Union of Concerned Scientists

Status of Fukushima Lessons

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Status to date

Good*

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

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.

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Original assumption that Fukushima invalidated has been replaced by the assumption that FLEX equipment can be placed and operated in time.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

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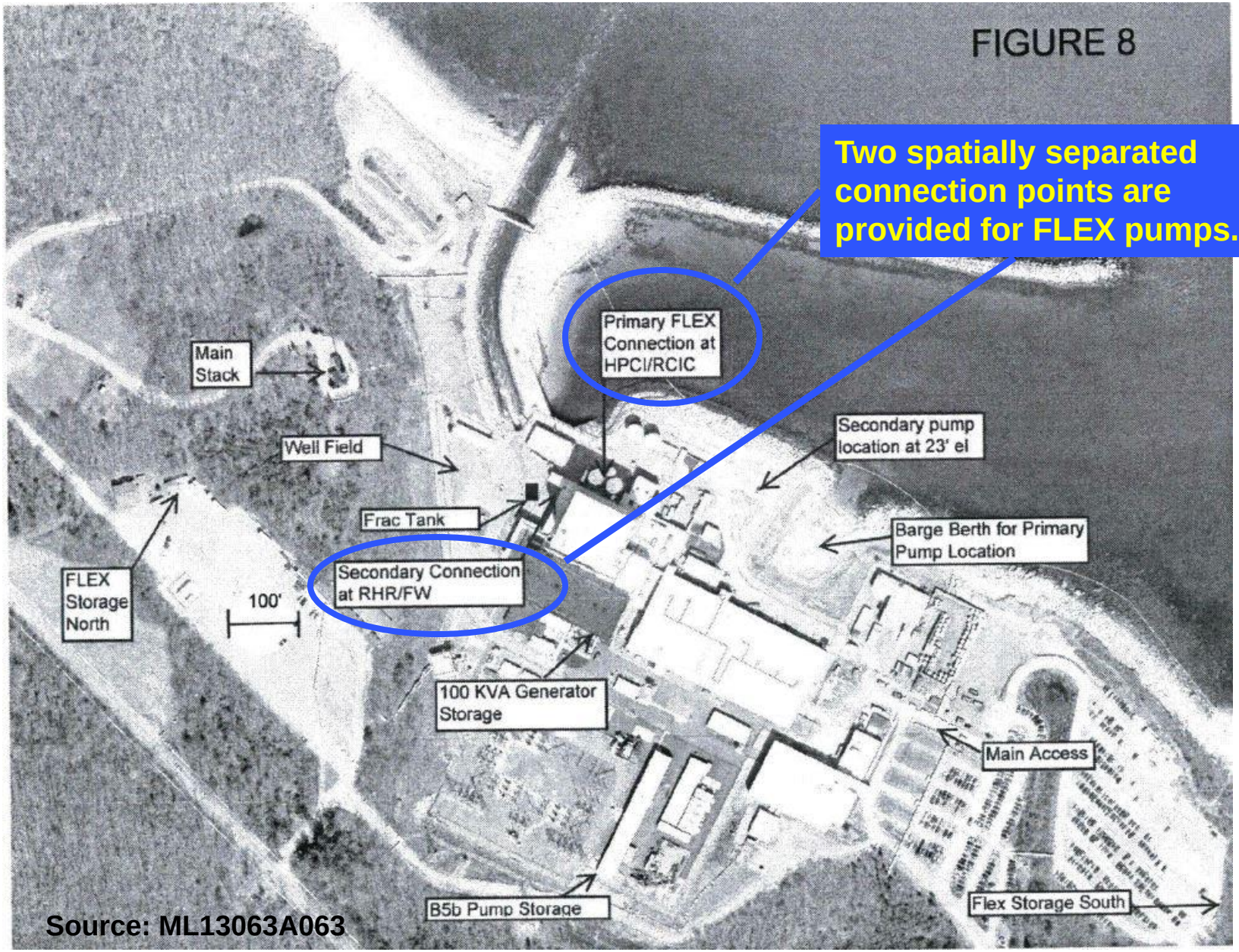
In general, FLEX provides at least N+1 widgets or connections when N is required for success.

