VERMONT

NUCLEAR DECOMMISSIONING CITIZENS ADVISORY PANEL

Meeting Two

Information Package

Relating to Vermont Yankee Plant's
Used Fuel Pool Safety

Presented at the Meeting
and

Submitted for the Record

With the Permission of the Chair

Points of Interest
Originally submitted to the Vermont State Nuclear Advisory Panel, October 2013

Testimony before the Vermont House Natural Resources and Energy Committee,
May 2013

E mail to Vermont's Chief of Radiological Health on Vermont Yankee
Decommissioning

Extract from NUREG 1738 USNRC "Technical Study of Spent Fuel Pool Accident Risk
at Decommissioning Nuclear Power Plants" – Pages scanned for integrity

By

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Vermont State Nuclear Advisory Panel-Meeting
October 16, 2013

Points of Interest

1. From the beginning nuclear power was not expected to be perfect. The originators and Congress knew that with human beings involved, accidents would happen. There would be all manner of human failures, in design, construction, operation and regulation. All this was considered in constructing the program. (see testimony to VT House Natural Resources and Energy Committee).

2. The NRC regulates to a standard of "safe enough." "Safer" and "risk free" are not realistic standards for being safe and getting any benefits. In every finding the NRC says "there is reasonable assurance" that public safety will be maintained.

3. The Used Fuel that is and will be at Vermont Yankee is "safe" in either the Fuel Pool or Dry Casks, per the NRC.

4. A 2003 report by Mr. Robert Alvarez et al, on reducing hazards of used fuel at power reactor sites is being re-publicized since the accident at Fukushima. It is based on the NRC report of 2001, which was their analysis of a Sandia Lab 1979 study.

   -the last section of the report is "Limitations" and the last Limitation is "We have considered generic PWR pools. Additional issues may well arise when specific PWR and BWR pools designs are analyzed."

   -the Vermont Yankee design has apparently not been analyzed, since one of the report's recommendations is fulfilled by the original plant design! From page 26

   "*Armor Exposed Outside Walls and Bottoms Against Projectiles*

   The water and fuel in the pool provide an effective shield against penetration of the pool wall and floor from the inside. It should be possible to prevent penetration by shaped charges from the outside with a stand-off wall about 3 meters away that would cause the jet of liquid metal formed by the shaped charge to expand and become much less penetrating before it struck the pool wall."

   Vermont Yankee's Fuel Pool is in the middle of the reactor building. There is a large gap, about 10 meters, between the east wall of the pool and the outside wall of the building. The east wall is the only one that can be in a line of fire. The other walls of the pool are shielded by the Dryer-Separator pool, the new fuel vault and the Turbine building.

   -the report does mention Operators in passing, but provides no analysis of all the things they might do to stop and reverse a loss of water from the fuel pool. This is strange, since the report does explain that as time passes the heat continuing to be generated by the used fuel decreases rapidly, allowing a lot of time for corrective action.

Operator actions to maintain Fuel Pool water are specified in the Fukushima accident Lessons Learned. These requirements should be reviewed before any action is taken on Mr. Alvarez' report.

-This report comes from an organization dedicated to the elimination of nuclear power, and should be evaluated in that light.

5. A recent letter in the press from Mr. Sachs of Brattleboro says the NRC will be gone once Decommissioning starts. The NRC will be regulating the site as long as used fuel is present. It will license the Independent Spent Fuel Installation.

Howard Shaffer PE

VERMONT LEGISLATURE

House Natural Resources and Energy Committee
Storage of Used (Spent) Reactor Fuel at the
Vermont Yankee Nuclear Power Station

Howard Shaffer PE (nuclear) VT, NH, MA

Thank you Chairman Klein and Committee Members for allowing me to come before you today. My purpose is to provide what I can from my experience on this important matter. My view is positive.

Virtually my entire career has been in nuclear power. My resume is attached.

