

**[ Union of  
Concerned Scientists**

## **Status of Fukushima Lessons**

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**Union of Concerned Scientists**

**[www.ucsusa.org](http://www.ucsusa.org)**

**Good morning. Thank you for  
soliciting our views on this topic.**

**Next slide please.**

**Status to date**

**Good\***

**My focus today will be on the  
mitigating strategies order.  
Many themes are applicable to  
other Fukushima lessons.**

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**Overall, we'd rate progress to date as Good, although with a fairly large caveat.**

**My remarks today will focus on the mitigating strategies order but the themes apply more broadly.**

**Next slide please.**

## **On the Good Side**

**Station blackout rule assumed that alternating current power would be restored within the plant-specific coping duration (typically 4 or 8 hours)**

**Mitigating strategies order seeks to provide core, containment and spent fuel cooling for an infinite period.**

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**The station blackout rule assumed that either the offsite power grid or onsite emergency diesel generators would be restored within hours. It provided no protection against power outages lasting longer than the assumed coping duration.**

**A strength of the mitigating strategies order is that it relies on no subjective duration.**

**Next slide please.**

### **On the Caveat Side**

**Original assumption that Fukushima invalidated has been replaced by the assumption that FLEX equipment can be placed and operated in time.**

**Is this assumption also invalid?**

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**But have we solved the problem or just swapped problems?**

**The mitigating strategies order assumes that FLEX will be deployed in time to prevent core damage.**

**UCS is not convinced that the order's assumption is valid.**

**Next slide please.**

## On the Good Side

February 2013 FLEX Integrated Plan

Equipment / Event (Note 1)	Qty	Seismic	External Floods	Hurricane / Tornado	Snow, Ice, Cold	High Temps
Duplex Strainer Trailer 400 GPM 1/8 Inch Size Req'd N = 1						
FLEX-North	1	1	1	1 or 0	1	1
FLEX-South	1	1	1	1 or 0	1	1
Total Available	N+1	N+1	N+1	N	N+1	N+1
Resin Demin Skid 60 cu-ft Mixed Bed Req'd N = 2						
FLEX-North	2	2	2	2 or 0	2	2
FLEX-South	2	2	2	2 or 0	2	2
Total Available	N+2	N+2	N+2	N	N+2	N+2
Frac or Bladder Tank Req'd N = 1						
On-Site North - Frac	1	1	1	1 or 0	1	1
FLEX-North - Bladder	1	1	1	1 or 0	1	1
FLEX-South - Bladder	1	1	1	1 or 0	1	1
Total Available	N+2	N+2	N+2	N	N+2	N+2
Air-Flowered Diaphragm Pumps Req'd N = 2						
FLEX-North	2	2	2	2 or 0	2	2
FLEX-South	2	2	2	2 or 0	2	2
Refuel Floor	1	1	1	1 or 0	1	1
Total Available	N+3	N+3	N+3	N	N+3	N+3
Battery Room Fans						

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**In general, FLEX provides at least N+1 widgets or connections when N is required for success.**

Source: ML13063A063

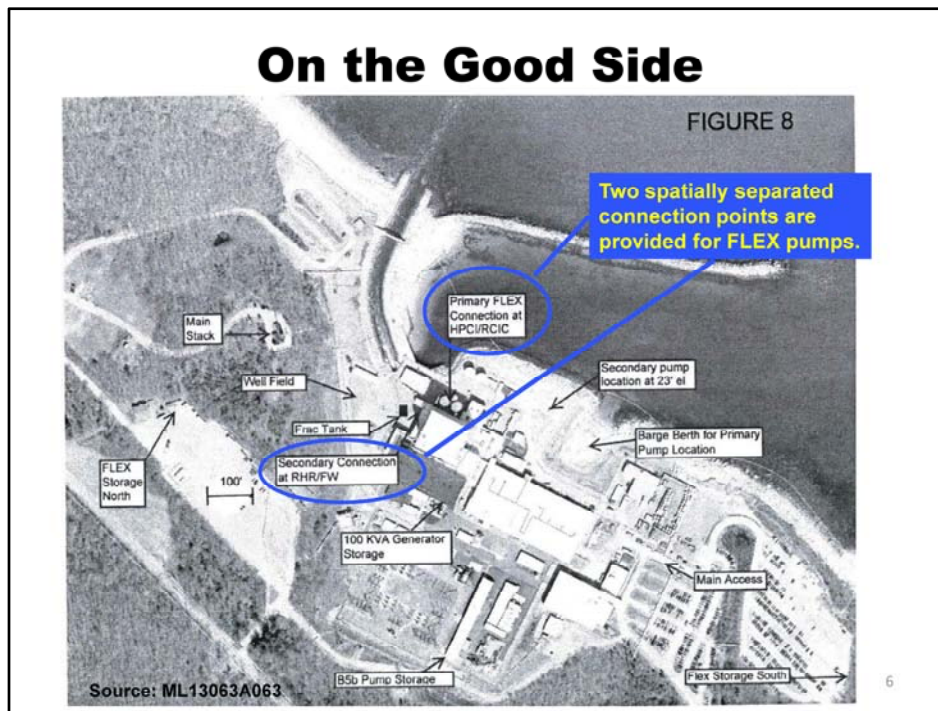
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**My apologies to Entergy for drafting Pilgrim to illustrate our points. My Pilgrim-specific comments generally apply to all operating reactors.**

