from the CPI program that may be of use as additional insight as well as reference material for the conduct of the IPE.

Coordination: RES and NRR concur with these recommendations. OGC has no legal objections. The ACRS has reviewed these recommendations and will provide comments separately.

James M. Taylor
Executive Director
for Operations

Enclosures: See next page

Enclosures:
1. Table 1, Bibliography of Major Reports Reviewed by the CPI Program
2. Figure 1, General Arrangement of Mark II Containment
3. Figure 2, Mark II Containment Reactor Pedestal Variations
4. Figure 3, General Arrangement of Mark III Containment
5. Figure 4, General Arrangement of Ice Condenser Containment
6. Figure 5, General Arrangement of Large Dry Containment
7. Draft Supplement to Generic Letter No. 88-20

Table 1
Bibliography of Major Reports Reviewed by the CPI Program

BWR MARK II AND III CPI PROGRAM

1. "Primary Containment Response for Unmitigated Short-Term Station Blackout at Peach Bottom," letter report to Dr. Thomas J. Walker, dated November 28, 1988, NUREG/CR-5317 (to be published).

2. "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," NUREG-1150, Volume 1, Summary Report, Second Draft for Peer Review, USNRC, June 1989.

3. F.E. Haskin, et. al., "Development and Status of MELCOR," presented at the Fourteenth Water Reactor Safety Information Meeting, Gaithersburg, Maryland, October 1988.

4. G.W. Parker, L.J. Ott, and S.A. Hodge, "Small-Scale BWR Core Debris Eutectics Formation and Melting Experiment," Nuclear Engineering and Design (to be published) North-Holland Amsterdam.

5. C.A. Kukielka, S. Seyedhosseini, and M.P. Carr, "Feedwater Coast-Down Measurement of a BWR," Proceedings of the U.S. NRC Sixteenth Water Reactor Safety Information Meeting, Gaithersburg, Maryland, NUREG/CP-0097, Volume 6, February 1989.

6. L.G. Greimann, et. al., "Reliability Analysis of Steel Containment Strength," NUREG/CR-2442, Ames Laboratory, Iowa State University, June 1982.

7. "Limerick Generating Station Probabilistic Risk Assessment", Bechtel Power Corporation, September 1982.

8. "Shoreham Nuclear Power Station Probabilistic Risk Assessment", Stone and Webster Engineering Corp., 1982.

9. T.L. Bridges, "Containment Penetration Elastomer Seal Leak Rate Tests," NUREG/CR-4944, Idaho National Engineering Laboratory, July 1987.

10. D.A. Brinson and G.H. Graves, "Evaluation of Seals for Mechanical Penetrations of Containment Buildings," NUREG/CR-5096, ERC International, August 1988.

11. R.F. Kulak, et. al., "Structural Response of Large Penetrations and Closures for Containment Vessels Subjected to Loading Beyond Design Basis," NUREG/CR-4064, Argonne National Laboratory, February 1985.

12. D.B. Clauss, "Failure Mechanism of LWR Steel Containment Buildings Subject to Severe Accident Loadings," Proceedings of the Third Workshop on Containment Integrity, NUREG/CP-0076, August 1986.

13. M.L. Corradini, "Analysis and Modeling of Large-Scale Steam Explosion Experiments," Nuclear Science and Engineering, 82, 429-447, 1982.

14. M.L. Corradini, "Molten Fuel/Coolant Interactions: Recent Analysis of Experiments," Nuclear Science and Engineering, 86, 372-387, 1986.

15. R.E. Blose, et. al., "SWISS: Sustained Heated Metallic Melt/Concrete Interactions with Overlaying Water Pools," NUREG/CR-4727, Sandia National Laboratories, July 1987.

16. Z.T. Mendoza, et. al., "Containment and Phenomenological Event Tree Evaluation at Full Power for the Shoreham Nuclear Power Station," Science Applications International Corp., February 1988.

17. "MAAP Analysis to Support Shoreham 100% Power PRA," Fauske and Associates, Inc., February 1988, Revised March 1988.

18. Oak Ridge National Laboratory Monthly Reports and Letter Report Dated December 29, 1989.

19. "BWR Owner's Group Emergency Procedure Guidelines, Revision 4," NEDO-31331, General Electric Company, March 1987.

