GE Nuclear Energy

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

February 25, 1993

Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Resolution of Outstanding Items of Section 3.11**

Dear Chet:

Enclosed are SSAR markups of selected portions of Section 3.11 supporting the resolution of outstanding items.

It should be noted that this markup includes Pages 31.3-10 and 31.3-16 of an earlier submittal and the proprietary affidavit under which they were originally issued is applicable.

Please provide copies of this transmittal to Butch Burton.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Norman Fletcher (DOE)
Bernie Genetti (GE)

JF93-39

Z222B

1/1

Environmental parameters include temperature, pressure, relative humidity, and neutron dose rate and integrated dose. Radiation dose for gamma and beta data for both normal and accident conditions will be provided by the COL applicant in accordance with the requirements in Subsection 12.2.3.1. The radiation requirements are site specific documentation owing to the need to model specific equipment which is applicant determined. The HVAC detailed modeling and the evolving considerations in the area of accident source terms are expected to generate significantly differing radiation requirments. Where applicable, these parameters are given in terms of a time-based profile.

The magnitude and 60-year frequency of occurrence of significant deviations from normal plant environments in the zones have insignificant effects on equipment total thermal normal aging or accident aging. Abnormal conditions are overshadowed by the normal or accident conditions in the Appendix 3I tables.

Margin is defined as the difference between the most severe specified service conditions of the plant and the conditions used for qualification. Margins shall be included in the qualification parameters to account for normal variations in commercial production of equipment and reasonable errors in defining satisfactory performance. The environmental conditions shown in the Appendix 3I tables do not include margins.

Some mechanical and electrical equipment may be required by the design to perform an intended safety function between minutes of the occurrence of the event but less than 10 hours into the event. Such equipment shall be shown to remain functional in the accident environment for a period of at least 1 hour in excess of the time assumed in the accident analysis unless a time margin of less than 1 hour can be justified. Such justification will include for each piece of equipment: (1) consideration of a spectrum of breaks; (2) the potential need for the equipment later in the event or during recovery operations; (3) detemination that failure of the equipment after performance of its safety function will not be detrimental to plant safety or mislead the operator; and (5) determination that the margin applied to the minimum operability time, when combined with other test margins, will account for the uncertainties accociated with the use of analytical techniques in the derivation of environmental parameters, the number of units tested, production tolerances, and test equipment inaccuracies

CNFM 3.11.2.1-1

The environmental conditions shown in the Appendix 3I tables are upper-bound envelopes used to establish the environmental design and quali- fication bases of safety-related equipment. The upper bound envelopes indicate that the zone data reflects the worse case expected environment produced by a compendium of accident conditions. Estimated chemical environmental conditions are also reported is Appendix 3I.

3.11.2 Qualification Tests and Analyses

Safety-related electrical equipment that is located in a harsh environment is qualified by test or other methods as described in IEEE 323

applicable locations. Alternatively, actual multi-support excitation effects may be taken into account by performing a multi-support excitation analysis.

(b) When determining stresses, the effects of relative seismic support movements will be considered. When these effects are considered significant, they may be obtained by performing a static structural analysis of the system, including anchor movements. Such effects (which are secondary) will be combined with primary (inertial) effects using the SRSS.

3K.4.2.4.1.4.6.3 Time History Analysis

Time history analysis will be performed when conditions arise invalidating the response spectrum method of analysis due to nonlinear phenomena, or when generation of in-equipment response spectra or a more exact result is desired. To integrate or differentiate, the analysis will be done by an applicable numerical integration technique. The largest time step used in the analysis will be 1/10 of the period of the highest significant mode of vibration of the equipment. The dynamic input will be the time history motion at the equipment support location. For equipment supported at several locations, the responses will be determined by simultaneous excitations using appropriate time history input at each support location. The scaled time interval will be varied as per Paragraph 3K.5.2(a)(6). If the equipment frequency is within the range of the supporting structure, then a time interval will be chosen such that the peak of the response spectrum shall be at the equipment resonance frequency. The total time interval range will be provided with the time history.