**A potential strength of FLEX is in providing at least N+1 options when N is required for success.**

**Next slide please.**

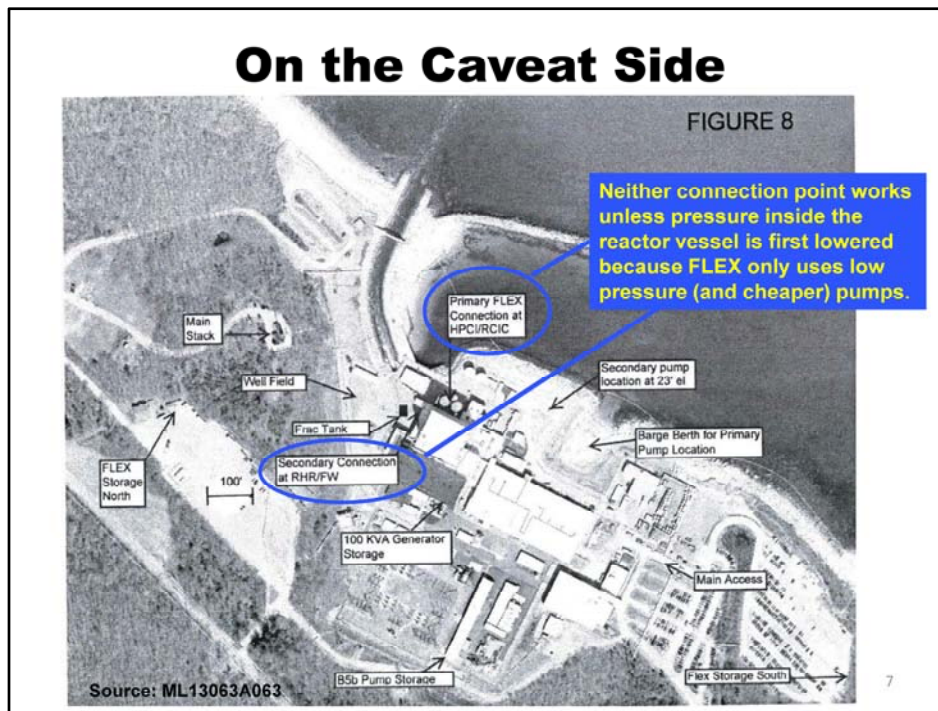
## On the Good Side



**This map of the Pilgrim site shows that multiple points are envisioned for connecting FLEX's makeup pumps.**

**Next slide please.**

## On the Caveat Side



But even a dozen connections could be useless because none of the FLEX pumps can provide high pressure makeup. The reactor pressure must be reduced by non-FLEX methods for FLEX's teeny tiny pumps to work.

Next slide please.

