Description of Dominant Scenarios

Loss of Offsite Power – plant centered & grid related events:

← {Insert (A) (over)}

Case 1 : FFU = 2.2 E-6

i) LOOP * DG fails to start/run * Offsite Power not recovered before fuel uncovery * No recovery from offsite Sources (fire engines, etc) = 33%

ii) LOOP with power recovered & DG(s) available * operator fails to re-start cooling system * failure of recovery actions (fire pumps & offsite sources) = 27%

iii) LOOP with offsite power not recovered but DG(s) available * operator fails to start diesel FP for cooling * failure of offsite sources = 22%

iv) LOOP with offsite power recovered, but DG(s) fail to start * operator fails to re-start cooling system * failure of recovery actions = 18%

Case 2 FFU = 4.0 E-6

Scenarios (ii) & (iv) above become more important because of less time for recovery of failed equipment

ii) = 46%
iv) = 20%
i) = 18%
iii) = 16%

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(over)

Loss of Offsite Power – severe weather events

Similar to LOOP caused by plant-centered & grid related events, however, initiating event frequency is smaller (.007/yr vs .08/yr) but probability of OSP recovery is also much smaller (0.02 for 1-yr fuel, 0.1 for 3-month fuel, vs 0.001). Note: all initiating event frequencies & OSP recovery probabilities are based on generic data

Case 1 : FFU = 2.2E-6

i) LOOP * DG fails to start/run * OSP not recovered * No recovery from offsite sources = 59 %.

ii) LOOP with OSP not recovered but DGs available * operator fails to start diesel FP for cooling * failure of offsite sources = 39 %

Case 2 : FFU = 1.2E-5

with less time for recovery of failed equipment, other scenarios become relatively more important. However, the above 2 scenarios still dominate

i) = 53%.
ii) = 45%

Case 3 : FFU = 8.6E-6

i) LOOP * OSP not recovered * No recovery from offsite sources = 81 %

ii) LOOP with OSP recovery * Operator fails to restart cooling system * No recovery from offsite sources = 19%

Internal Fire

(risk from this IE is dominated by one) The scenario which involves a fire in the building that is not suppressed, and that is large enough to either fail the offsite power feeds, or the fuel pool cooling pumps. Fuel will uncover if the operator fails to cool the pool using the diesel powered fire pump or if recovery using offsite sources (e.g. fire engine) fails. Note: because of the fire, recovery of OSP or the cooling pumps is not modeled.

Case 1: FFU = 6.7 E-6

Initiating event frequency = 8.9×10^{-3} per year based on generic data on pump initiated and electrical cabinet initiated fires.

Case 2: FFU = 15 E-5

Initiating event frequency is similar to above, however, in this case, cutting & welding is assumed to be prevalent. ~~Ito~~ Using generic data, the IE frequency = 0.04 per year. However, at 1 month, it is also assumed that the probability of fire suppression is also greater since the building is more likely to be occupied. ~~The prob of suppression or~~ The prob that a fire is suppressed and that there is no effect on SFP cooling function is 0.05 for this case, versus 0.1 in Case 1 (over)

Loss of Cooling

The initiating event includes the loss of coolant system flow from the failure of pumps or valves, from piping failures, from ineffective heat sink (e.g. loss of heat exchangers) or a local loss of power (electrical connections, etc.)

Operational data (NUREG-1275, Vol 12) shows that the frequency of loss of SFP cooling events in which a temperature increase of more than 20°F occurred can be estimated to be on the order of 2 to 3 events per 1000 reactor years. The data also showed that, for the majority of events, the duration for the loss of cooling is less than one hour. Only 3 events exceeded 24 hours, with the maximum duration being 32 hours. There were 4 events where the temperature increase exceeded 20°F, with the maximum increase being 50°F

For loss of cooling events, the is a lot of time for operator recovery. In the case of 1 yr old fuel, 127 hours is available. For 1 month fuel, the recovery time is 52 hours. Therefore, risk of fuel uncovery is small

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Loss of Coolant Inventory

This initiator includes loss of coolant inventory from events such as those resulting from configuration control errors, siphoning, piping failures, and gate and seal failures.

Operational data provided in NUREG-1275 Vol 12 show that the frequency of loss of inventory events in which ~~loss of~~ a level decrease more than 1 foot occurred can be estimated to be on the order of less than 1 event per 100 reactor years. Most of these events are as a result of operator error and are recoverable. NUREG-1275 shows that ~~only~~ except for one event that lasted for a duration of 72 hours, ~~with all the and~~ there were no ~~other~~ events that lasted for more than 24 hours. Eight events resulted in a level decrease of between 1 and 5 feet, and another two events resulted in a inventory loss of between 5 and 10 feet.

Using ~~the above~~ information from NUREG-1275, it can be estimated that in 6% of the time, a loss of inventory event will ~~result in~~ be large enough and/or occur for a duration that is long enough, so that isolation of the loss is required if the only system available is the spent fuel pool make up system. For the other 94% of the cases, operation of the makeup pump is sufficient to prevent fuel uncovery.

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Seismic Event

In this analysis, it is assumed that the SFP is robust for seismic events < 3 times SSE. It is assumed that the HCLPF value for the SFP integrity is 3xSSE. For the majority of plants, 3xSSE is in the range of 0.4g to 0.5g. ~~A search of the~~ Seismic hazard curves provided by EPRI (EPRI NP-4726, EPRI-NP 6395-D) and Lawrence Livermore National Laboratory (NUREG-1488) show that, for most plants, the mean frequency for seismic accelerations of 0.4g to 0.5g is on the order of, or less than, 2×10^{-5} per year.

Using the definition of HCLPF (95% confidence that the value will not be exceeded for >5% of the time) we estimate a frequency of a seismic event that will challenge SFP integrity to be:

$$2 \times 10^{-5} \times 0.05 = 1 \times 10^{-6} \text{ per year.}$$

Given this earth quake, it is assumed that the SFP structure will fail, the pool will drain, there will be no recovery, and fuel uncovery frequency $= 1 \times 10^{-6}$.

For the cases (5% of the time) where pool ~~integrity~~ is intact, we assume that some part of the SFP cooling components will fail, therefore, cooling will be lost. However, recovery from off site sources is possible. The contribution from this scenario is also estimated to be 1×10^{-6}/yr.