BACKGROUND

Missing from the nuclear debate has been clarity about the overall design philosophy of US nuclear generating facilities. From the beginning, every aspect of the program- hardware, training, management and regulation-has been designed, not on the belief that accidents MIGHT happen, but on the certainty that accidents WILL happen. Experience with human performance proves that there will be mistakes. If the benefits were to be enjoyed, then all possible means to first prevent accidents, and second to deal with the consequences of accidents had to be developed and put in place.

A key part of the design process is asking "What if..?" scenarios for all imaginable events that could happen. The design and licensing process continues and asks "How could this happen" and "How long does this take to happen?" and "What are the odds that it will happen?" Fast-breaking events require controls that respond instantly and automatically, while longer-term events include actions by trained nuclear operators. For example, the Design Basis pipe break initiates a series of automatic programmed shutdown responses for the first ten minutes. At that point, the nuclear operations team takes over the process. The operators are the first responders. At Fukushima, the operators worked diligently until the accident was under control. It took more than a day before there was any release, and the order to evacuate residents in the vicinity came hours before that.

USED (Spent) FUEL STORAGE

One-third of the nuclear fuel in the Vermont Yankee reactor is replaced every 18 months. The fuel that is removed from the reactor and stored on-site continues to be a valuable resource because only about 10% of the energy contained in the fuel has been used and 90% of that energy can be reclaimed through recycling and used to create more electricity.

The solid ceramic fuel pellets in the fuel bundles that have been removed from the reactor as spent fuel and stored in dry casks, are air cooled by natural circulation through the cask. The pellets have been stored in water for more than five years and are generating very little heat. With the shielding in the 100-ton storage casks, the used fuel is very secure. Even if a cask was broken open and the pellets scattered on the ground, they would just lie there, continuing to be air cooled. Radiation dose to the offsite public would be insignificant.

Used fuel in the pool is also very secure. The reactor building and radioactive waste storage facilities are designed for the maximum Design Basis earthquake and 360 mph winds from a tornado with 300 mph winds advancing at 60 mph. The fuel pool and the entire cooling system are in those buildings. The system is powered by two redundant emergency backup diesel generators when normal power is lost. There also are backup water supplies to the spent fuel storage pool. Post 9-11 and based on hypothetical spent pool fire studies, the fuel is stored in the pool in a checker-board pattern, with the fuel most recently removed from the reactor, which generates the most heat, surrounded by older fuel (which has been cooling in the pool for up to 35 years) that will absorb heat.

There was an event this February at Pilgrim plant in Massachusetts, a plant like Vermont Yankee. This event illustrates the design margin. During storm Nemo all offsite power was lost for two days. The reactor scrammed and emergency backup diesels started automatically, as designed. The reactor was brought to cold shutdown by the Pilgrim reactor operations team in 10 hours, and fuel pool cooling, which can be suspended for a long time due to the large volume of water in the pool, was restored **after 21 hours!**

UNDERSTANDING THE NUCLEAR DEBATE

I've struggled to understand how the debate over nuclear power got to be so politically polarized. Starting with the famous book "Soft Energy Paths"--the author wants to do away with nuclear weapons (don't we all?) and he concludes we must do away with all nuclear power generation--a source of 20 per cent of the US electricity supply--in order to do this. This means finding and developing economically-viable technologies to replace the 24/7 base-load power generated by nuclear plants without massive increases in the use of fossil fuels.

Unfortunately, it also has led in some quarters to doing as much as possible to discredit nuclear power. Some supporters of nuclear power call this spreading FUD – Fear Uncertainty and Doubt.

Using examples that increase fear of radiation is a common tactic. For example the warning that and element has a "half-life of millions of years" implies that it will be harmful or dangerous that long. The opposite is true. The longer the half-life, the more slowly the radiation is given off and the lower the dose each year.