## On the Caveat Side

February 2013 FLEX Integrated Plan

Equipment / Event (Note 1)	Qty	Seismic	External Floods	Hurricane / Tornado	Snow, Ice, Cold	High Temps
Duplex Brainer Trailer 400 GPM 1 1/2 Inch Side Rex'd N = 1						
FLEX-North	1	1	1	1 or 0	1	1
FLEX-South	1	1	1	1 or 0	1	1
Total Available	N+1	N+1	N+1	N	N+1	N+1
Resin Demin Skid 60 cu-ft Mixed Bed Rex'd N = 2						
FLEX-North	2	2	2	2 or 0	2	2
FLEX-South	2	2	2	2 or 0	2	2
Total Available	N+2	N+2	N+2	N	N+2	N+2
Frac or Bladder Tank Rex'd N = 1						
On-Site North - Frac	1	1	1	1 or 0	1	1
FLEX-North - Bladder	1	1	1	1 or 0	1	1
FLEX-South - Bladder	1	1	1	1 or 0	1	1
Total Available	N+2	N+2	N+2	N	N+2	N+2
Air-Powered Diaphragm Pumps Rex'd N = 2						
FLEX-North	2	2	2	2 or 0	2	2
FLEX-South	2	2	2	2 or 0	2	2
Refuel Floor	1	1	1	1 or 0	1	1
Total Available	N+3	N+3	N+3	N	N+3	N+3
Battery Room Fans						

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**0 < N and  
nature rather  
than the NRC's  
assessment  
determines the  
outcome.**

Source: ML13063A063

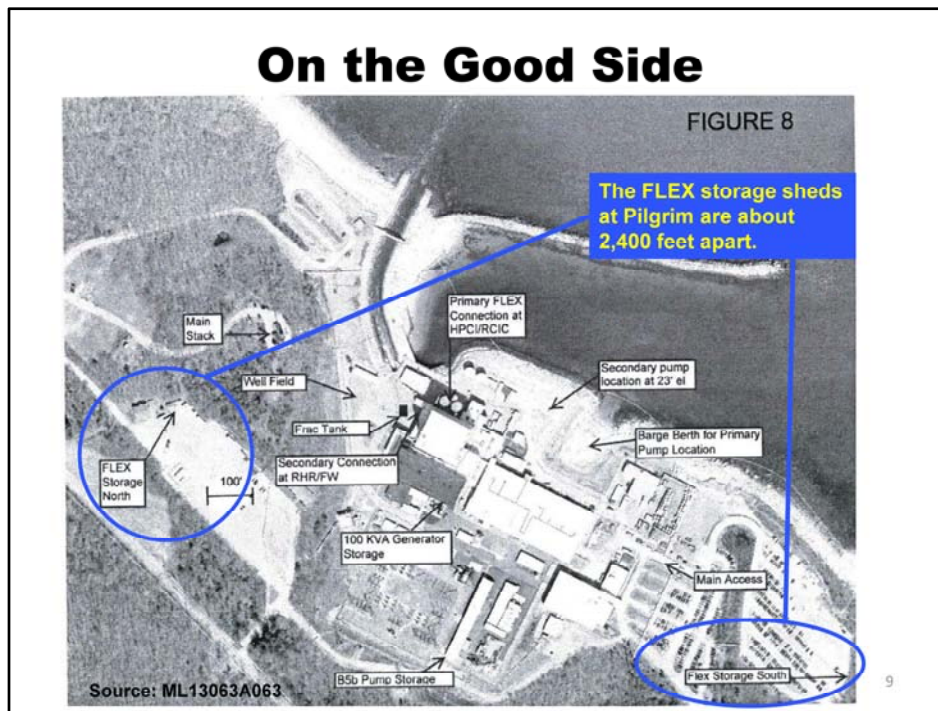
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**Entergy's analysis for Pilgrim shows that a tornado could disable all of the FLEX equipment. Having more equipment that workers cannot use is not the proper goal here.**

**Next slide please.**



## On the Good Side



To guard against a tornado affecting both FLEX storage locations, Entergy positioned them more than a stone's throw apart.

Next slide please.