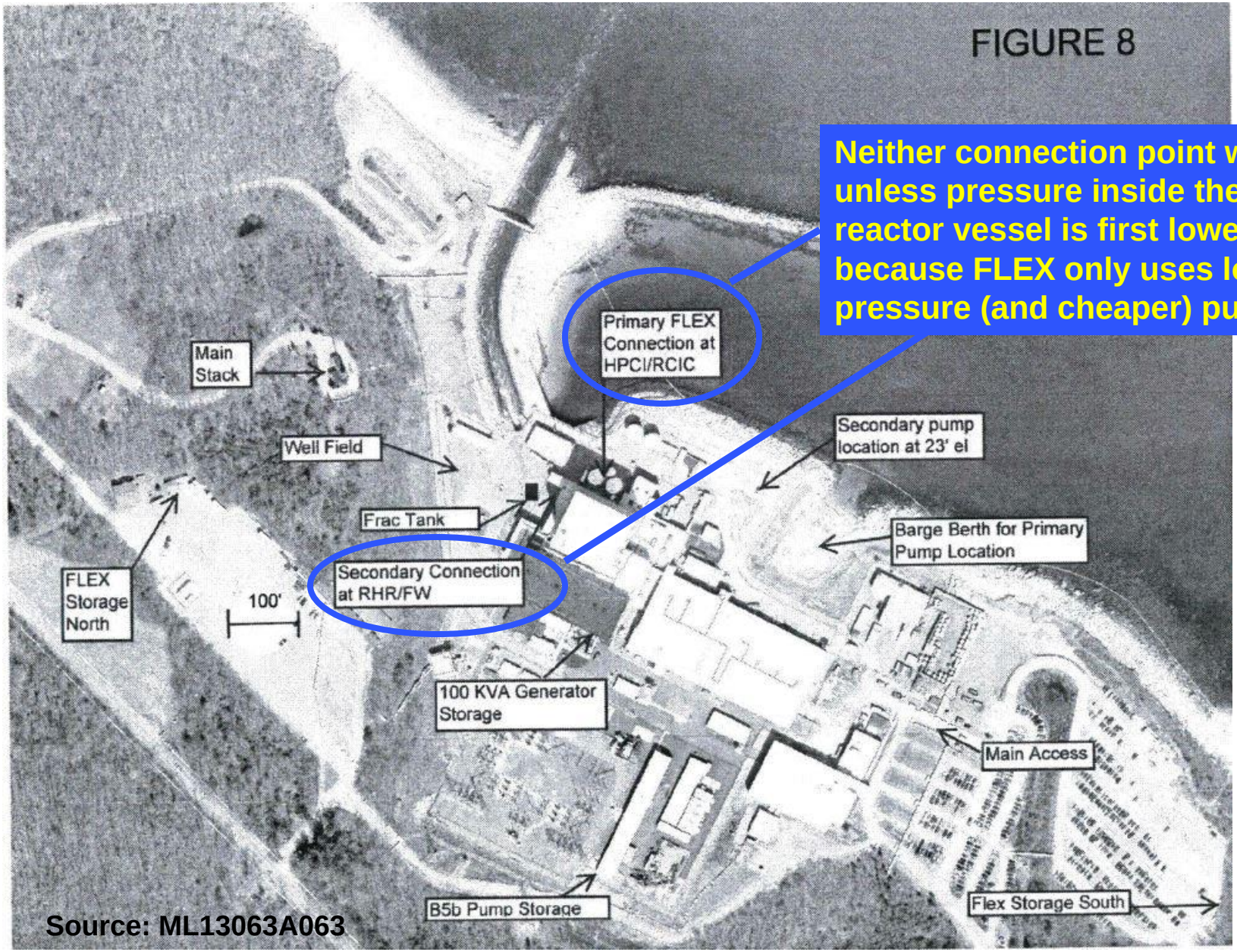
Source: ML13063A063

On the Good Side



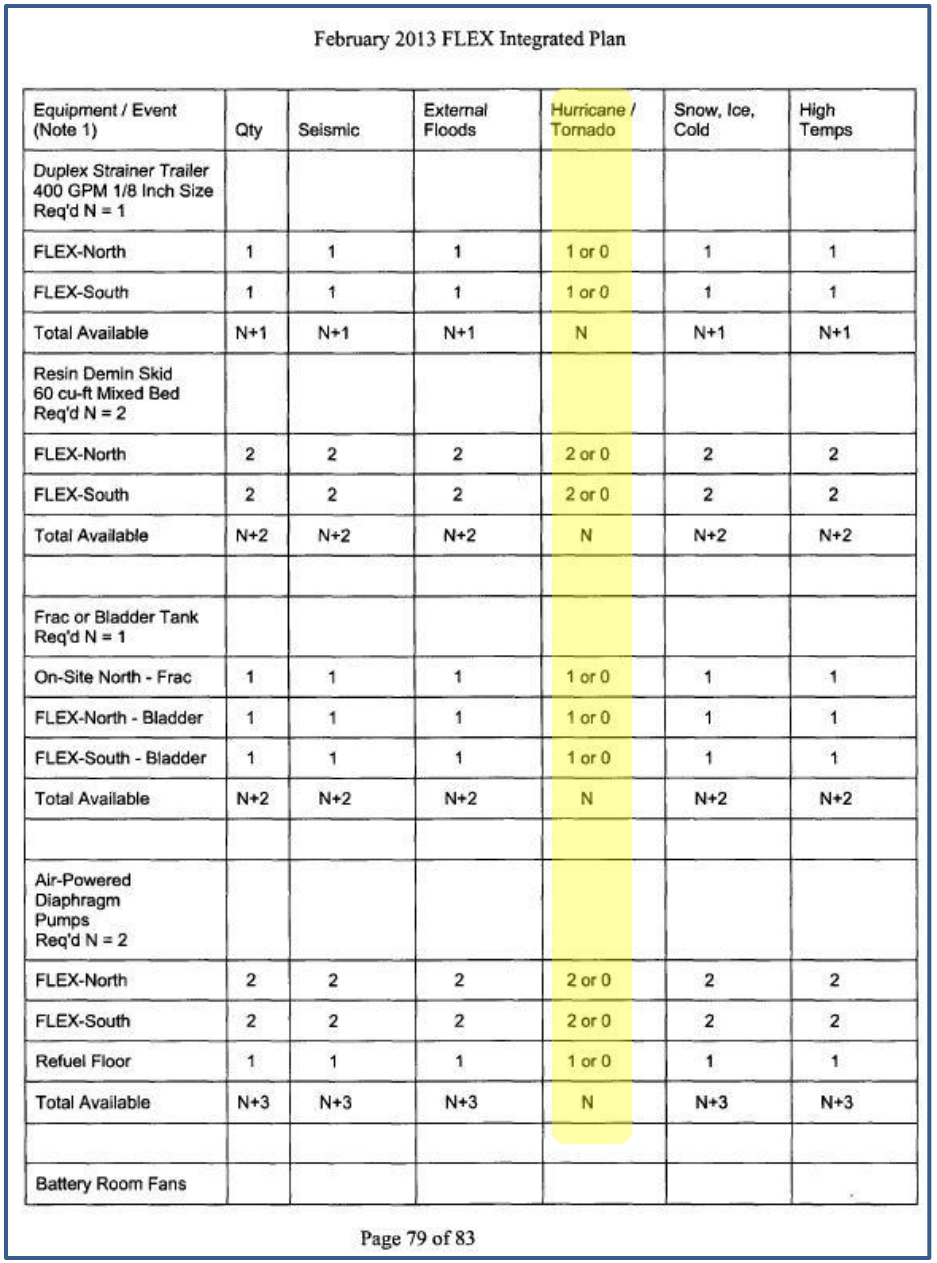
Source: ML13063A063

On the Caveat Side



Source: ML13063A063