20. "Containment Performance Working Group," NUREG-1037, US NRC, May 1985.

21. "Estimates of Containment Loads from Core Melt Accidents," NUREG-1079, US NRC, December 1985.

22. A.M. Kolaczkowski and A.C. Payne, "Station Blackout Accident Analysis (Part of NRC Task Action Plan A-44)," NUREG/CR-3226, May 1985.

23. "Susquehanna Steam Electric Station Individual Plant Examination," NPE-86-001, Pennsylvania Power and Light Company, 1986.

24. "Limerick Generating Station, Units 1 and 2, Response to Request for Additional Information Regarding Consideration of Severe Accident Mitigation Design Alternatives," letter from Philadelphia Electric Company, June 23, 1989.

25. C.N. Amos, et. al., "Evaluation of Severe Accident Risks and the Potential for Risk Reduction: Grand Gulf, Unit 1," Draft NUREG/CR-4551, Volume 4, April 1987.

26. M.T. Drouin, et. al., "Analysis of Core Damage Frequency Grand Gulf Unit 1 Internal Events," NUREG/CR-4550, Volume 5, Revision 1, February 1989.

27. R.S. Denning, et. al., "Radionuclide Release Calculations for Selected Severe Accident Scenarios," NUREG/CR-4624, Volume 4, July 1986.

28. S.E. Dingman, et. al., "Melcor Analysis for Accident Progression Issues," NUREG/CR-5331 (to be published).

29. "Grand Gulf Nuclear Station - Integrated Containment Analysis," IDCOR-TR23.1GG, Mississippi Power and Light Company, March 1985.

30. A.L. Camp, et. al., "Light Water Reactor Hydrogen Manual," NUREG/CR-2726, August 1988.

ICE CONDENSER CPI PROGRAM

1. Hossein P. Nourbakhsh, "A Preliminary Assessment of Ice Condenser Containment Performance Issues", Draft BNL Report, November 1989.

2. William J. Galyean, "Selected Issues on Ice Condenser Containments", Informal INEL Report, September 1989.

3. NUREG-1150, "Severe Accident Risks: An Assessment for Five U. S. Nuclear Power Plants", Summary Report, Second draft for peer review, June 1989.

4. NUREG-4551, "Evaluation of Severe Accident Risks: Sequoyah Unit 1", Volume 5, Draft revision 1, to be published.

5. David C. Williams, "CONTAIN Calculations for DCH Scenarios in Sequoyah", SNL letter report to the NUREG-1150 Source Term Panel, April 1988.

6. David C. Williams, "CONTAIN Calculations for the Ice Condenser Parametrics Program: Potential for Mitigation of DCH Scenarios", SNL interim report, October 1988.

DRY CONTAINMENT CPI PROGRAM

1. Bozoki, G., et al., "Interfacing Systems LOCA: Pressurized Water Reactors," NUREG/CR-5102, BNL-NUREG-2135, Brookhaven National Laboratory, February 1989.

2. Chambers, R., et al., "Accident Management of Surry Direct Containment Heating by Depressurization of the Reactor Coolant System -- Progress Report," EGG-SSRE-7854, EG&G Idaho Inc., September 1987.

3. Ferrell, C. and Soffer, L., "Resolution of Unresolved Safety Issue A-48: Hydrogen Control Measures and Effects of Hydrogen Burns on Safety Equipment," NUREG-1370, September 1989.

4. Griesmeyer, J.M. and Smith, L.N., "A Reference Manual for the Event Progression Analysis Code (EVNTRE)," NUREG/CR-5174, SAND88-1607, September 1989.

5. Park, C.K., et al., "Evaluation of Severe Accident Risks: Zion Unit 1," NUREG/CR-4551, BNL/NUREG-52029, Vol. 7, Draft Revision 1, Brookhaven National Laboratory, July 1989.

6. Sherman, M.P. and Berman, M., "The Possibility of Local Detonations During Degraded-Core Accidents in the Bellefonte Nuclear Power Plant," NUREG/CR-4803, SAND86-1180, January 1987.

7. Sherman, M.P., Tiszen, S.R., and Benedick, W.B., "FLAME Facility-The Effect of Obstacles and Transverse Venting on Flame Acceleration and Transition to Detonation for Hydrogen-Air Mixtures at Large Scale," NUREG/CR-5275, SAND85-1264, April 1989.

