Current Decommissioning Plants

On January 18, 2001, the NC-WARN released a news-release on the technical study of spent fuel pool accident risk at decommissioning nuclear power plants, which was developed by the U.S. Nuclear Regulatory Commission. The news-release states that the conclusion that decommissioning plants should meet the NRC safety goals is based on a list of 10 Industry Decommissioning Commitments (IDCs) and that possibly not all plants meet these assumptions. As a result, the risk associated with those plants could increase by at least a factor of 10. The implication is that some of the existing decommissioning plants may not be safe.

The NRC's evaluation of the risk at decommissioning nuclear power plants did take into account the 10 IDCs committed to by the nuclear industry as well as seven additional staff assumptions that were deemed important to the calculation of risk. These 17 assumptions were used to help create boundary conditions for the mathematical risk analysis of the decommissioning plants. These assumptions were derived in part from staff visits to four of the 19 decommissioning plants to gather information necessary to model a generic spent fuel pool cooling system, which turned out to be much different from those systems used to cool spent fuel pools at operating plants. These visits determined that there were many good practices employed at current decommissioning plants, but that there were few regulatory requirements that would force a licensee to necessarily develop or retain these practices. This finding motivated the NRC's decision to publically identify its important assumptions to help assure all stakeholders were aware of areas that could help keep the risk from decommissioning plants low and to provide input for future Commission rulemaking efforts.

In performing its risk evaluation, the NRC identified two types of events that could cause the spent fuel in a spent fuel pool (SFP) to heat up. The first type rapidly drains the pool of its inventory and is considered to not be mitigible once the event has occurred. Events belonging to this type include extremely large seismic events greater than design basis earthquakes and heavy load drops in or near the spent fuel pool (dropped objects in the 100-ton weight range). The second type either slowly drains the pool, or slowly heats up and boils off the pool inventory. Events belonging to this type include loss of offsite power due to severe weather, fires, failure of the spent fuel pool cooling system, and siphon events.

Most of the 17 assumptions directly bear on the second type of event, which is very slow in developing and provides ample time for intervention by the decommissioning plant operators or outside resources (e.g., the local fire department.) Decommissioning plants have a margin of hundreds of hours between the start of an initiating event and the uncovery of spent fuel in the pool due to pool heat up and boiloff. The NRC found that the operators at the four decommissioning plants visited were highly trained, extremely professional, and very knowledgeable about the plant. Most were former senior reactor operators or reactor operators. In addition, the current decommissioning plants are well bounded by many of the study's initial conditions that would increase the time available to take action. The current decommissioning plants have all been shut down longer three years, which results in lower decay heat levels than used in the study. Also, the fuel at the current decommissioning plants have lower burnups than used in the study, which is another reason why the decay heat level is lower. Because the fuel has a lower decay heat level, it will take more time for the pool water to heatup and boil off and, once the fuel is uncovered, to heatup the spent fuel to a temperature where a zirconium fire could start. The NRC risk assessment credits plants with effectively mitigating these events the vast majority of times, which would also be true for the current decommissioning plants.

A few of the 17 assumptions bear on the first type of event, which rapidly drains the spent fuel pool inventory. Extremely large seismic events are required to fail the spent fuel pools in a manner that would quickly drain the pool. In most cases the size of the earthquake needed to fail the pool would also fail the local infrastructure (e.g., roads, bridges, buildings, electrical power, communications) to the extent that a formal emergency evacuation plan would not alter how any evacuation was conducted, as most emergency, police, state, and other resources would be heavily engaged in a massive rescue effort throughout the area affected. The NRC realizes that the current decommissioning plants have not implemented the seismic checklist identified in the NRC's risk assessment. We note that the design and thickness of SFPs (e.g., sides and bottom are about 4.5 to 6 feet thick reinforced concrete) are driven by the shielding requirements to protect against the radiation from the spent fuel. The amount of rebar in the concrete is determined by industry standards. This combination happens to assure that the spent fuel pools are very robust seismically, although they are primarily designed for radiation shielding. Additionally, as discussed above for the slow developing events, the spent fuel at current decommissioning plants have lower decay heat levels. As a result, even if the low probability catastrophic seismic event occurs, there is an even lower probability that a zirconium fire would occur due to the lower decay heat levels.