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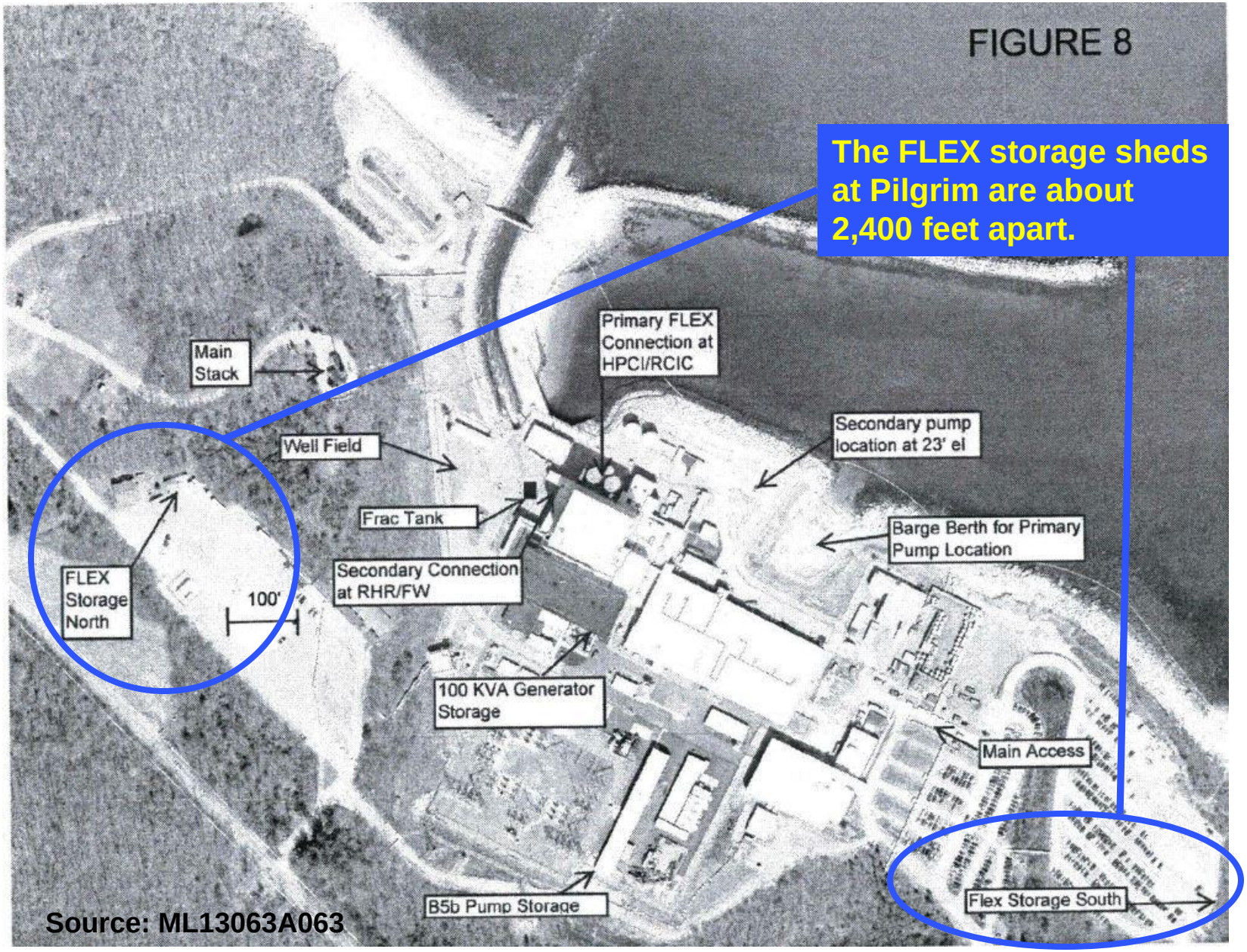
0 < N and nature rather than the NRC's assessment determines the outcome.