8. Tutu, N.K. et al., "Estimation of Containment Pressure Loading Due to Direct Containment Heating for the Zion Plant," NUREG/CR-5282, BNL-NUREG-52181 (Draft Report), Brookhaven National Laboratory, June 1989.

9. USNRC, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Plants, Summary Report," NUREG-1150, Second Draft for Peer Review, June 1989.

10. Williams, D.C. and D.L.Y. Louie, "CONTAIN Analysis of Direct Containment Heating Events in the Surry Plant," Fourth Proceedings of Nuclear Thermal Hydraulics, p.87, American Nuclear Society, 1988.

11. Wong, C.C., "Hydrogen Production and Combustion-Induced Loadings of the Large-Dry and Subatmospheric PWR Containment," Letter Report to P. Worthington (NRC), Sandia National Laboratories, May 1986.

12. Yang, J.W., "Summary of PWR Dry Containment Issues," draft Brookhaven National Laboratory, May 1989.

13. Yang, J.W., "PWR Dry Containment Issue Characterization," draft Brookhaven National Laboratory, August 1989.

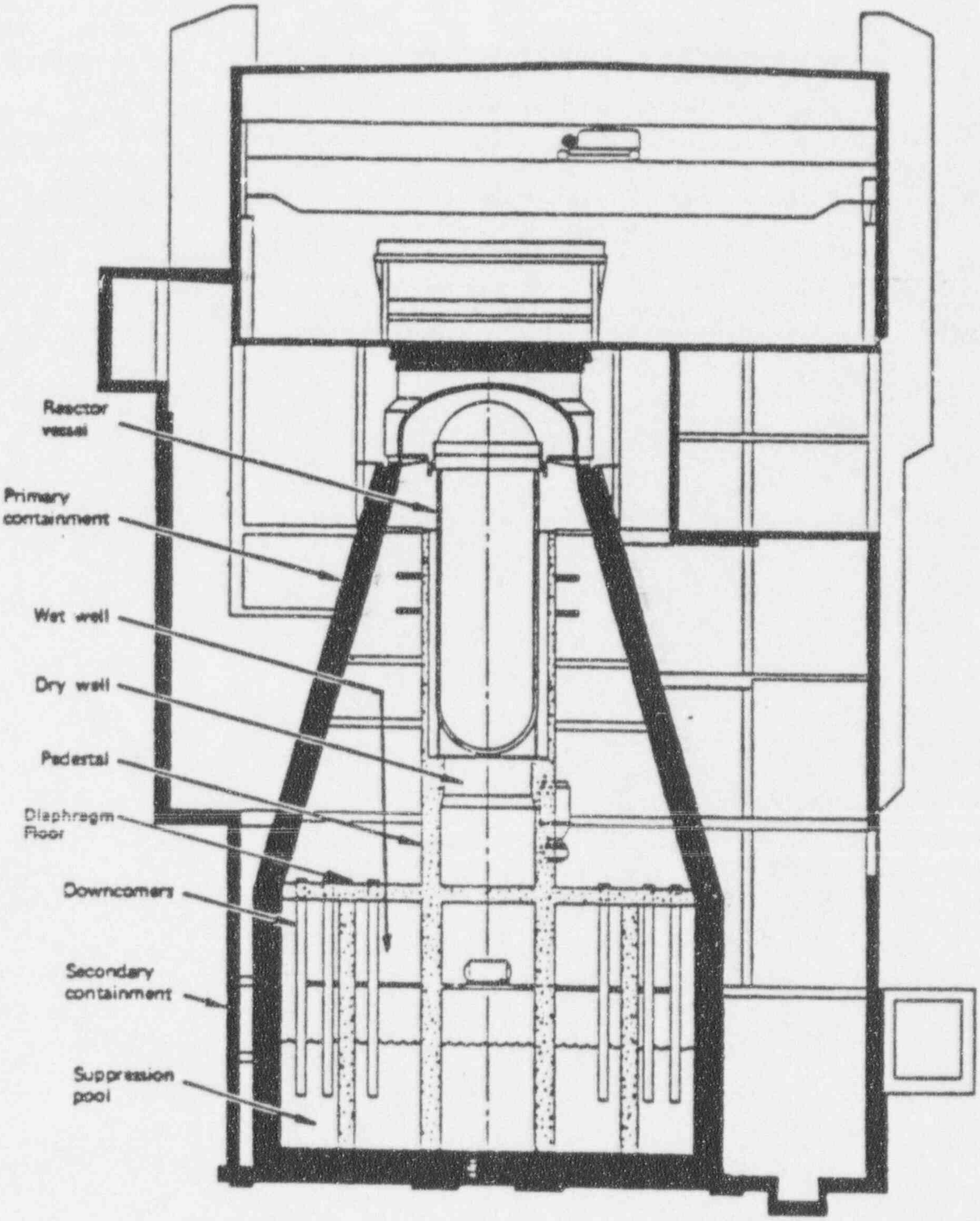
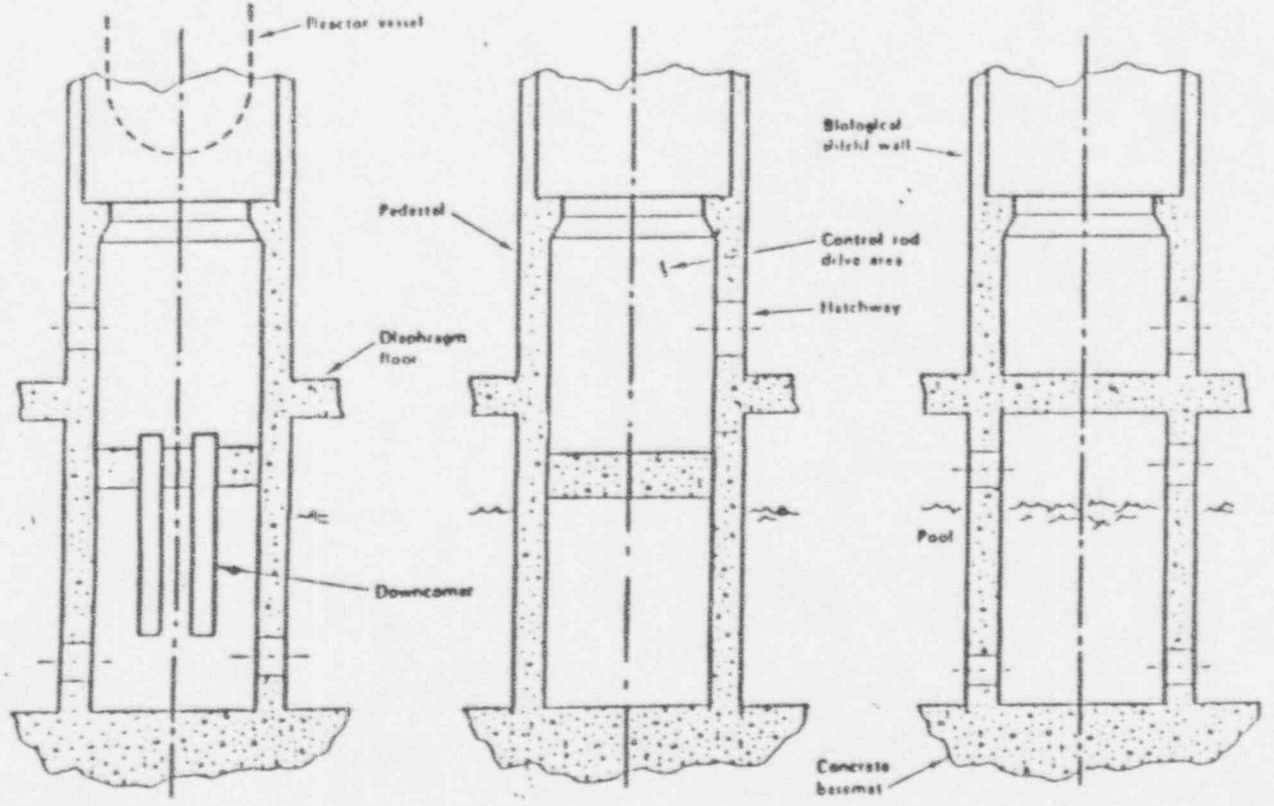


Figure 1. BWR Mark II containment.