Another event that could rapidly drain the pool is a heavy load drop in or near the spent fuel pool. This event was assumed in the risk assessment to not be mitigable. For such an event, the operators would be immediately aware that a heavy load drop had occurred and could contact off-site resources. There is no reason to believe that a successful evacuation of the surrounding area could not be accomplished in the time available. In addition to the time it will take for the pool water to drain, the staff estimated in the study that a plant which has been shutdown for four years would have over 20 hours after fuel uncovery for the spent fuel to heat up to a temperature where a zirconium fire could start. (Youngest plant is Big Rock Point, which shutdown in 8/97 but has very low burnup fuel and SFP is in containment, next youngest plant is Zion 1 which shutdown in 2/97). For current decommissioning plants, that time for the fuel to heat up is even longer because of the lower decay heat levels in the spent fuel as discussed above for the slow developing events. In addition, other accident management mitigation strategies might be employed to help prevent a zirconium fire (e.g., adding fire protection water or lake water). The NRC intends to investigate the frequency of heavy load lifts at decommissioning sites and will determine if changes to inspection guidance or plant-specific backfits are necessary, particularly for plants equipped with non-single failure proof cranes.

Based on length of shutdown, time available for mitigation, and time available for evacuation, at this time the NRC concluded that immediate action is not required to forestall a risk-significant situation at any decommissioning plant. The NRC does intend to continue to monitor and evaluate the risk of decommissioning plants and will alter its inspection guidance and other practices as necessary to assure that risk remains low. The NRC will be investigating the need to incorporate aspects of the 17 assumptions into future updates to decommissioning plant inspection guidance.

ISSUE	CONCLUSION ABOUT EFFECT OF ISSUE ON EP AT CURRENT DECOMMISSIONING SITES
IDC No 1 - Cask drop analyses or single failure proof crane for handling heavy loads	One of dominant contributors to risk. Lack of full EP mitigated if newest fuel in SFP is at least 2 - 5 years old. Based on capability to make ad-hoc evacuation of surrounding area if time available. Still have land interdiction. Downside - non-single failure proof cranes may have upwards of two orders of magnitude higher frequency of heavy load drops compared to single failure proof (SF proof) cranes. For 100 lifts a year, a non SF proof crane has about a 1E-5 per year chance of having a catastrophic heavy load drop compared to about 1E-7 for single failure proof crane.
IDC No 2 - Procedures to bring off- and on-site resources to bear	At four sites found fuel handlers knowledgeable about whom to contact off-site. Time available on most situations is so long, fuel handler can delay response for long time and still have time to recover. Downside - History says that a licensee will tend to try and do what ever it can before calling in offsite resources or using drastic measures (e.g., Davis Besse loss of feedwater event). Delay in bringing in offsite resources could make recovery less probable without clear point at which offsite resources MUST be called in.
IDC No 3 - Procedures to communicate during severe weather and seismic events	Currently have some capabilities at four plants for severe weather events. May lose this with going to dedicated SFP control rooms versus operating reactor control rooms that have radio as well as phone lines. Time available is significant and probably would not be risk significant.
IDC No 4 - Offsite resource plan in place	Time available on mitigatable events is so long that this should not have a major effect on risk. Downside - I have no idea how long it takes to get in portable heat exchangers or other equipment that might be needed. Not sure if this is available in 24 hours or 72 hours or more.