3K.4.2.4.1.4.6.4 Generation of In-Equipment Spectra

As a part of the dynamic qualification of equipment, in-equipment response spectra may be generated to qualify components of the equipment dynamically. In-equipment response spectra will be obtained at critical locations of the components from time-history analysis of the equipment or, where appropriate methods are available, by response spectra analysis. The in-equipment qualification plan shall identify the locations at which in-equipment response spectra will be generated and will prove that the in-equipment response spectra generated at such locations will produce the maximum critical responses of the components. In-equipment response spectra from time-history response will be generated and be in accordance with the requirement specified in Paragraph 3K.5.2(a)(6).

3K.4.2.4.2 Qualification Determination

The equipment type will be considered qualified by demonstrating that the equipment performance will meet or exceed its specified values for the most severe environment or sequence of environments specified during the qualified life. An important step in this process will be the determination that the qualification to the requirements adequately envelops the equipment applications.

3K.4.2.5 Combined Qualification

Equipment may be qualified by type test, analysis, previous operating experience, or any combination of these three methods.

3K.4.2.6 On-going Qualification

Some equipment may have a qualified life less than the design life of a nuclear power generating station. The qualified life may be extended by installing additional equipment of the same type in locations where service conditions equal or exceed those of the equipment to be qualified, removing them after a planned period less than the previously qualified life and subjecting them to a type test qualification program. This test would include additional accelerated age conditioning, dynamic, and DBE tests. Completion of this type test extends the qualified life of the installed equipment by the length of time simulated during age conditioning. This procedure may be repeated until the qualified life equals the required installed life of the equipment or the equipment is to be replaced before its qualified life is exceeded.

3K.4.2.7 Margins

CNPM
3.11.2.1-1

Margin is defined as the difference between the most severe specified service conditions of the plant and the conditions used for qualification. Margins will be included in the qualification parameters to account for normal variations in commercial production of equipment, reasonable errors in defining satisfactory performance.

Margins will be applied to the specified service conditions regardless of the qualification method selected. The specific (quantified) margins applied will be documented for each phase of the qualification. The levels of margin provided in Table 3K.4-2 are considered appropriate for most applications. Other margins may be used if justified as adequate for the situation. In all cases the margins will be documented. Negative factors will be applied when lowering the value of the service condition increases the severity. The application of margin to the age-conditioning of equipment will only consider, and conservatively account for, any uncertainties in the process of acceleration.

Some mechanical and electrical equipment may be required by design to perform an intended safety function between minutes of the occurrence of the event but less than 10 hours into the event. Such equipment will be shown to remain functional in the accident environment for period of at least one hour in excess of the time assumed in the accident analysis unless a time margin of less than one hour can be justified. Such justification will include for each piece of equipment: (1) consideration of a spectrum of breaks; (2) the potential need for the equipment later in the event or during recovery operations; (3) a determination that failure of the equipment after performance of its safety function will not be detrimental to plant safety or mislead the operator; and (5) determination that the margin applied to the minimum operability, time, when combined with other test margins, will account for the uncertainties associated with the use of analytical techniques in the derivation of environmental parameters, the number of units tested, production tolerances, and test equipment inaccuracies.

and permitted by 10CFR50.49(f) (Reference 1). Equipment type test is the preferred method of qualification.

Safety-related mechanical equipment that is located in a harsh environment is qualified by analysis of materials data which are generally based on test and operating experience.

CNFM 3.11.2.1-1

The qualification methodology is described in detail in the NRC approved licensing Topical Report on GE's environmental qualification program (Reference 2) in Appendix 3K. This report also addresses compliance with the applicable portions of the General Design Criteria of 10CFR50, Appendix A, and the Quality Assurance Criteria of 10CFR50, Appendix B. Additionally, the report describes conformance to NUREG-0588 (Reference 3), and Regulatory Guides and IEEE Standards referenced in Section 3.11 of NUREG-0800 (Standard Review Plan).

Appendix

Mild environment is that which, during or after a design basis event (DBE, as defined in Reference 2), would at no time be significantly more severe than that which exists during normal, test and abnormal events.

The COL applicant will require vendors of equipment located in a mild environment to submit a certificate of compliance certifying that the equipment has been qualified to assure its required safety- related function in its applicable environment. This equipment is qualified for dynamic loads as addressed in Sections 3.9 and 3.10. Further, a surveillance and maintenance program will be developed to ensure equipment operability during its designed life. (See Subsection 3.11.6).

3.11.3 Qualification Test Results

The results of qualification tests for safety-related equipment will be documented, maintained, and reported as mentioned in Subsection 3.11.6.