Shoreham
Nine Mile Point 2

WNP-2
LaSalle 1/2

Limerick 1/2
Susquehanna 1/2

Figure 2 - Variations in the Mark II pedestal configuration

Enclosure 3

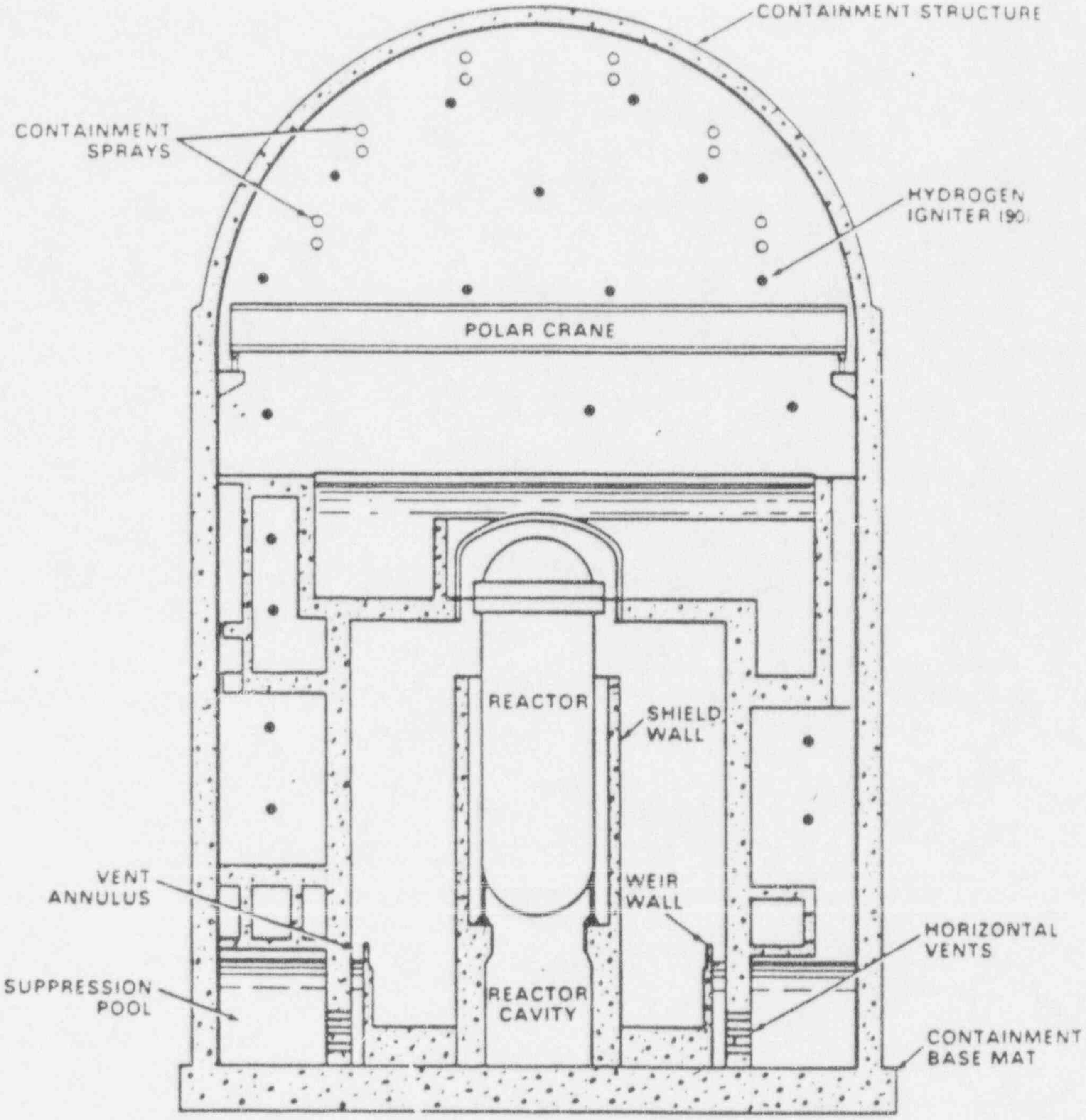


Figure 3 - Mark III Containment

(River Bend has neither Containment Sprays nor Vacuum Breakers)

LARGE DRY CONTAINMENT (ZION)

