From: Robert Palla
To: George Hubbard, Glenn Kelly, Timothy Collins
Date: Tue, Aug 22, 2000 9:34 AM
Subject: Risk Increase from EP Changes Versus RG 1.174 LERF Criterion

Attached FYI is a brief writeup discussing the risk increases associated with EP changes and how they compare to the RG 1.174 criterion re: delta LERF. This is still very draft so any comments would be helpful.

CC: Daniel Barss, Jason Schaperow, Mark Rubin

M/87

but what is the basis for this?

how many of these can you make?

Allowable Level of Risk Increase In Accordance With RG 1.174

In accordance with RG 1.174, if the baseline LERF is less than 1E-5 per year, plant changes can be approved that increase LERF by up to 1E-6 per year. Relaxations in EP requirements do not impact the frequency of events involving a large early release (i.e., SFP fire frequency) but instead would increase the consequences associated with the large release. Hence, in applying the ΔLERF concept to the issue of EP changes it is necessary to translate the allowable increase in LERF into an allowable increase in risk.

The risk increase associated with a ΔLERF of 1E-6 per year at Surry can be bounded by considering the consequences for a worst case large early release sequence at Surry, in conjunction with the maximum allowable frequency increase (i.e., 1E-6 per year). The consequences associated with the source term that produced the greatest number of early fatalities in the NUREG-1150 study for Surry are provided in Table 1 below. The consequences are reported separately for internal events and seismic events and are discussed in more detail in the appendix regarding the PPG. The maximum allowable level of risk increase is the product of the consequences (weighted by the respective frequency of internal and seismic events for power operation) and the allowable frequency increase of 1E-6 per year. This risk increase is provided in the last column of Table 1.

Table 2 provides approximate estimates of the risk increase that could be associated with EP relaxations at a plant conforming with the reference plant analysis and assumptions. These estimates represent an upper bound on the risk increase since they tend to maximize the value of formal EP in the "full EP" case and minimize the value of ad hoc EP in the "no radiological preplanning" case. The results indicate that relaxation of the requirements for radiological preplanning would result in an increase of about 1E-5 early fatalities per year, which is about a factor of 5 below the maximum allowable increase in Table 1. The EP relaxation would result in an increase of about 1 person-rem per year, which is about a factor of 10 below the maximum allowable increase in Table 1. Since the SFP fire frequency for the reference plant is about a factor of 3 lower than the PPG of 1E-5 per year, a plant operating nominally at the PPG would have a smaller margin to the allowable risk limits but would still be at or below the limits under the above assumptions.

The sensitivity of the risk increase estimates is strongly dependent on the assumptions regarding the effectiveness of emergency evacuation in seismic events, since these events dominate the SFP fire frequency. In NUREG-1150, evacuation in seismic events was treated either of two ways depending on the peak ground acceleration (PGA) of the earthquake:

- for low PGA earthquakes (<0.6g), 99.5% of the population was assumed to evacuate however the evacuation was assumed to start later and proceed more slowly than evacuation for internally-initiated events. A delay time of 1.5 x the normal delay time and an evacuation speed of 0.5 x the normal evacuation speed was assumed for this case.

- for high PGA earthquakes (>0.6g), it was assumed that there would be no effective evacuation and that many structures would be uninhabitable. The population in the emergency response zone was modeled as being outdoors for the first 24 hours, and then relocating at 24 hours.

Since the large majority of the SFP fire frequency involves large seismic events with PGA exceeding 0.6g, the baseline estimate of the risk increase associated with EP relaxation assumes no effective evacuation for the first 24 hours, consistent with the NUREG-1150 model. However, two additional cases were also considered to explore the sensitivity of the risk increase to evacuation assumptions. In both cases the seismic event was assumed to only partially degrade the emergency response.

In the first sensitivity case, it was assumed that evacuation would be carried out consistent with the NUREG-1150 model for low g earthquakes if current EP requirements are maintained, i.e., 99.5% of the population evacuates, the evacuation delay time is increased by 50 percent, and the time to complete the evacuation is doubled. This is extremely optimistic given the damage to communication and notification systems, buildings and structures, and roads that would accompany any seismic event severe enough to fail the SFP. With no preplanning for radiological accidents, the population evacuating was reduced to 95% and the evacuation delay time was further increased to three times the normal delay time. The second sensitivity case assumed the same delays but evacuation of only 50% of the population.

For purposes of assigning consequences, the "full EP" cases were represented by the results from the early evacuation case (i.e., evacuation is started and completed prior to the release) and the "no preplanning for radiological accidents" cases were represented by the results from the late evacuation case (i.e., evacuation is not started until after the release has occurred). By maximizing the effectiveness of evacuation in the full EP case and minimizing its effectiveness in the no preplanning case, the risk increase associated with EP relaxations would tend to be maximized.

The results of the sensitivity studies indicate that even under the most optimistic assumptions regarding the value of EP in seismic events, the change in risk associated with relaxation of the requirements for radiological preplanning is still quite small. The EP relaxation would result in an increase of about 1.7E-4 early fatalities per year, which is still below the maximum allowable increase in Table 1, and an increase of about 12 person-rem per year, which is only slightly higher than the maximum allowable increase in Table 1.

Table 1 - Allowable Level of Risk Increase In Accordance With RG 1.174 ΔLERF Criterion

Risk Measure	Consequences -- conditional upon source term that produces greatest early fatalities (per event)		Allowable frequency increase in accordance with RG 1.174 (events per year)	Allowable risk increase (per year)
	Internal Events [1]	Seismic Events [2]		
Early fatalities	12	250	1E-6	1.9E-4
Population dose (p-rem within 50 miles)	3.3E6	1.1E7	1E-6	9.1
Latent cancer fatalities	11000	22000	1E-6	0.019

1 - mean CDF for internal events for power operation at Surry is 4.0E-5 per reactor year based on NUREG-1150

2 - mean CDF for seismic events for power operation at Surry is 1.2E-4 per reactor year based on NUREG-1150 and use of LLNL seismic hazard curves

Table 2 - Risk Increase Associated With Relaxing EP Requirements

Event Type	Major Contributor	Freq (per year)	Minimum Time to Release (h)	Full EP				No Preplanning for Radiological Accidents				Δ Risk per year from EP reduction	
				% Evac	Evacuation Model	Conseq per event		% Evac	Evacuation Model	Conseq per event			
						EF	p-rem			EF	p-rem	EF	p-rem
Boildown	LOOP (severe weather)	1.8E-7	>>24	99.5	Early	0.05	6.3E6	95	Early	0.54	6.3E6	9E-8	0
Rapid Draindown	Cask Drop	2.0E-7	<10	99.5	Early	0.05	6.3E6	95	Late	55	1.0E7	1E-5	0.7
	Seismic [1]	3.0E-6	<10	0	No evacuation Relocation at 24 h	?	~1.5E7	0	No evacuation Relocation at 24 h	?	~1.5E7	0	0
	Sensitivity Case 1 [2]			99.5	1.5x normal delay 0.5x normal speed	0.05	6.3E6	95	3x normal delay 0.5x normal speed	55	1.0E7	1.6E-4	11.1
	Sensitivity Case 2			50	1.5x normal delay 0.5x normal speed	5	6.3E6	50	3x normal delay 0.5x normal speed	55	1.0E7	1.5E-4	11.1

1 - Evacuation model for full EP case is consistent with NUREG-1150 assumptions for high acceleration earthquakes

2 - Evacuation model for full EP case is consistent with NUREG-1150 assumptions for low acceleration earthquakes