## **On the Caveat Side**

**NRC *assumes* that “Should one storage area be lost, the surviving storage area has adequate equipment.”**



**Tornado that devastated Moore, OK must not have been aware of the 2,400 foot rule.**

**Disaster Picture: FEMA**

**Source: ML13225A587**

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**The NRC assumed that one and only one location will be compromised by extreme weather.**

**Apparently, the tornado that devastated Moore, Oklahoma did not know about this 2,400 foot rule when it destroyed far larger portions of that city.**

**Next slide please.**

## On the Caveat Side

February 2013 FLEX Integrated Plan

Equipment / Event (Note 1)	Qty	Seismic	External Floods	Hurricane / Tornado	Snow, Ice, Cold	High Tempe
(Note 5) Req'd N + 2						
FLEX-North	1	1	1	1 or 0	1	1
FLEX-South	1	1	1	1 or 0	1	1
Batt Room, Staged	2	2	2	2	2	2
Total Available	N+2	N+2	N+2	N+1	N+2	N+2
Small Diesel Generator, 120/240 VAC 1-Ph Req'd N = 1 - 12 kW Req'd N + 2 - 6 kW						
FLEX-North	3	3	3	3 or 0	3	3
FLEX-South	3	3	3	3 or 0	3	3
Total Available	N+3	N+3	N+3	N	N+3	N+3
Debris Removal Wheel Loader On-Site, Req'd N = 1	N	N	N	N	N	N

**Notes:**

- The Tornado Event is the most limiting and potentially results in only "N" FLEX Equipment available, including the loss of the B.5.b Pump, but this event has no potential to drain the SFP, which is the basis for the primary SFP Spray capability of the B.5.b Pump in accordance with 10 CFR 50.54(h) for Security-Related Events. All other events will result in at least "N+2" FLEX Pumps available, each of which has the same capability as the B.5.b Pump and can provide SFP Spray at the same flow rates and conditions. The B.5.b requirement includes a SFP makeup rate of at least 500 GPM and SFP Spray requirement of 250 GPM and is not based on a particular leakage or boil-off makeup rate, it is the required spray flow needed to prevent exposed spent fuel from reaching the oxidation temperature after a SFP shutdown. This B.5.b capability is not compromised in any way by the simultaneous deployment of FLEX Equipment. For all ELAP and LUHS Events, "N" FLEX Pumps provide the required capacity for Core Cooling, Containment Heat Removal, and SFP Makeup Water.

**N+3 = N when only one debris remover is provided, unless events are "tidy" and only deposit debris in designated places.**

Source: ML13063A063

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**Entergy claims to have N+3 capabilities. But N+3 may only equal N unless extreme weather cooperates by only cluttering up one small area.**

**Next slide please.**

## **On the Caveat Side**

**NRC technical evaluation  
report:**

**“The single debris removal  
equipment identified may not  
be able to move debris to  
enable transport of equipment  
within the 6-9 hour time  
restriction for the pumps and  
generators.”**

Source: ML13225A587

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**As the NRC’s review of Entergy’s plan noted, the N debris remover may not be able to free up the N+1, N+2, and N+3 equipment in time.**

**The Japanese word for this situation may be Fukushima.**

**Next slide please.**

## On the Good Side

February 2013 FLEX Integrated Plan

### Attachment 5 PNPS FLEX Equipment Storage Sea Vans

PNPS will be storing FLEX equipment in Sea Vans at two separate locations at the opposite extremes of the Owner Controlled Area (approximately 1800ft geographically separated). The locations are also at the higher elevations on the site, a minimum of 30ft above mean sea level. The North Storage Area is partially established and is as shown in the photos below. The Sea Vans are supplied with AC power for equipment heaters and lighting, one Sea Van is environmentally controlled, and the others ventilated. The site storage is located and arranged to also support equipment testing, operability, and provide for rapid deployment.



FLEX Storage North; lighting and power is provided to each Sea Van.

**Equipment  
over and  
above that  
provided  
for B.5.b is  
now onsite.**

Source: ML13063A063

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**Another strength of the mitigating strategies order is that considerably more equipment is now staged onsite. Workers have more options. Next slide please.**

## **On the Caveat Side**

**Equipment heaters protect FLEX equipment from cold weather damage before the BDBEE.**

**NRC Bulletin 79-24 discussed events at nuclear plants where safety-related systems were disabled by cold weather. These systems were monitored and surveilled, yet failed.**

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**But will that equipment be damaged before the need arises?**

**There are no regulatory requirements to monitor the storage shed heaters or to fix them within some timeframe if one happens to notice that they are broken.**

**Monitored and tested safety equipment has been disabled by cold weather, but NRC assumes that unmonitored and untested equipment somehow avoids this outcome.**