Implying that radiation comes only from the generation of electricity with nuclear power, and nuclear weapons is also false. Radiation is natural. The Uranium in the granite in this statehouse building was radioactive millions of years ago, and will be radioactive in millions more. This is a natural part of our environment, and we all get low doses of radiation continually.

The sun's light, heat and other radiation comes from nuclear reactions. We could even say the "Solar Power is Nuclear Power."

Here is an example of a peaceful use of radioactive material. (Hold up EXIT sign)

Thank you.

E Mail

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Sent: Tuesday, October 22, 2013 2:15 PM
To: wirwin@state.vt.us
Cc: hshaffer3@myfairpoint.net
Subject: FW: Vermont Yankee Decommissioning

Sent: Tuesday, October 22, 2013 11:07 AM
To: 'Bill Irwin'
Cc: Buteau, Bernard R; Meredith Angwin (mjangwin@earthlink.net); Guy Page (page@vtep.org); Robert Hargraves (robert.hargraves@gmail.com); Willem Post (wilpost@aol.com)
Subject: Vermont Yankee Decommissioning

Hi Bill,

I read your statement that VY's Decommissioning is "New Territory."

Does that mean that this is the first GE MK I to be decommissioned? If so, I think you mean that because the fuel pool is in the Reactor Building, as opposed to a separate building, that dismantling of the Reactor building will be delayed or constrained until 5 years after the last fuel to have operated in the reactor is removed to Dry Casks. This applies to the Radwaste building too, since the filter-demineralizers for the fuel pool cooling system are there. Plus make-up water for the pool, cooling water, and electric power must be maintained.

If a program to tear down the buildings around the pool is proposed, then it will have to be proven to the NRC that it is safe. All contingencies and accidents during the tear-down will have to be analyzed.

Regards

Howard Shaffer

NUREG-1738

Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants

Manuscript Completed: January 2001
Date Published: February 2001

Prepared by
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Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ABSTRACT

This study contains the results of the NRC staff's evaluation of the potential accident risk in a spent fuel pool at decommissioning plants in the United States. This study was prepared to provide a technical basis for decommissioning rulemaking for permanently shutdown nuclear power plants. This study describes a modeling approach of a typical decommissioning plant with design assumptions and industry commitments; the thermal-hydraulic analyses performed to evaluate the behavior of spent fuel stored in the spent fuel pool at decommissioning plants; the risk assessment of spent fuel pool accidents; the consequence calculations; and the sensitivity study and implications for decommissioning regulatory requirements. Preliminary drafts of this study were issued for public comments and technical reviews in June 1999 and February 2000. Comments from interested stakeholders, the Advisory Committee on Reactor Safeguards, and other technical reviewers have been taken into account in preparing this study. A broad quality review was also carried out at the Idaho National Engineering and Environment Laboratory, and a panel of human reliability analysis experts evaluated the report's assumptions, methods, and modeling. Public comments on draft versions of this study are discussed in Appendix 6 of this NUREG.

EXECUTIVE SUMMARY

This report documents a study of spent fuel pool (SFP) accident risk at decommissioning nuclear power plants. The study was undertaken to support development of a risk-informed technical basis for reviewing exemption requests and a regulatory framework for integrated rulemaking.

The staff published a draft study in February 2000 for public comment and significant comments were received from the public and the Advisory Committee on Reactor Safeguards (ACRS). To address these comments the staff did further analyses and also added sensitivity studies on evacuation timing to assess the risk significance of relaxed offsite emergency preparedness requirements during decommissioning. The staff based its sensitivity assessment on the guidance in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis." The staff's analyses and conclusions apply to decommissioning facilities with SFPs that meet the design and operational characteristics assumed in the risk analysis. These characteristics are identified in the study as industry decommissioning commitments (IDCs) and staff decommissioning assumptions (SDAs). Provisions for confirmation of these characteristics would need to be an integral part of rulemaking.