Source: ML13063A063

On the Good Side



Source: ML13063A063

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

On the Caveat Side

February 2013 FLEX Integrated Plan

Equipment / Event (Note 1)	Qty	Seismic	External Floods	Hurricane / Tornado	Snow, Ice, Cold	High Temps
(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:

1. 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(hh) 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 draindown. 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

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

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

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.

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

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 the reactor vessel pressure gets lowered enough to let FLEX's low pressure pump(s) provide makeup flow.

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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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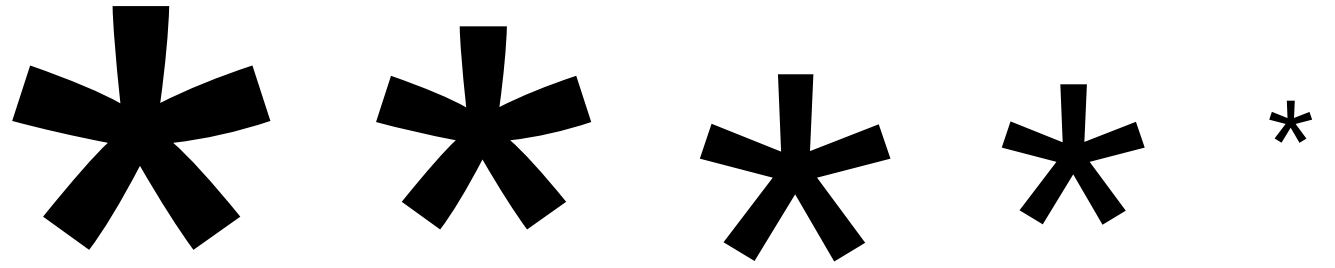
Source: ML13225A587

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.



The caveat would shrink if:

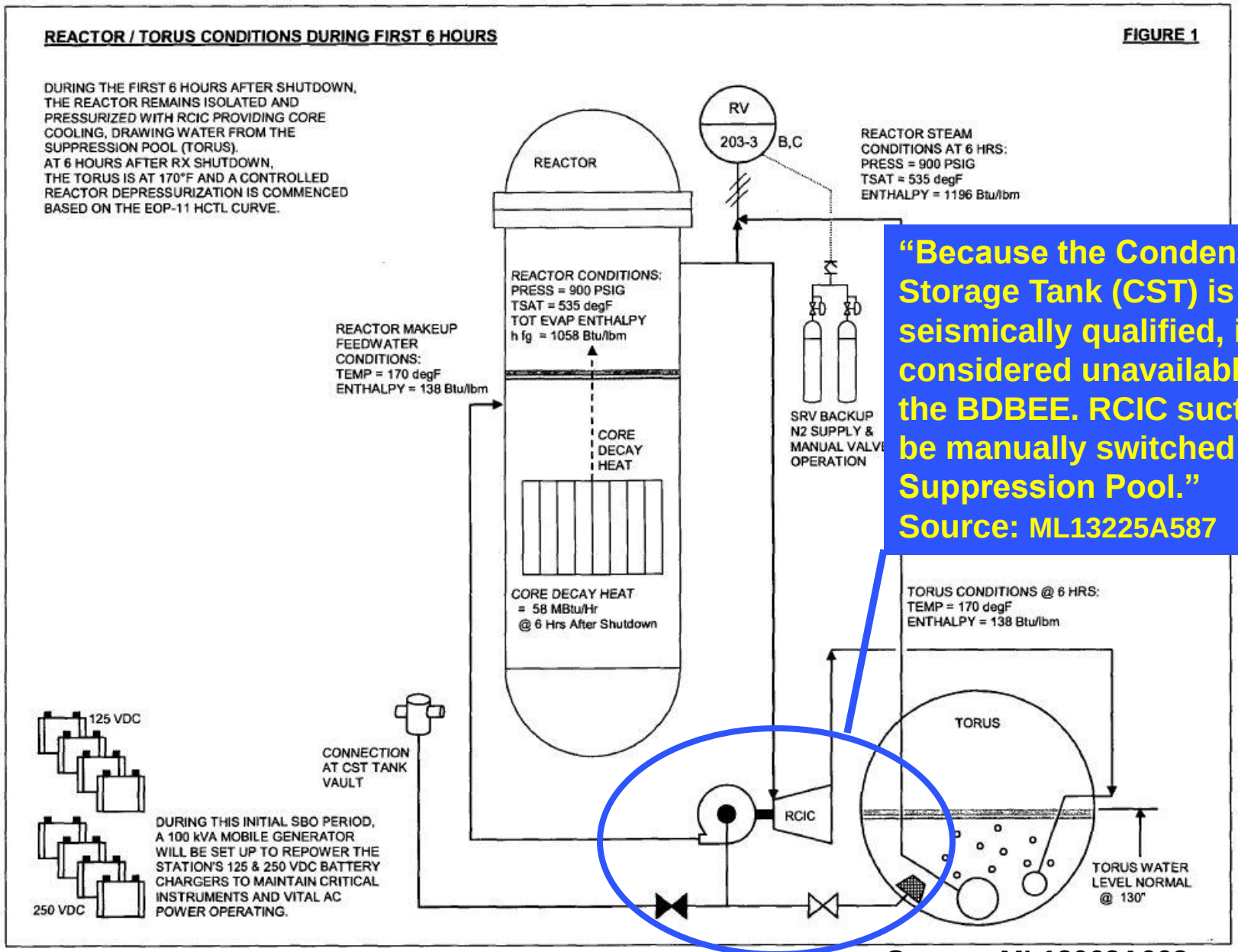
- **FLEX employed both high and low pressure pumps**
- **FLEX storage sheds were less vulnerable to common-mode losses**
- **Regulatory requirements governed FLEX equipment while in storage**
- **Non-conservative assumptions that transform BDBEE into BBDBEE were eliminated**