**Next slide please.**

## **On the Caveat Side**

**NRC requires that workers periodically check air inlet and outlet ventilation ports for dry casks for blockage, but not for FLEX storage pods.**



Source: NRC Flickr Gallery

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**Regulatory requirements have workers periodically inspecting the air inlet and outlet ports for dry storage systems for ventilation flow obstructions.**

**But NRC assumes that FLEX's unmonitored storage sheds at the same site are somehow immune to such blockage mechanisms.**

**Next slide please.**



## Pilgrim's BDBEE Plan

A simplified description of the Pilgrim Integrated Plan to mitigate the postulated extended loss of ac power (ELAP) event is that the licensee will initially remove the core decay heat by using the Reactor Core Isolation Cooling (RCIC) system. The steam-driven RCIC pump will initially supply water to the reactor from the condensate storage tank, or the suppression pool, depending on availability. Steam from the reactor will then be vented through the safety relief valves to the suppression pool in the torus to gradually cool down the reactor pressure vessel (RPV). RPV depressurization will be stopped at a pressure of about 120 pounds per square inch gauge (psig) to ensure sufficient steam pressure for continued RCIC operation. Once FLEX pumps are deployed, with suction aligned to Cape Cod Bay, the RCIC turbine will be shut down and the FLEX pumps will be used to inject seawater into the RPV. Water will fill the RPV and flow out the SRVs to the suppression pool. Before the suppression pool temperature exceeds 281 degrees Fahrenheit, the suppression pool (torus) will be vented to atmosphere using the hardened vents to release heat and stop the temperature increase. In the long term, the licensee will fill a tank with fresh water from wells at the site, and then inject fresh water into the RPV and establish a stable water level with heat removal by boiling. The licensee's analysis shows that the suppression pool will not overflow during this event. Source: ML13225A587

**The plan non-conservatively assumes that the reactor vessel pressure gets lowered enough to let FLEX's low pressure pump(s) provide makeup flow.**

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**This is the NRC's summary of Pilgrim's plan developed in response to the mitigating strategies order.**

**As previously noted, the plan non-conservatively assumes that the reactor pressure is somehow lowered to allow the little bitty FLEX pumps to work.**

**Next slide please.**



## Pilgrim's BDBEE Plan

A simplified description of the Pilgrim Integrated Plan to mitigate the postulated extended loss of ac power (ELAP) event is that the licensee will initially remove the core decay heat by using the Reactor Core Isolation Cooling (RCIC) system. The steam-driven RCIC pump will initially supply water to the reactor from the condensate storage tank, or the suppression pool, depending on availability. Steam from the reactor will then be vented through the safety relief valves to the suppression pool in the torus to gradually cool down the reactor pressure vessel (RPV). RPV depressurization will be stopped at a pressure of about 120 pounds per square inch gauge (psig) to ensure sufficient steam pressure for continued RCIC operation. Once FLEX pumps are deployed, with suction aligned to Cape Cod Bay, the RCIC turbine will be shut down and the FLEX pumps will be used to inject seawater into the RPV. Water will fill the RPV and flow out the SRVs to the suppression pool. **Before the suppression pool temperature exceeds 281 degrees Fahrenheit, the suppression pool (torus) will be vented to atmosphere using the hardened vents to release heat and stop the temperature increase.** In the long term, the licensee will fill a tank with fresh water from wells at the site, and then inject fresh water into the RPV and establish a stable water level with heat removal by boiling. The licensee's analysis shows that the suppression pool will not overflow during this event. **Source: ML13225A587**

**The plan non-conservatively assumes that instrumentation not covered by post-Fukushima orders will guide operators into taking proper and timely actions.**

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**And the plan non-conservatively assumes that plant instrumentation not covered by any of the NRC's post-Fukushima reliability orders somehow continues to work just fine and guides the operators into taking proper and timely mitigating actions. Next slide please.**