The results of the study indicate that the risk at SFPs is low and well within the Commission's Quantitative Health Objectives (QHOs). The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious. The results are shown in Figures ES-1 and ES-2. Because of the importance of seismic events in the analysis, and the considerable uncertainty in seismic hazard estimates, the results are presented for both the Lawrence Livermore National Laboratory (LLNL) and the Electric Power Research Institute (EPRI) seismic hazard estimates. In addition, to address a concern raised by the ACRS, the results also include a sensitivity to a large ruthenium and fuel fines release fraction. As illustrated in the figures, the risk is well below the QHOs for both the individual risk of early fatality and the individual risk of latent cancer fatality.

The study includes use of a pool performance guideline (PPG) as an indicator of low risk at decommissioning facilities. The recommended PPG value for events leading to uncovery of the spent fuel was based on similarities in the consequences from a SFP zirconium fire to the consequences from a large early release event at an operating reactor. A value equal to the large early release frequency (LERF) criterion (1×10^{-5} per year) was recommended for the PPG. By maintaining the frequency of events leading to uncovery of the spent fuel at decommissioning facilities below the PPG, the risk from zirconium fires will be low and consistent with the guidance in RG 1.174 for allowing changes to the plant licensing basis that slightly increase risk. With one exception (the H.B. Robinson site) all Central and Eastern sites which implement the IDCs and SDAs would be expected to meet the PPG regardless of whether LLNL or EPRI seismic hazard estimates are assumed. The Robinson site would satisfy the PPG if the EPRI hazard estimate is applied but not if the LLNL hazard is used. Therefore, Western sites and Robinson would need to be considered on a site-specific basis because of important differences in seismically induced failure potential of the SFPs.

The appropriateness of the PPG was questioned by the ACRS in view of potential effects of the fission product ruthenium, the release of fuel fines, and the effects of revised plume parameters. The staff added sensitivity studies to its analyses to examine these issues. The consequences of a significant release of ruthenium and fuel fines were found to be notable, but not so important as to render inappropriate the staff's proposed PPG of 1×10^{-5} per year. The plume parameter sensitivities were found to be of lesser significance.

In its thermal-hydraulic analysis, documented in Appendix 1A, the staff concluded that it was not feasible, without numerous constraints, to establish a generic decay heat level (and therefore a decay time) beyond which a zirconium fire is physically impossible. Heat removal is very sensitive to these additional constraints, which involve factors such as fuel assembly geometry and SFP rack configuration. However, fuel assembly geometry and rack configuration are plant specific, and both are subject to unpredictable changes after an earthquake or cask drop that drains the pool. Therefore, since a non-negligible decay heat source lasts many years and since configurations ensuring sufficient air flow for cooling cannot be assured, the possibility of reaching the zirconium ignition temperature cannot be precluded on a generic basis.

The staff found that the event sequences important to risk at decommissioning plants are limited to large earthquakes and cask drop events. For emergency planning (EP) assessments this is an important difference relative to operating plants where typically a large number of different sequences make significant contributions to risk. Relaxation of offsite EP a few months after shutdown resulted in only a "small change" in risk, consistent with the guidance of RG 1.174. Figures ES-1 and ES-2 illustrate this finding. The change in risk due to relaxation of offsite EP is small because the overall risk is low, and because even under current EP requirements, EP was judged to have marginal impact on evacuation effectiveness in the severe earthquakes that dominate SFP risk. All other sequences including cask drops (for which emergency planning is expected to be more effective) are too low in likelihood to have a significant impact on risk. For comparison, at operating reactors additional risk-significant accidents for which EP is expected to provide dose savings are on the order of 1×10^{-5} per year, while for decommissioning facilities, the largest contributor for which EP would provide dose savings is about two orders of magnitude lower (cask drop sequence at 2×10^{-7} per year).[1] Other policy considerations beyond the scope of this technical study will need to be considered for EP requirement revisions and previous exemptions because a criteria of sufficient cooling to preclude a fire cannot be satisfied on a generic basis.