3.11.4 Loss of Heating, Ventilating, and Air Conditioning

To ensure that loss of heating, ventilating, and air conditioning (HVAC) system does not adversely affect the operability of safety-related controls and electrical equipment in buildings and areas served by safety-related HVAC systems, the HVAC systems serving these areas meet the single-failure criterion. Section 9.4 describes the safety-related HVAC systems including the detailed safety evaluations. The loss of ventilation calculations are based on maximum heat loads and consider operation of all operable equipment regardless of safety classification.

3.11.5 Estimated Chemical and Radiation Environment

3.11.5.1 Chemical Environment

Equipment located in the containment drywell and wetwell is potentially subject to water spray modes of the RHR system. In addition, equipment in the lower portions of the containment is potentially subject to submergence. The chemical composition and resulting pH to which safety-related equipment is exposed during normal operation and design basis accident conditions is reported in Appendix 3I.

Sampling stations are provided for periodic analysis of reactor water, refueling and fuel storage pool water, and suppression pool water to assure compliance with operational limits of the plant technical specifications.

3.11.5.2 Radiation Environment

Safety-related systems and components are designed to perform their safety-related function when exposed to the normal operational radiation levels and accident radiation levels.

Electronic equipment subject to radiation exposure in excess of 1000 R and mechanical equipment in excess of 10,000 R will be qualified in accordance with Reference 1. OPEN 3.11.3-2

The normal operational exposure is based on the radiation sources provided in Chapter 12.

Radiation sources associated with the DBA and developed in accordance with NUREG-0588 (Reference 3) are provided in Chapter 15.

Integrated doses associated with normal plant operation and the design basis accident condition for various plant compartments are described in Appendix 3I.

3.11.6 COL License Information

3.11.6.1 Environmental Qualification Document

The EQD shall be prepared summarizing the qualification results for all safety-related equipment. The EQD shall include the following:

(1) The test environmental parameters and the methodology used to qualify the equipment located in mild and harsh environments shall be identified.

(2) A summary of environmental conditions and qualified conditions for the safety-related equipment located in a harsh environment zone shall be presented in the system component evaluation work (SCEW) sheets as described in Table I-1 of GE's environmental qualification program (Reference 2). The SCEW sheets shall be compiled in the EQD.

(3) Equipment gama and beta radiation dose data for both normal and accident conditions will be provided in accordance with the requirements of Subsection 12.2.3.1.

3.11.6.2 Environmental Qualification Records

The results of the qualification tests shall be recorded and maintained in an auditable file.

3.11.6.3 Surveillance, Maintenance and Experience Information

The COL applicant will require vendor equipment certificates of qualification compliance and will develop a surveillance and maintenance program in accordance with Subsection 3.11.2.

Non-safety-related control systems subjected to adverse environments will be evaluated for safety implications to safety-related protective functions, and equipment wetting and flooding above the flood level will be addressed in accordance with Subsection 3.11.1.

3.11.7 References

(1) Code of Federal Regulations, Title 10, Chapter I, Part 50, Paragraph 50.49, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plant.

Deleted
(2) General Electric Environmental Qualification Program, NEDE-24326-1 P, Proprietary Document, January 1983.

(3) Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment, NUREG-0588.

Environmental parameters include temperature, pressure, relative humidity, and neutron dose rate and integrated dose. Radiation dose for gamma and beta data for both normal and accident conditions will be provided by the COL applicant in accordance with the requirements in Subsection 12.2.3.1. The radiation requirements are site specific documentation owing to the need to model specific equipment which is applicant determined. The HVAC detailed modeling and the evolving considerations in the area of accident source terms are expected to generate significantly differing radiation requirments. Where applicable, these parameters are given in terms of a time-based profile.

CNFM 3.11.3-4

(SEE SAMPLE Pg. 3I.3-16)

The magnitude and 60-year frequency of occurrence of significant deviations from normal plant environments in the zones have insignificant effects on equipment total thermal normal aging or accident aging. Abnormal conditions are overshadowed by the normal or accident conditions in the Appendix 3I tables.

Margin is defined as the difference between the most severe specified service conditions of the plant and the conditions used for qualification. Margins shall be included in the qualification parameters to account for normal variations in commercial production of equipment and reasonable errors in defining satisfactory performance. The environmental conditions shown in the Appendix 3I tables do not include margins.