## Pilgrim's BDBEE Plan

A simplified description of the Pilgrim Integrated Plan to mitigate the postulated extended loss of ac power (ELAP) event is that the licensee will initially remove the core decay heat by using the Reactor Core Isolation Cooling (RCIC) system. The steam-driven RCIC pump will initially supply water to the reactor from the condensate storage tank, or the suppression pool, depending on availability. Steam from the reactor will then be vented through the safety relief valves to the suppression pool in the torus to gradually cool down the reactor pressure vessel (RPV). RPV depressurization will be stopped at a pressure of about 120 pounds per square inch gauge (psig) to ensure sufficient steam pressure for continued RCIC operation. Once FLEX pumps are deployed, with suction aligned to Cape Cod Bay, the RCIC turbine will be shut down and the FLEX pumps will be used to inject seawater into the RPV. Water will fill the RPV and flow out the SRVs to the suppression pool. Before the suppression pool temperature exceeds 281 degrees Fahrenheit, the suppression pool (torus) will be vented to atmosphere using the hardened vents to release heat and stop the temperature increase. In the long term, the licensee will fill a tank with fresh water from wells at the site, and then inject fresh water into the RPV and establish a stable water level with heat removal by boiling. *The licensee's analysis shows that the suppression pool will not overfill during this event.* Source: ML13225A587

**The plan non-conservatively assumes that RCIC takes suction from the suppression pool. When RCIC takes suction from its normal and usual source, the suppression pool fills more.**

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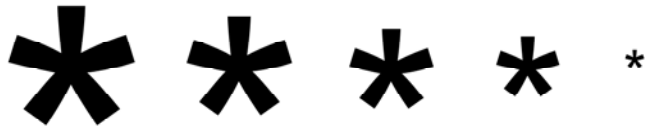
The plan also non-conservatively assumes that the reactor core isolation cooling system, called RCIC, will only draw water from the suppression pool and provide it to the reactor vessel for core cooling. This water will return to the suppression pool as steam flowing through the relief valves.

When RCIC draws water from its normal source, the condensate storage tank, the suppression pool will fill up much faster.

But somehow RCIC is magically re-aligned to its non-preferred supply source and the very bad outcome of the suppression pool overfilling is conveniently averted.

This assumption is non-conservative and non-flexible.

Next slide please.



**The caveat would shrink if:**

- **FLEX employed both high and low pressure pumps**
- **FLEX storage sheds were less vulnerable to common-mode losses**
- **Regulatory requirements governed FLEX equipment while in storage**
- **Non-conservative assumptions that transform BDBEE into BBDBEE were eliminated**

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The mitigating strategies order would be better if it resulted in pumps that would work under both high and low reactor pressure conditions, if these pumps and collateral equipment were stored in locations less susceptible to common-mode losses, if regulatory requirements ensured sufficient monitoring of equipment while in storage, and if many non-conservative assumptions were eliminated that transform beyond design basis external events into barely beyond design basis external events.

## **Acronym List**

**BDBEE – one acronym too many in the series of Class 9, severe accident, and Beyond Design Basis External Event labels for bad days**