Insurance does not lend itself to a "small change in risk" analysis because insurance affects neither the probability nor the consequences of an event. As seen in figure ES-2, as long as a zirconium fire is possible, the long-term consequences of an SFP fire may be significant. These long-term consequences (and risk) decrease very slowly because cesium-137 has a half life of approximately 30 years. The thermal-hydraulic analysis indicates that when air flow has been restricted, such as might occur after a cask drop or major earthquake, the possibility of a fire lasts many years and a criterion of "sufficient cooling to preclude a fire" can not be defined on a

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[1]Consistent with PRA limitations and practice, contributions to risk from safeguards events are not included in these frequency estimates. EP might also provide dose savings in such events.

generic basis. Other policy considerations beyond the scope of this technical study will therefore need to be considered for insurance requirements.

The study also discusses implications for security provisions at decommissioning plants. For security, risk insights can be used to determine what targets are important to protect against sabotage. However, any revisions in security provisions should be constrained by an effectiveness assessment of the safeguards provisions against a design-basis threat. Because the possibility of a zirconium fire leading to a large fission product release cannot be ruled out even many years after final shutdown, the safeguards provisions at decommissioning plants should undergo further review. The results of this study may have implications on previous exemptions at decommissioning sites, devitalization of spent fuel pools at operating reactors and related regulatory activities.

The staff's risk analyses were complicated by a lack of data on severe-earthquake return frequencies, source term generation in an air environment, and SFP design variability. Although the staff believes that decommissioning rulemaking can proceed on the basis of the current assessment, more research may be useful to reduce uncertainties and to provide insights on operating reactor safety. In particular, the staff believes that research may be useful on source term generation in air, which could also be important to the risk of accidents at operating reactors during shutdowns, when the reactor coolant system and the primary containment may both be open.

In summary, the study finds that:

1. The risk at decommissioning plants is low and well within the Commission's safety goals. The risk is low because of the very low likelihood of a zirconium fire even though the consequences from a zirconium fire could be serious.

2. The overall low risk in conjunction with important differences in dominant sequences relative to operating reactors, results in a small change in risk at decommissioning plants if offsite emergency planning is relaxed. The change is consistent with staff guidelines for small increases in risk.

3. Insurance, security, and emergency planning requirement revisions need to be considered in light of other policy considerations, because a criterion of "sufficient cooling to preclude a fire" cannot be satisfied on a generic basis.

4. Research on source term generation in an air environment would be useful for reducing uncertainties.

risk = what could happen × odds that it will happen.