Some mechanical and electrical equipment may be required by the design to perform an intended safety function between minutes of the occurrence of the event but less than 10 hours into the event. Such equipment shall be shown to remain functional in the accident environment for a period of at least 1 hour in excess of the time assumed in the accident analysis unless a time margin of less than 1 hour can be justified. Such justification will include for each piece of equipment: (1) consideration of a spectrum of breaks; (2) the potential need for the equipment later in the event or during recovery operations; (3) detemination that failure of the equipment after performance of its safety function will not be detrimental to plant safety or mislead the operator; and (5) determination that the margin applied to the minimum operability time, when combined with other test margins, will account for the uncertainties accociated with the use of analytical techniques in the derivation of environmental parameters, the number of units tested, production tolerances, and test equipment inaccuracies

The environmental conditions shown in the Appendix 3I tables are upper-bound envelopes used to establish the environmental design and quali- fication bases of safety-related equipment. The upper bound envelopes indicate that the zone data reflects the worse case expected environment produced by a compendium of accident conditions. Estimated chemical environmental conditions are also reported is Appendix 3I.

3.11.2 Qualification Tests and Analyses

Safety-related electrical equipment that is located in a harsh environment is qualified by test or other methods as described in IEEE 323

Table 3I.3-9

Radiation Environment Conditions Inside Primary Containment Vessel
Plant Normal Operating Conditions

(b) Radiation environment

Number	Plant Zone/ Typical Equipment	Operating dose rate(1)(3) Gamma (R/h)	Beta (R/h)	Neutron (N/cm^2-sec)	Integrated dose(2)(3) and Neutron fluence Gamma (R)	Beta (R)	Neutron (N/cm^2)
b-1	Upper drywell area [Fig's. 1.2-3/ 5.1-3]			[illegible]^{4}			$1x10^{14}$
b-2	Upper area of lower drywell [Fig's. 1.2-3a/ 5.1-3]			$2x10^{4}$			$5x10^{13}$
b-3	Lower area of lower drywell [Fig's. 1.2-3b/ 11.2-2]			$1x10^{4}$			$3x10^{13}$
b-4	Wetwell area (suppression pool and air space) [Fig's. 1.2-3c/ 6.2-39, 7.6-11]			$8x10^{2}$			$2x10^{12}$

Notes:

(1) Operating dose rate is at 100% rated power and away from the radiation source.

(2) Integrated dose means the integrated value over 60 years.

(3) The gamma and beta doses will be provided ~~when acceptable radiation source terms become defined~~ by the applicant referencing the ABWR design in accordance with the requirements of Subsection 12.2.3.1.

The normal operational exposure is based on the radiation sources provided in Chapter 12.

Radiation sources associated with the DBA and developed in accordance with NUREG-0588 (Reference 3) are provided in Chapter 15.

Integrated doses associated with normal plant operation and the design basis accident condition for various plant compartments are described in Appendix 3I.

3.11.6 COL License Information

3.11.6.1 Environmental Qualification Document

The EQD shall be prepared summarizing the qualification results for all safety-related equipment. The EQD shall include the following:

(1) The test environmental parameters and the methodology used to qualify the equipment located in mild and harsh environments shall be identified.

(2) A summary of environmental conditions and qualified conditions for the safety-related equipment located in a harsh environment zone shall be presented in the system component evaluation work (SCEW) sheets as described in Table I-1 of GE's environmental qualification program (Reference 2). The SCEW sheets shall be compiled in the EQD.

COL 3.11.3-2

(3) Equipment gama and beta radiation dose data for both normal and accident conditions will be provided in accordance with the requirements of Subsection 12.2.3.1.

3.11.6.2 Environmental Qualification Records

The results of the qualification tests shall be recorded and maintained in an auditable file.

3.11.6.3 Surveillance, Maintenance and Experience Information

The COL applicant will require vendor equipment certificates of qualification compliance and will develop a surveillance and maintenance program in accordance with Subsection 3.11.2.

Non-safety-related control systems subjected to adverse environments will be evaluated for safety implications to safety-related protective functions, and equipment wetting and flooding above the flood level will be addressed in accordance with Subsection 3.11.1.

3.11.7 References

(1) Code of Federal Regulations, Title 10, Chapter I, Part 50, Paragraph 50.49, Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plant.