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

Backup Slides

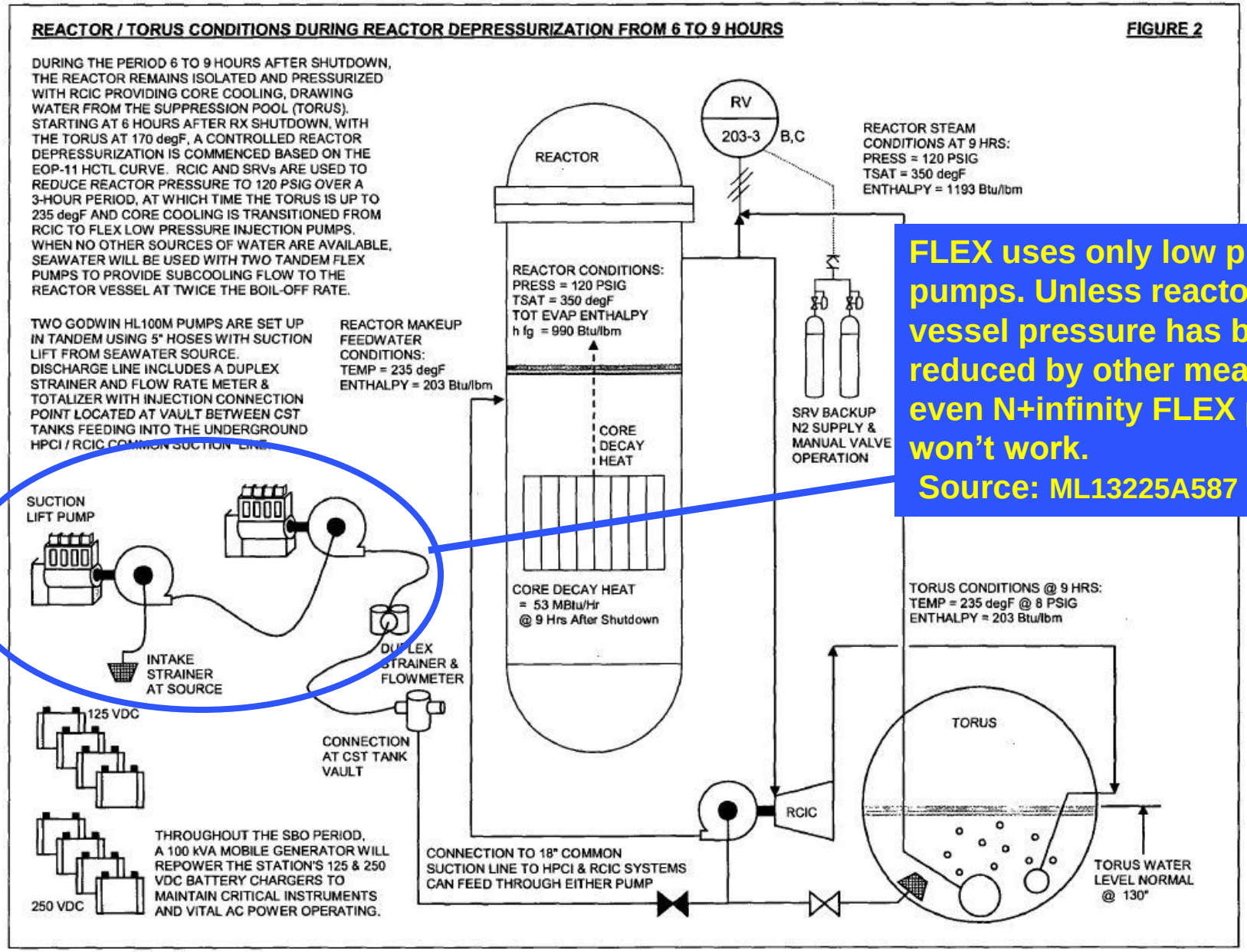
Pilgrim's BDBEE Plan



"Because the Condensate Storage Tank (CST) is not seismically qualified, it is considered unavailable for the BDBEE. RCIC suction will be manually switched to the Suppression Pool."
Source: ML13225A587