**FLEX – Diverse and Flexible Mitigation Capability**

**NRC – Nuclear Regulatory Commission**

**RCIC – Reactor core isolation cooling**

**SBO – station blackout where all AC power is unavailable**

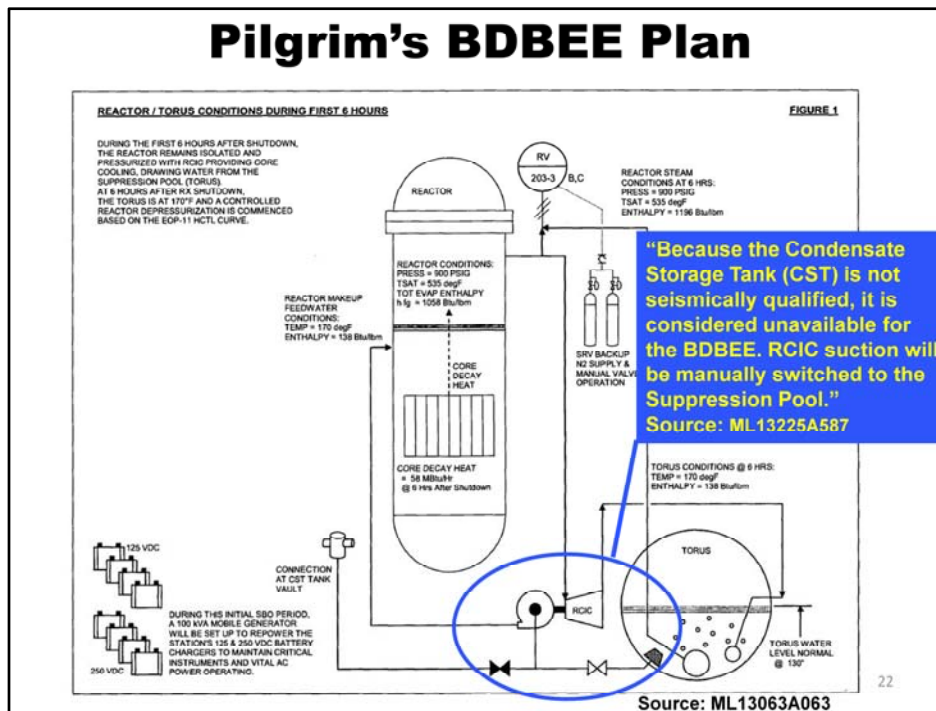
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Yogi Berra may have had this situation in mind when he said, “It’s déjà vu all over again.” Two decades ago, the NRC mandated hardened containment vents be provided on boiling water reactors. After Fukushima demonstrated that this safety upgrade would not work during the very accident in which it would most likely be needed, the NRC mandated that the old hardened containment vents now be made reliable. Two years ago, the NRC mandated that mitigating strategies be provided for all nuclear power reactors. Will it take another disaster before the NRC then mandates that the old mitigating strategies be made reliable? That answer is literally in your hands. Thank you.

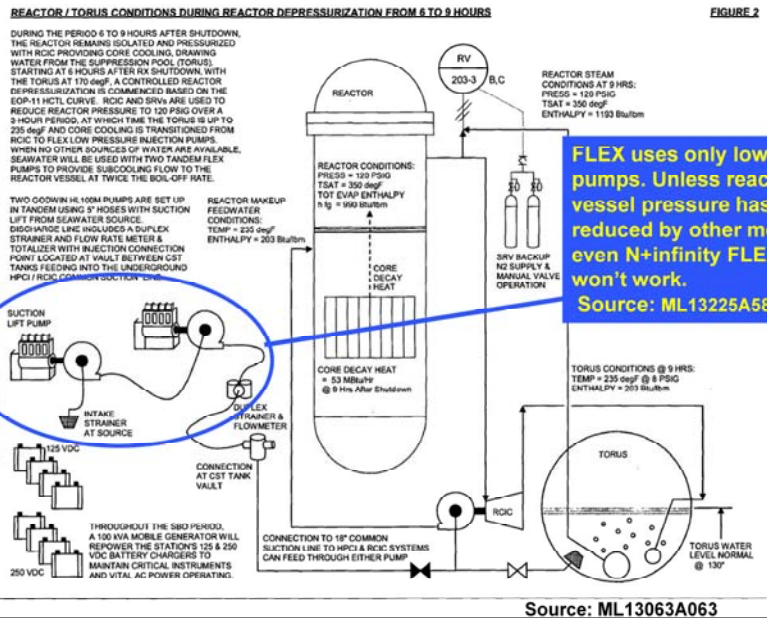
## **Backup Slides**

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# Pilgrim's BDBEE Plan



# Pilgrim's BDBEE Plan



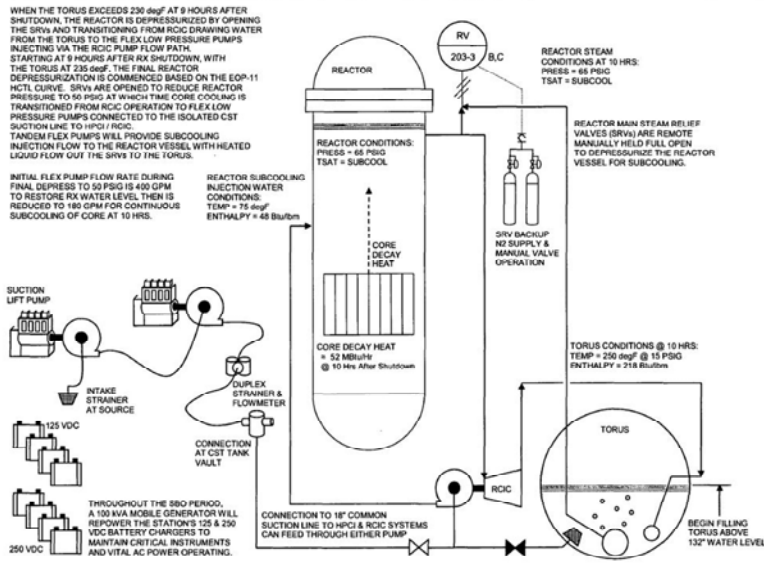
**FLEX uses only low pressure pumps. Unless reactor vessel pressure has been reduced by other means, even N+infinity FLEX pumps won't work.**  
Source: ML13225A587