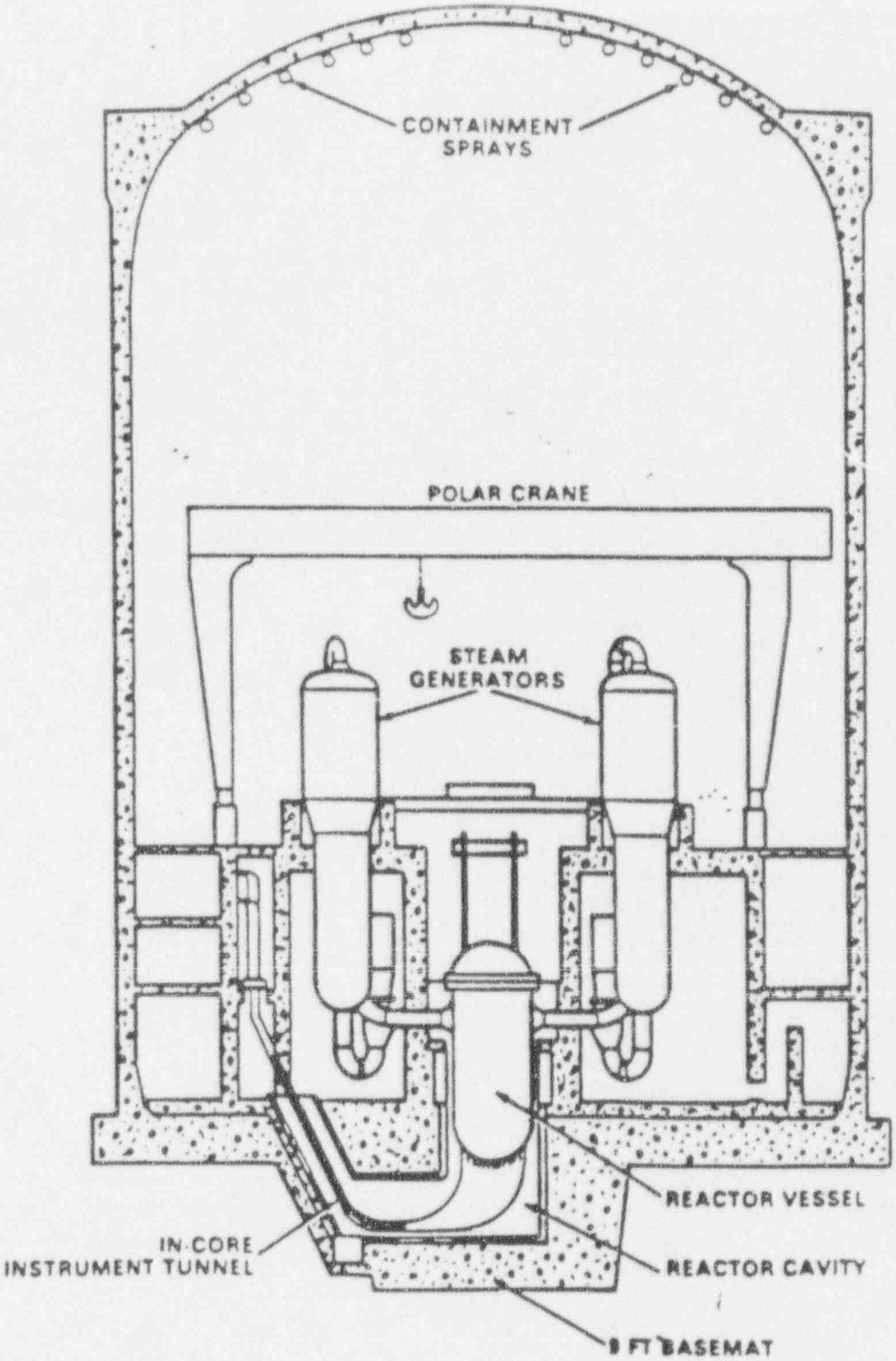


Figure 5 - Schematic of the containment design for the Zion plant.