Source: ML13063A063

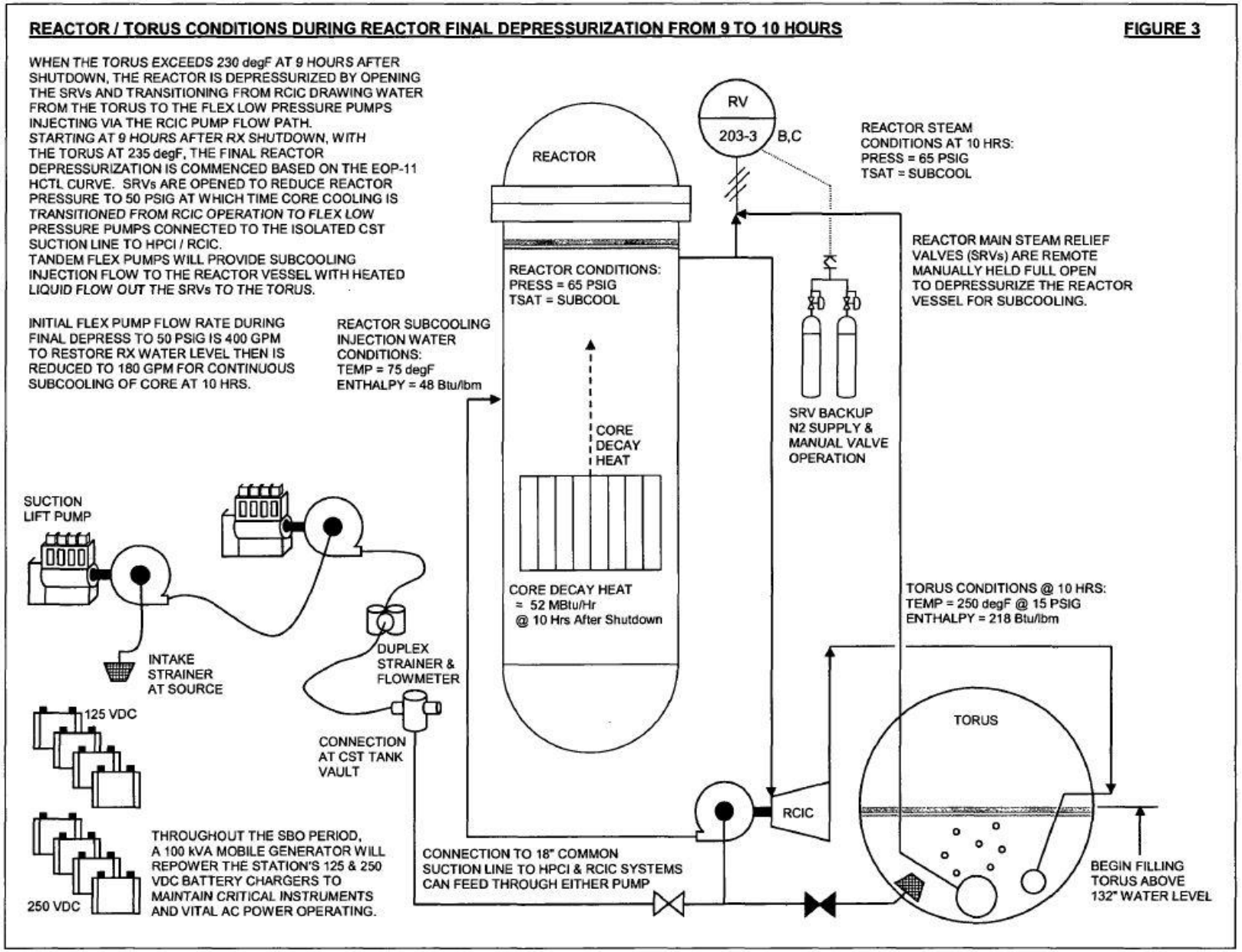
Pilgrim's BDBEE Plan



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

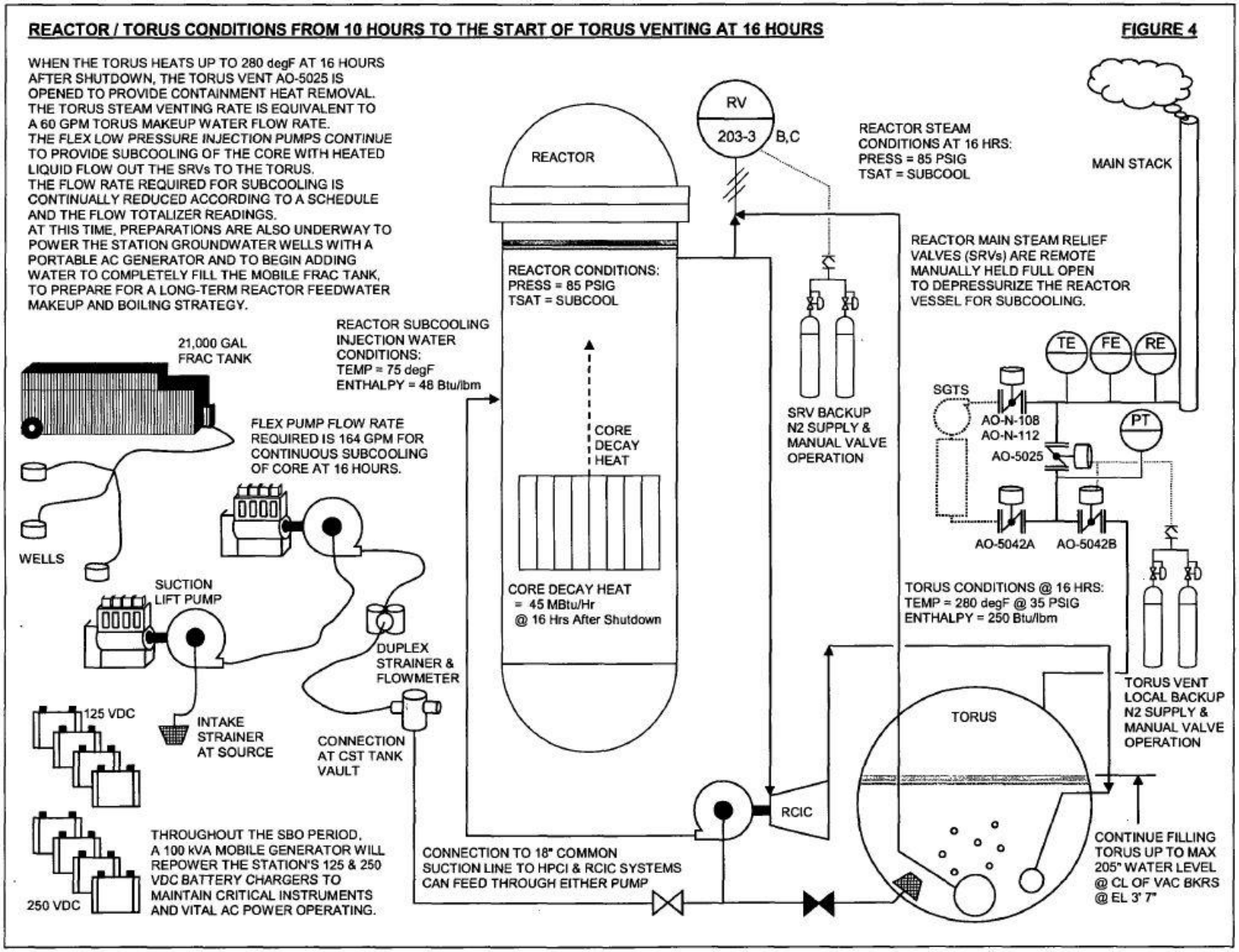
Source: ML13063A063