Deleted

(2) ~~General Electric Environmental Qualification~~ Program, NEDE-24326-1-P, Proprietary Document, January 1983.

(3) Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment, NUREG-0588.

Table 31.3-15

Thermodynamic Environment Conditions Inside Reactor Building (Secondary Containment) Plant Accident Conditions

(a) Pressure, temperature and relative humidity

Plant Zone/Typical Equipment					
Control rod drive hydraulic system (scram etc. of hydraulic control unit) [Fig's. 1.2-4 /4.6-8	Temperature (^{O}C)	100	100	66	66
	Pressure (Kg/cm^{2}g)	0.035	0.035	0.035	0
	Humidity (%)	Steam	Steam	100	90 max
	Time (2)	1(h)	6(h)	12(h)	100(day)
MS isolation valve (1) MS drain isolation valve Nitrogen line isolation valve (1), (4) Process water line isolation valve (1),(4) [Fig's. 1.2-2, 1.2-3, 1.2-3a, 5.1-3]	Temperature (^{O}C)	171	100	66	66
	Pressure (Kg/cm^{2}g)	0.035	0.035	0.035	0
	Humidity (%)	Steam	Steam	100	90 max
	Time(2)	1(h)	6(h)	12(h)	100(day)
Feedwater isolation valve (1) [Fig's. 1.2-2, 1.2-3, 1.2-3a/ 5.1-3]	Temperature (^{O}C)	171	100	66	66
	Pressure (Kg/cm^{2}g)	0.035	0.035	0.035	0
	Humidity (%)	Steam	Steam	100	90 Max.
	Time(2)	1(h)	6(h)	12(h)	100(day)
RCIC injection valve(1), check valve (inside MS tunnel), steam line isolation valve [Fig's. 1.2-2, 1.2-3, 1.2-3a/5.4-8]	Temperature (^{O}C)	171	100	66	66
	Pressure (Kg/cm^{2}g)	0.035	0.035	0.035	0
	Humidity (%)	Steam	Steam	100	90 Max.
	Time(2)	1(h)	6(h)	12(h)	100(day)
RCIC (valve except isolation valve, assemblies, cable, turbine) [Fig's. 1.2-4/ 5.4-8]	Temperature (^{O}C)	100(3)	66	66	
	Pressure (Kg/cm^{2}g)	0.035	0.035	0	
	Humidity (%)	Steam	100	90 Max.	
	Time(2)	6(h)	12(h)	100(day)	
RCIC turbine electric control system (3),(6) [Fig's. 1.2-5/ 5.4-8]	Temperature (^{O}C)	100	66	66	
	Pressure (Kg/cm^{2}g)	0.035	0.035	0	
	Humidity (%)	Steam	100	90 Max.	
	Time(2)	6(h)	12(h)	100(day)	
RHR (LPFL, cooling system at S/D, containment cooling. Service water system) valve, pump (motor, seal cooler) instrument control electric equipment (including cable and sources of electricity) [Fig's. 1.2-4/ 5.4-10]	Temperature (^{O}C)	100	66	66	
	Pressure (Kg/cm^{2}g)	0.035	0.035	0	
	Humidity (%)	Steam	100	90 Max.	
	Time(2)	6(h)	12(h)	100(day)	

Pg 1 of 5

NRC Question: The staff noted in the DSER that the integrated gamma accident dose is in primary containment for the ABWR is given as 6 x 10^7 rads, which is less than the typical value of about 2 x 10^8 rads quoted in the safety analysis reports of several operating reactors (e.g. Perry: 2.7 x 10^8 ; River Bend : 1.7 x 10^8 rads; Clinton: 2 x 10^8 rads' Nine Mile Point: 1.4 x 10^8 rads). It is not clear why the ABWR integrated gamma accident dose is lower than the corresponding doses quoted for several operating reactors. GE's position which was provided in Section 5.3.2.1.5 of SSAR Amendment 15, did not adequately address this issue. To resolve this issue GE must fully explain why the ABWR integrated gamma accident dose is lower than the corresponding doses quoted for several operating reactors. This is Open Item 3.11.3-3.

OPEN 3.11.3-3

Reply: The value of 6 x 10^7 rads originally reported in the ABWR SSAR is not the total integrated gamma dose for the primary containment for U.S. application but is the total integrated gamma dose as stipulated for the Kashiwaski 6/7 reactors being built and licensed under Japanese regulations. The difference between this value and the quoted existing U.S. reactors is one of philosophical approach between the two countries. To examine this difference we will compare the above ABWR calculation to that of the original TVA STRIDE design (BWR 6) which is shown in the following table.