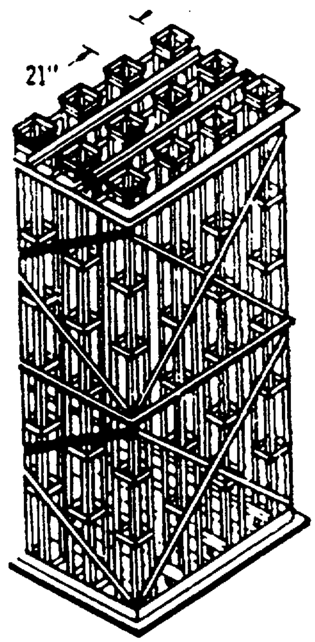
IDC No 5 - SFP instrumentation including readouts and alarms for SFP temperature, water level, and radiation	Boil off and slow drain down events are so slow that having two or more walkdowns per day should provide adequate assurance in the near term that inventory is not being lost. Downside - Walkdowns may not be required. None of these instruments needs to be operable (with exception of radiation alarm if moving fuel.)
IDC No 6 - SFP seal design results in limited leakage on seal failure	Could be a problem if an older plant has a seal design where the failure of the seal (e.g., around one of the weir doors) had the capability of failing in a manner that allowed rapid draining of the pool. No information on this.
IDC No 7 - Procedures to reduce drain down risk including siphon protection and pump controls [DID THE SFP TASK FORCE ON SUSQUEHANNA CHECK ON THIS FOR DECOMMISSIONING PLANTS?]	Would still be a slow event in most cases and should be caught by walkdowns. Could be a problem is the plant has large pipes deep into the SFP. No operating plants are supposed to have such pipes. Not sure if decommissioning plants do.
IDC No 8 - Onsite restoration plan to repair SFP cooling systems or makeup water to the SFP. No need to enter SFP area.	Need to not enter SFP area only important if got within three feet (or lower) of uncovering the spent fuel. Frequency of this should be low. External inventory addition not deemed to be useful in our analysis (based on how modeled) for large seismic and heavy load drop events, which are the dominant events. External addition does not help you in the event of severe weather either. I am not aware that the effect of adding cold water to exposed hot fuel has been studied for spent fuel pools.
IDC No 9 - Procedures to control plant evolutions with potential to rapidly drain SFP	See IDC No 1. This could have a large effect for plants that are moving heavy objects over the spent fuel pool or surrounding area. Lack of extra controls and lack of a single failure proof crane could increase the risk from heavy load drops by a fraction where the numerator is 10 or 100 and the denominator is number of heavy load lifts per year accomplished divided by 50 (the assumed number of lifts in the report.)
IDC No 10 - Test alternative pool makeup capability and keep functional	Probably already being done because most times this capability is the fire water system which must be tested per insurance requirements. Volumetric flow rate may be low, but boiloff rate is slow too. For loss of inventory events, the rate of loss will determine the efficacy of the fire water pumps.

SDA No 1 - Design at least as capable as assumed in report	Most likely achieved at all plants since modeled design was very spartan
SDA No 2 - Walkdowns at least once per shift. Know time available to makeup inventory.	Found this to be what was happening at the four plants I visited. During stakeholder meetings, industry representatives indicated they had procedures that required walkdowns. No reason to believe (especially after the Dresden event) that operators are not walking down the SFPs. The NRC staff should confirm that all decommissioning plants have fuel handlers walking down the pools at least twice a day and preferably three times a day.
SDA No 3 - Control room instrumentation will directly monitor SFP temperature and water level. Alarm associated with level at which call in off-site resources.	Walkdowns should catch events where control room instrumentation does not portray an accurate picture of the SFP water level situation.
SDA No 4 - Licensee assures no drain paths more than 15 feet below surface of SFP	Normally only would be a small line, if goes to the bottom of the pool (e.g., 1-2 inch line). Alarms and walkdowns should alert fuel handlers to diversion of SFP inventory. Should not be too risk significant because this was checked for operating reactors. Not sure if checked for decommissioning plants. NRC should confirm.
SDA No 5 - Perform load drop consequence analysis or have single failure proof crane	See IDC No 1. Very important for non-single failure proof cranes. Mitigated by the actual number and frequency of heavy load lifts being performed at decommissioning plants today.
SDA No 6 - Successfully complete seismic check list.	Very important. If list not checked and verified, then could be a vulnerability that would lower the capacity of the SFP significantly. At this time we see no reason to believe that such vulnerabilities exist. Mitigated for plants with no vulnerabilities by the fact that the required large earthquake to severely damage the pool would destroy the infrastructure of the surrounding area including roads, bridges, and buildings. Therefore, formal EP not effective in these cases.
SDA No 7 - Maintain program to surveil and monitor Boraflex in high-density SFP racks	Very slow acting problem. Operator rounds should detect pool heat up if instrumentation does not.