ICE CONDENSER CONTAINMENT (SEQUOYAH)

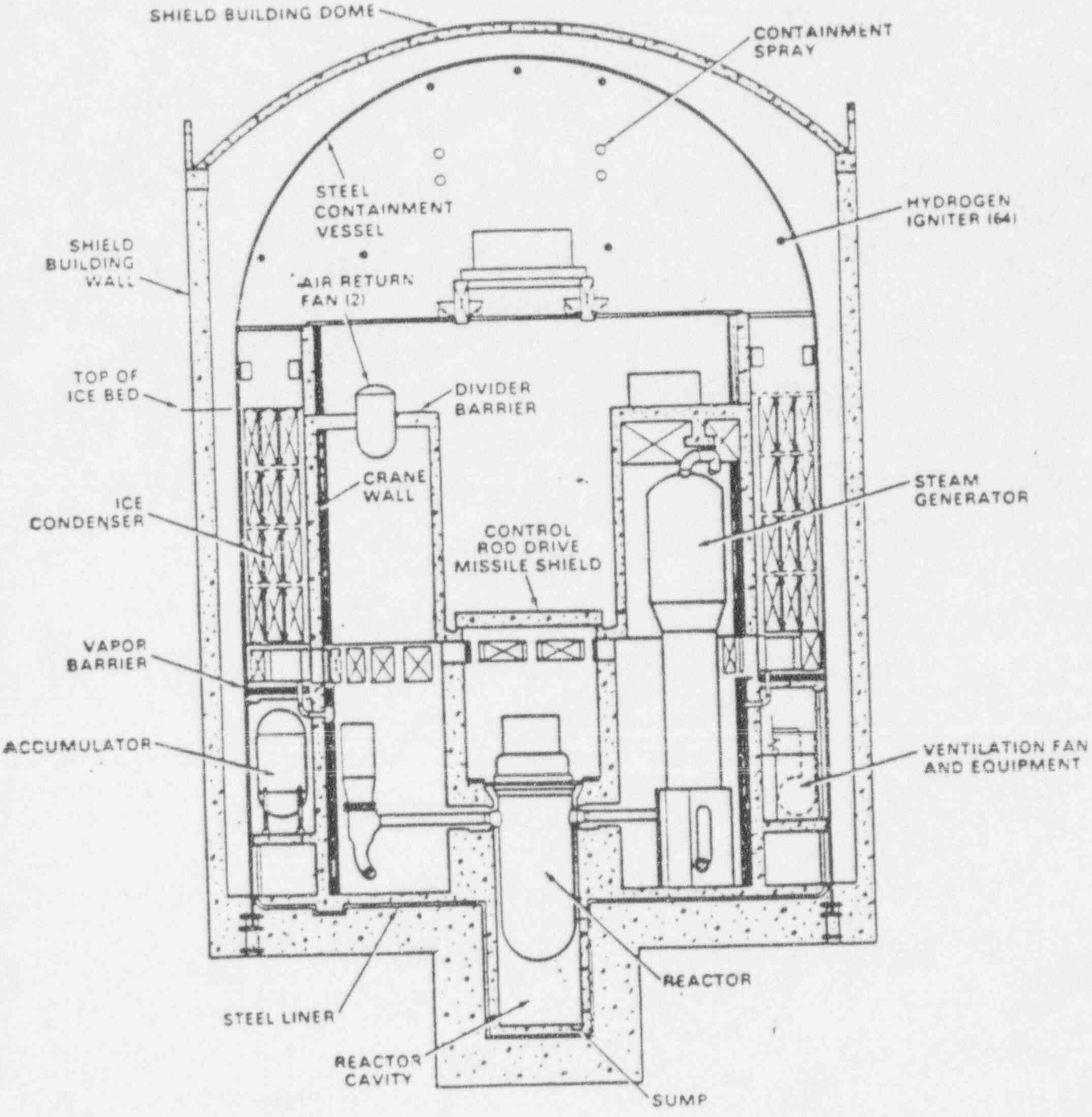


Figure 4 - Schematic of the containment design for the Sequoyah plant.

Enclosure 7
DRAFT

TO: ALL LICENSEES HOLDING OPERATING LICENSES AND CONSTRUCTION PERMITS FOR NUCLEAR POWER REACTOR FACILITIES

SUBJECT: CONSIDERATION OF CONTAINMENT PERFORMANCE IMPROVEMENT INSIGHTS IN THE INDIVIDUAL PLANT EXAMINATION FOR SEVERE ACCIDENT VULNERABILITIES - 10 CFR 50.54(f) - GENERIC LETTER NO. 88-20, SUPPLEMENT NO. 2

This letter announces the availability of NUREG-xxxx, "----------". This document contains technical information relative to containment performance issues for PWR containments and for BWR Mark II and Mark III containments. Similar technical information for BWR Mark I containments was discussed in SECY 89-017, "Mark I Containment Performance Improvement Program", dated January 23, 1989, and summarized in an enclosure to Generic Letter 88-20, Supplement 1, dated August 29, 1989. The technical information may be useful to licensees during their examinations of their plants for vulnerabilities to severe accidents.