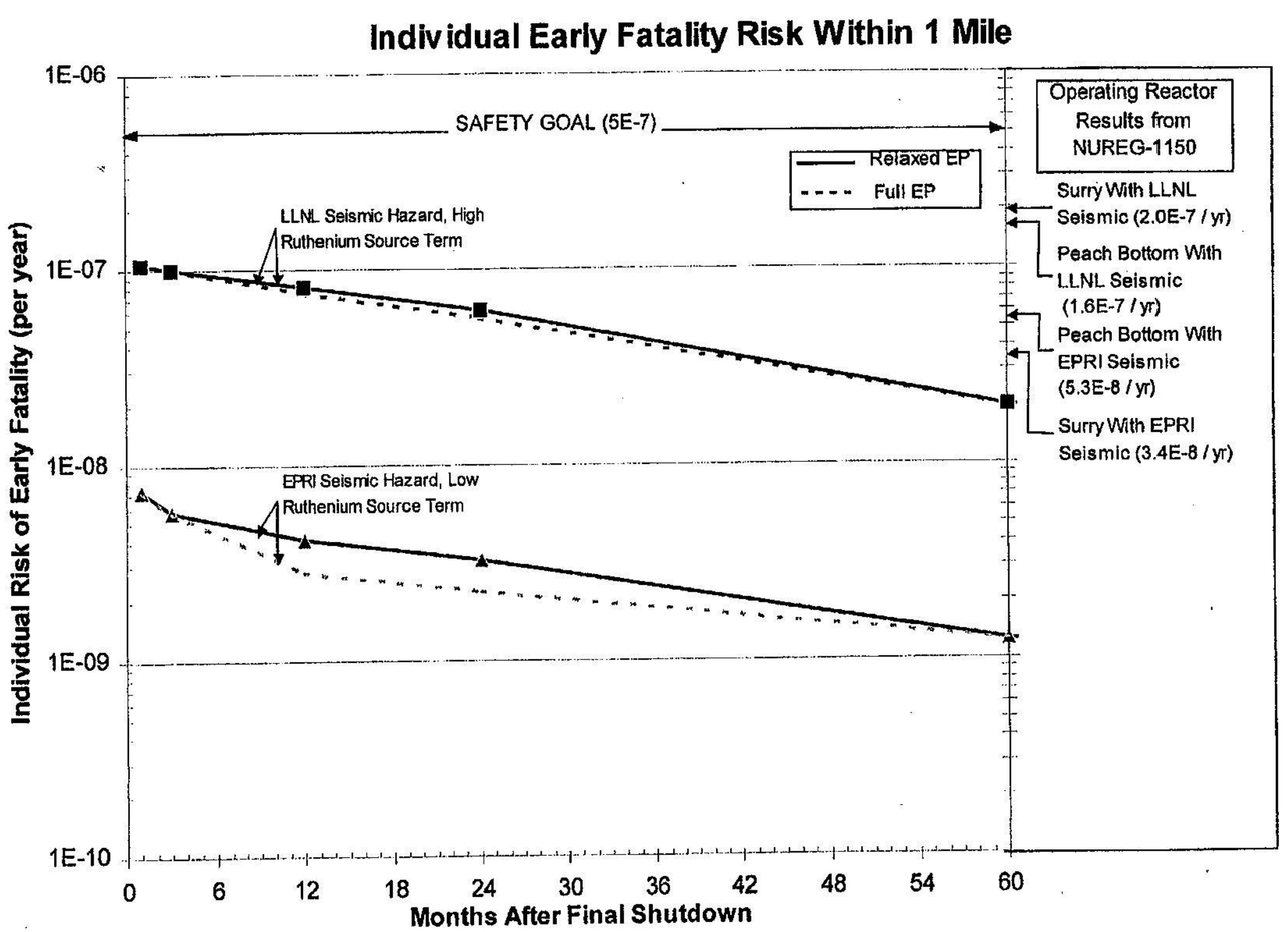
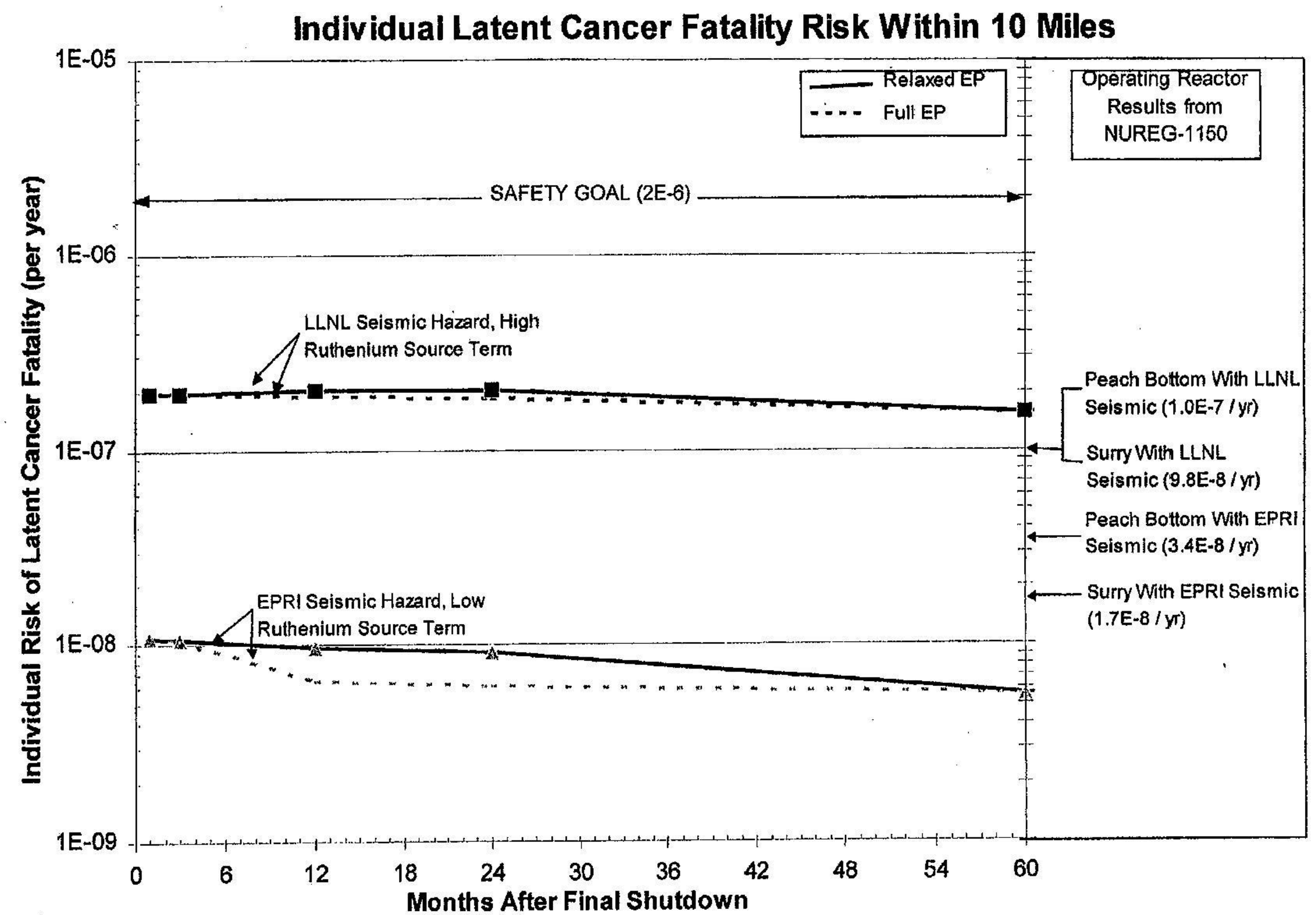