Source: ML13063A063

# Pilgrim's BDBEE Plan

REACTOR / TORUS CONDITIONS DURING REACTOR FINAL DEPRESSURIZATION FROM 9 TO 19 HOURS

FIGURE 3



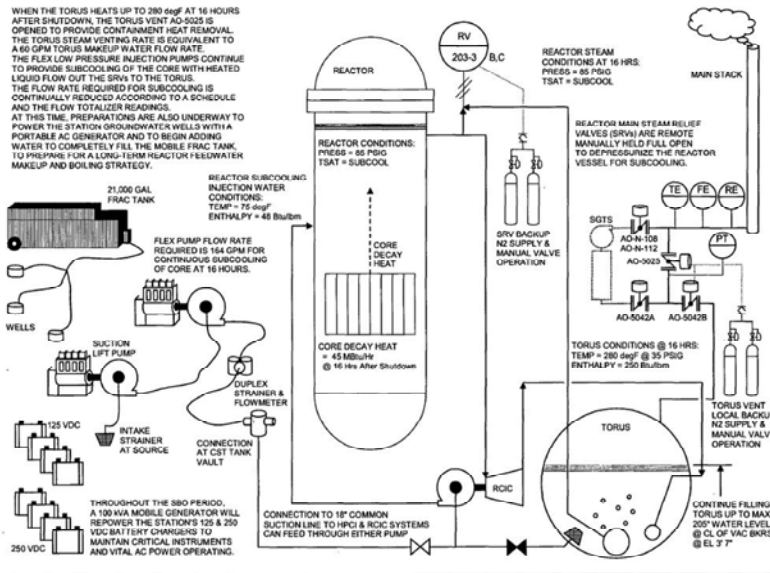
Source: ML13063A063



# Pilgrim's BDBEE Plan

## REACTOR / TORUS CONDITIONS FROM 10 HOURS TO THE START OF TORUS VENTING AT 16 HOURS

FIGURE 4

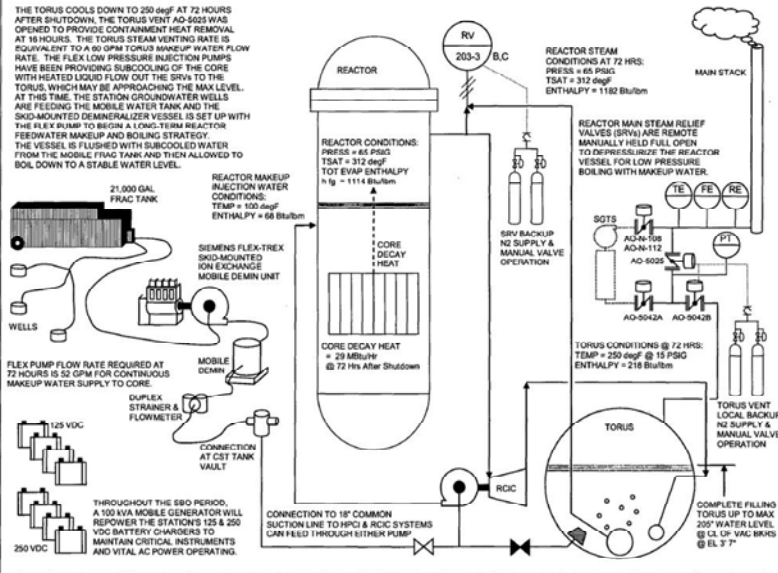


Source: ML13063A063

# Pilgrim's BDBEE Plan

REACTOR / TORUS CONDITIONS DURING TORUS VENTING AFTER 16 HOURS TO MAKEUP MODE AT 72 HOURS

FIGURE 5



Source: ML13063A063