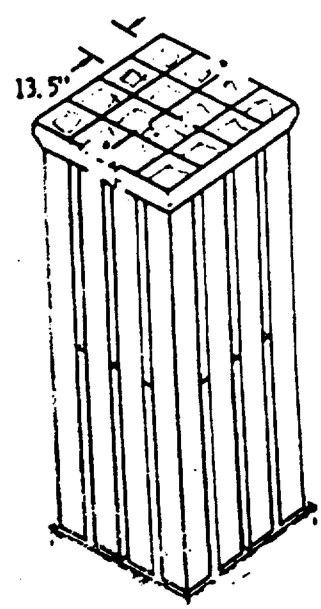
High Density and Low Density spent fuel racks:

<u>Low Density racks</u>:
- criticality control is provided by spacing between assemblies
- large center-to-center spacing
- PWR: walls of the SF racks are open lattice, however some could have solid walls
- BWRs: channel boxes are kept around assemblies in SFP - therefore for fluid flow, the racks are always considered to have solid walls.

Low Density Rack with an open frame (oldest design)



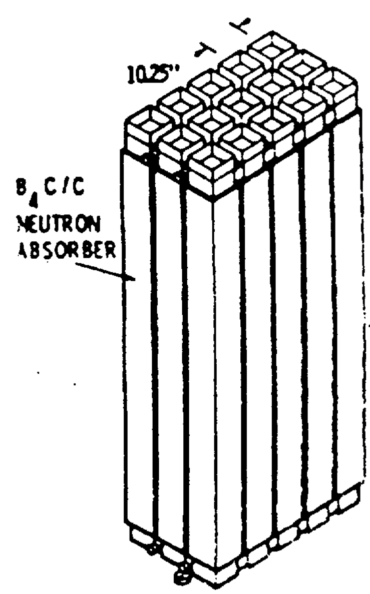
Low density rack with solid wall frame



High Density racks:
- criticality control is provided by neutron shielding plates (e.g.. boraflex)
- PWR and BWR designs are similar
- walls of the SF racks are solid and form boxes around the assemblies
- smaller center-to-center spacing
- ~5 inch diameter hole in bottom of rack for water or air flow

- Older high density racks have spaces between the boxes around the assemblies
- Current high density racks have no space between boxes and actually share a wall with the next assembly

High Density Racks have neutron absorbers on solid walls



Generic Issue - 82:

GI-82 examined SFP storage accidents for 2 reasons:
(1) New use of high density spent fuel storage racks because of decision not to reprocess fuel
(2) Laboratory studies identified possibility of zirconium fire

Concluded to take "no action" option for several reasons:
(1) did not pass the backfit test (could not identify any cost benefit options)
(2) risk met safety goals
(3) reducing risk from SFP would still leave a comparable risk from the reactor

Changes in spent fuel storage since GI-82 resolved:
(1) higher burnup fuel / higher decay heat levels
 GI-82: 30-40 GWD/MTU[2]
 Now: 60 GWD/MTU
(2) higher density racking
 GI-82: independent boxes around each assembly with space between boxes[2]
 Now: shared boron walls to form boxes around assemblies

Changes in information since GI-82 resolved:
(1) uncertainty on release fractions, particularly ruthenium
 GI-82: reactor fractions[1]
 TWG: sensitivity studies on Ruthenium, fewer on Cesium, Iodine, Tellurium, Lanthanum, Strontium, and Barium

(2) potential for uncoolable geometry from large seismic event
 GI-82: analysis used intact SF rack geometry[2]
 TWG: could not assume any geometry due to beyond design basis seismic event

(3) greater probability of partial draindown
 GI-82: supporting analysis stated that partial draindown could be worse than complete draindown but considered partial draindown a transition phase to complete draindown[2]
 TWG: seismic expert concluded that an earthquake could break the pool wall but stopped several feet above the floor causing a partial draindown

[1] NUREG-1353, "Regulatory Analysis for the Resolution of Generic Issue 82, "Beyond Design Basis Accidents in Spent Fuel Pools", April 1989

[2]NUREG/CR-0649, "Spent Fuel Heatup Following Loss of Water During Storage," March 1979