Four specific insights are believed by the staff to be important enough so as to require special consideration by the licensees of the plant types to which they apply. These insights are briefly summarized below, and discussed more fully in NUREG-xxxx.

Venting of Mark II Containments

The primary benefit from venting of Mark II containments is the prevention of core melt for loss of decay heat removal (TW) sequences. This is the same benefit as for Mark I plants. Because the Mark II containment is of larger volume, the time available for operator recovery actions should be longer and the likelihood that venting would be required is believed to be lower. However, for less probable cases in which venting is initiated after core melt and subsequent vessel failure have occurred, the benefit of scrubbing of fission products can not be assured for Mark II containments to the same degree as in Mark I plants. This is because molten core materials on the floor of the containment may fail downcomers or drain lines and result in suppression pool bypass.

Because of varying hardware and procedures at Mark II plants and the apparent reduced benefits of venting in Mark II plants, licensees with Mark II containments should evaluate venting using plant-specific hardware and procedures as part of the IPE process. This evaluation should consider cost-effective means to reduce the potential negative aspects of venting and increase the potential benefit and should also include other means of improving reliability of suppression pool cooling as an alternative to venting.

In addition, the Mark I improvements contained in Supplement 1 to GL-88-20 dated August 29, 1989 may also be applicable to Mark II containments and should, therefore, be considered by licensees with Mark II containments as part of the IPE.

Backup Power for Igniters in Mark III Containments

A potential vulnerability for Mark III plants involves station blackout, during which the hydrogen igniters would be inoperable. Under these conditions, a detonable mixture of hydrogen could develop which would be ignited upon restoration of power. Licensees with Mark III containments should evaluate the cost-effectiveness of diverse backup power to the hydrogen igniters as part of the IPE. A backup power supply meeting the requirements for the Alternate AC option of the Station Blackout Rule would satisfy the intent of the diverse backup power.

In addition, the Mark I improvements contained in Supplement 1 to GL-88-20 dated August 29, 1989 may also be applicable to Mark III containments and should, therefore, be considered by licensees with Mark III containments as part of the IPE.

Backup Power for Igniters in PWR Ice Condenser Containments

The same situation could occur in ice condenser containments as in Mark III containments relative to hydrogen detonations following restoration of power. Therefore, licensees with ice condenser containments should evaluate the cost-effectiveness of diverse backup power (as defined above) to the hydrogen igniters as part of the IPE.

Potential for Detonation of Hydrogen in PWR Dry Containments

Depending on the degree of compartmentalization and the release point of the hydrogen from the vessel, local detonable mixtures of hydrogen could be formed during a severe accident and important equipment, if any is nearby, could be damaged following a detonation. In addition, smaller subatmospheric containments may develop detonable mixtures of hydrogen on a global basis. Licensees with dry containments should evaluate containment vulnerabilities to hydrogen combustion and potential cost-effective improvements (including accident management procedures) as part of the IPE.

It should be noted that currently available computer codes may tend to overestimate mixing of hydrogen in the containment and may not be adequate to evaluate the potential for high local concentrations of hydrogen. Thus any analyses should be supplemented by judgement as to the adequacy of the results. NUREG-CR-5275 provides a discussion of one method that has been used to evaluate the potential for local hydrogen detonations.

Regulatory Basis

Generic Letter 88-20 was issued pursuant to 10 CFR 50.54(f). A copy of the 10 CFR 50.54(f) evaluation which justified issuance of Generic Letter 88-20 is in the NRC's Public Document Room. This supplement does not change the scope of Generic Letter 88-20. Therefore, there is no additional burden associated with this letter, and an OMB clearance number is not required.

Sincerely,

James G. Partlow
Associate Director for Projects
Office of Nuclear Reactor Regulation

Enclosure:

List of Most Recently Issued
Generic Letters