TVA Stride Primary Containment Integrated Gamma Dose

Source	Dose (rads carbon)
100 % Noble Gases + daughters airborne	2.54 x 10^7
50% Halogens + daughters airborne	7.55 x 10^7
25% Halogens + daughters plateout	
Wall Plateout	7.04x 10^6
Equipment Plateout	1.20 x 10^6
Total of Plateout	1.90 x 10^7
Total Dose	1.20 x 10^8

Noble Gas Dose

In the ABWR, a preliminary calculation for the noble gases has been done and is shown in the attached figures. In all three figures we see that the integrated drywell dose approaches 1.2 x 10^7 rads in each of the three major primary containment volumes. In Stride, a single volume was used to contain all the fission product release whereas in ABWR there are three separately distinct volumes which are separated by meters of concrete. In ABWR it is possible that for a short time, on the order of hours, all the noble gases would be contained in a single volume, this would certainly not be the case for a 100 day evaluation. This short period containment has not been considered in the attached figures but will be in the final

evaluation. Therefore if a single volume (forcing all the release into a single volume for 100 days) were considered, the ABWR dose would increase an estimated factor of 2 to approximated 2.4×10^7 rads which is similar to Stride.

Halogen Airborne Dose

The airborne halogen dose is similar to the noble gas dose and for ABWR is roughly estimated at approximately 4×10^7 rads, again dividing the fission product release between three compartments. In a similar fashion if a single compartment were considered the dose would be approximately 8×10^7 rads which is similar to tho Stride value of 7.55×10^7 rads.

Halogen Plateout Dose

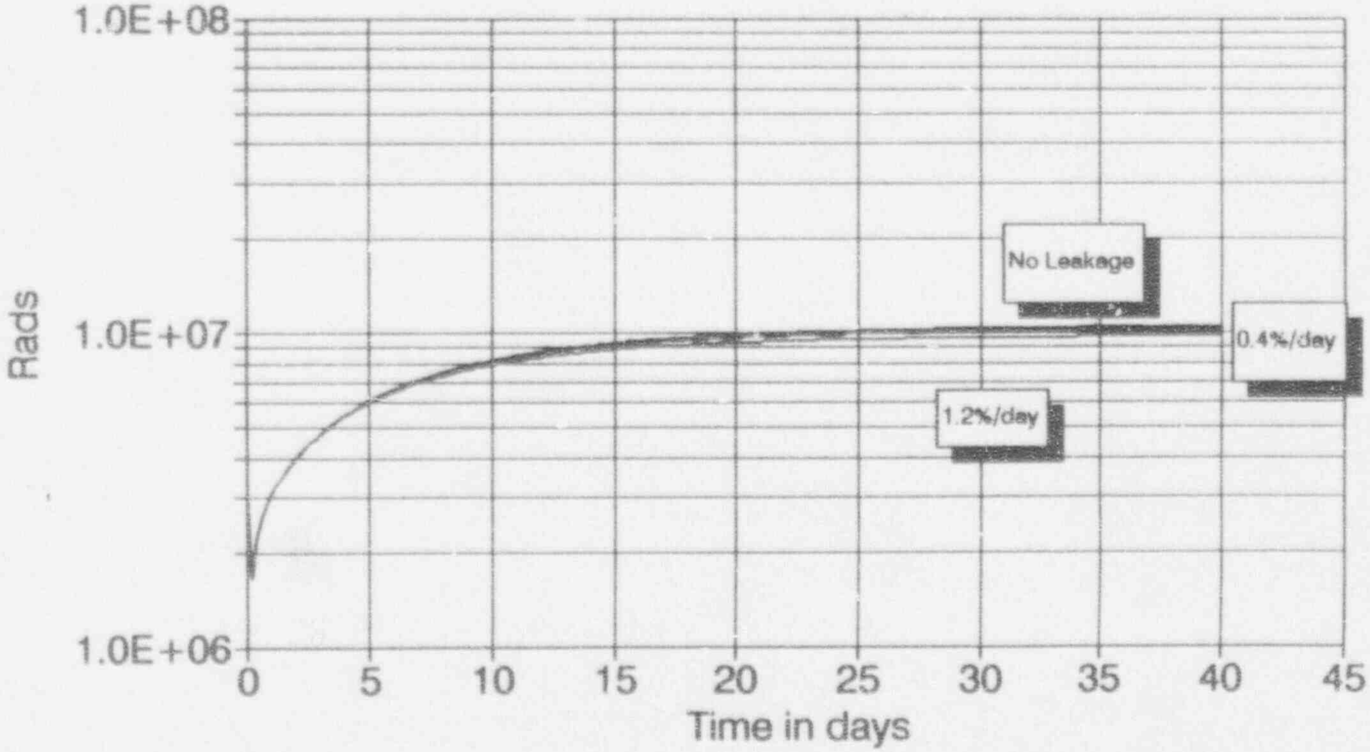
It is at this point that the K-6/7 analysis and the standard U.S. analysis differ. The standard U.S. analysis as is shown in the above table also considers an additional 25% halogen plated out onto the containment surfaces. The K-6/7 analysis does not. No estimate exists yet as to what this factor will be on ABWR since it needs to be determined if the release would be divided between the three volumes equally or by some mechanistic algorithm or whether all the release will be concentrated in a single volume. Nevertheless, it is not likely that ABWR will vary significantly from other analyses.