Individual Early Fatality Risk Within 1 Mile
SAFETY GOAL (5E-7)
Relaxed EP
Full EP
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Operating Reactor Results from NUREG-1150
Surry With LLNL Seismic (2.0E-7 / yr)
Peach Bottom With LLNL Seismic (1.6E-7 / yr)
Peach Bottom With EPRI Seismic (5.3E-8 / yr)
Surry With EPRI Seismic (3.4E-8 / yr)
Individual Risk of Early Fatality (per year)
1E-06
1E-07
1E-08
1E-09
1E-10
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown

Figure ES-1


Individual Latent Cancer Fatality Risk Within 10 Miles
1E-05
1E-06
1E-07
1E-08
1E-09
Individual Risk of Latent Cancer Fatality (per year)
0
6
12
18
24
30
36
42
48
54
60
Months After Final Shutdown
Relaxed EP
Full EP
Operating Reactor Results from NUREG-1150
SAFETY GOAL (2E-6)
LLNL Seismic Hazard, High Ruthenium Source Term
EPRI Seismic Hazard, Low Ruthenium Source Term
Peach Bottom With LLNL Seismic (1.0E-7 / yr)
Surry With LLNL Seismic (9.8E-8 / yr)
Peach Bottom With EPRI Seismic (3.4E-8 / yr)
Surry With EPRI Seismic (1.7E-8 / yr)