Pilgrim's BDBEE Plan



Source: ML13063A063

Pilgrim's BDBEE Plan



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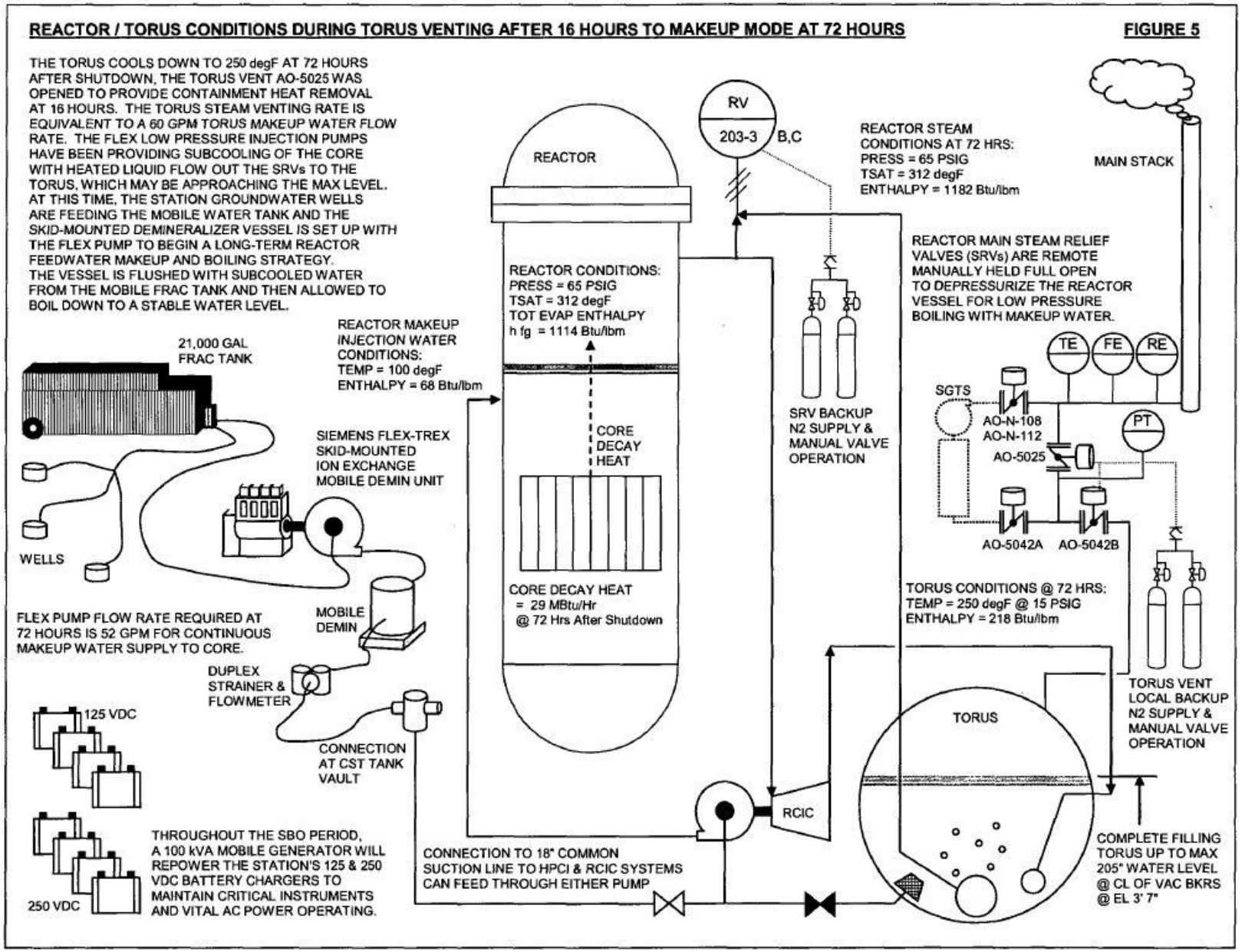

Source: ML13063A063