Conclusion

The above discussion has attempted to describe the original basis and differences between existing plant analyses and the value originally found in the ABWR SSAR. As is shown, when the ABWR evaluation is compete, it is not expected that the final ABWR will vary significantly from current plants.

Lower Drywell Integrated Dose

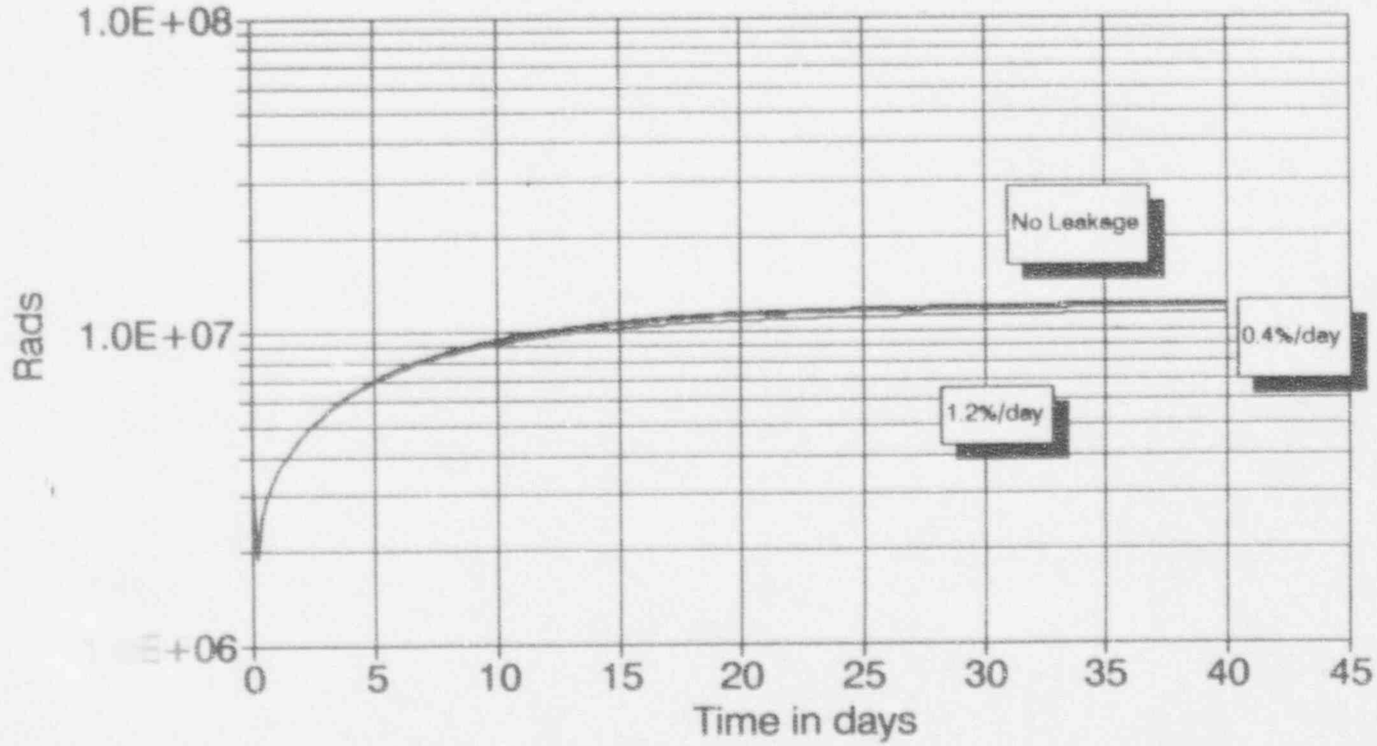
from Noble Gas at various Leakages



Pg 3 of 5

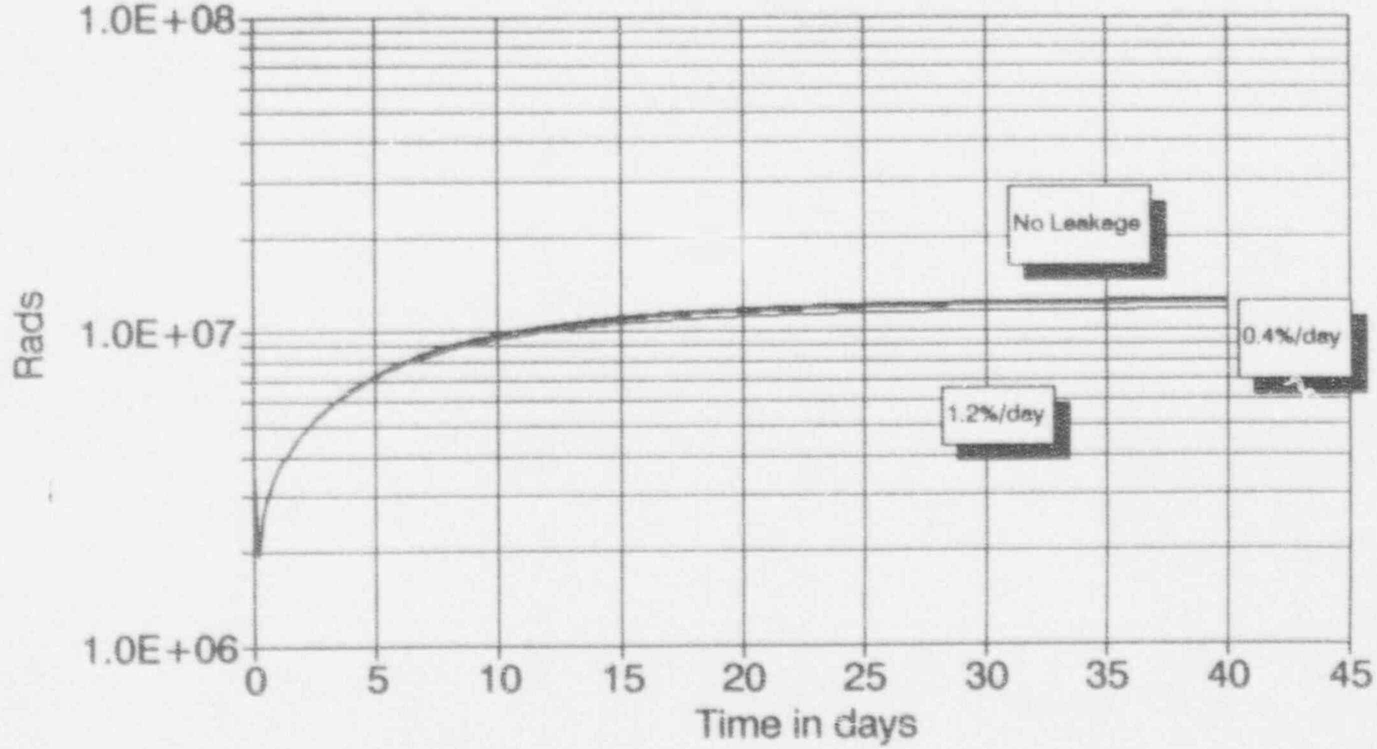
Upper Drywell Integrated Dose

from Noble Gas at various Leakages



Pg. 4 of 5

Wetwell Integrated Dose
from Noble Gas at various Leakages



Pg 5 of 5