WESF

THE CATASTROPHE POTENTIAL AT THE WASTE ENCAPSULATION STORAGE FACILITY

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September 14, 2020


225B

B Plant and WESF

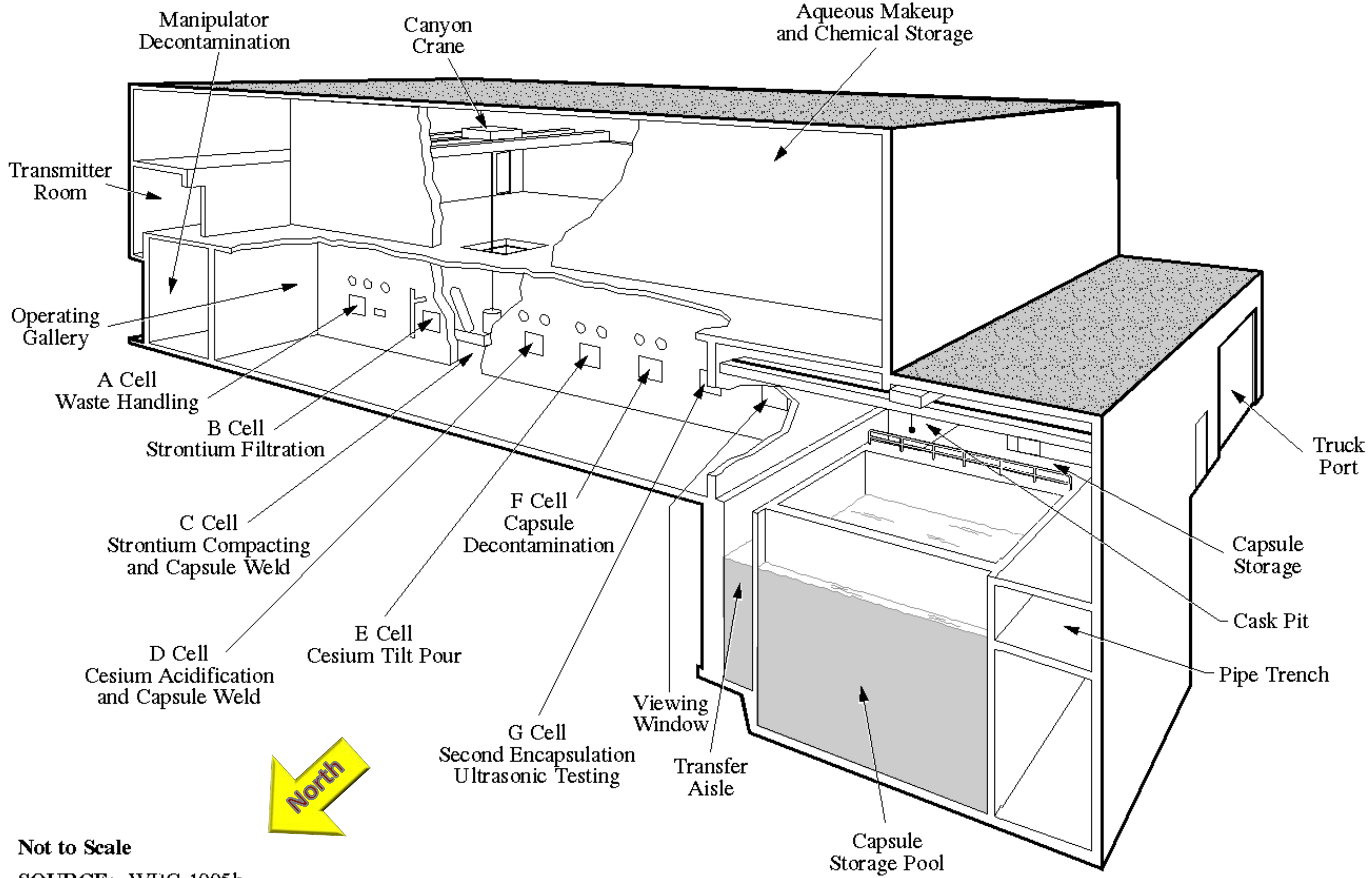
THE SITE

- WESF – the Waste Encapsulation Storage Facility
- Built 1971-73. Began use in 1974.
- 84 million of curies of extremely radioactive and dangerous cesium-135, cesium-137, strontium-90 and their daughter products in “capsules”.
- Contained in ~2,000 capsules stored in a basin under 18 feet of water.
- 46 year old basin. Designed to last 30 years. Severely damaged & failing.
- Gamma radiation has reduced the concrete strength to less than 0%-75% of design
- Complete failure is inevitable. The only questions are when? and how fast?
- When the basin fails - ALL of the contents of the cesium capsules will be released.

THE PROBLEM IDENTIFIED

- March 2011 Fukushima blew up
- DOE began a disaster potential analysis nation wide
- Gregory Z. Morgan, an DOE engineer at Hanford analyzed WESF
  - **Concrete walls and floors of WESF basin severely degraded**
  - **Centerline of walls down to <84% of design strength. Surfaces – no strength**
- August 1, 2012 DOE declared a PISA (Potential Inadequacy of a Safety Analysis)
- August 27, 2012 PISA confirmed
- February 13, 2013 - I presented a technical analysis to the Hanford Advisory Board River and Plateau Committee – the committee decided not to pursue it.
- ~2015-2016 DOE commits to moving the capsules to dry storage by 2022-2023
- August 1, 2017 – I retired from the Oregon Department of Energy. Greg retired from DOE about a year later.

Figure B.4.2.1 Waste Encapsulation and Storage Facility



Not to Scale

SOURCE: WHC 1995h

919/K471-74.CDR


TUBING
OUT OF SERVICE

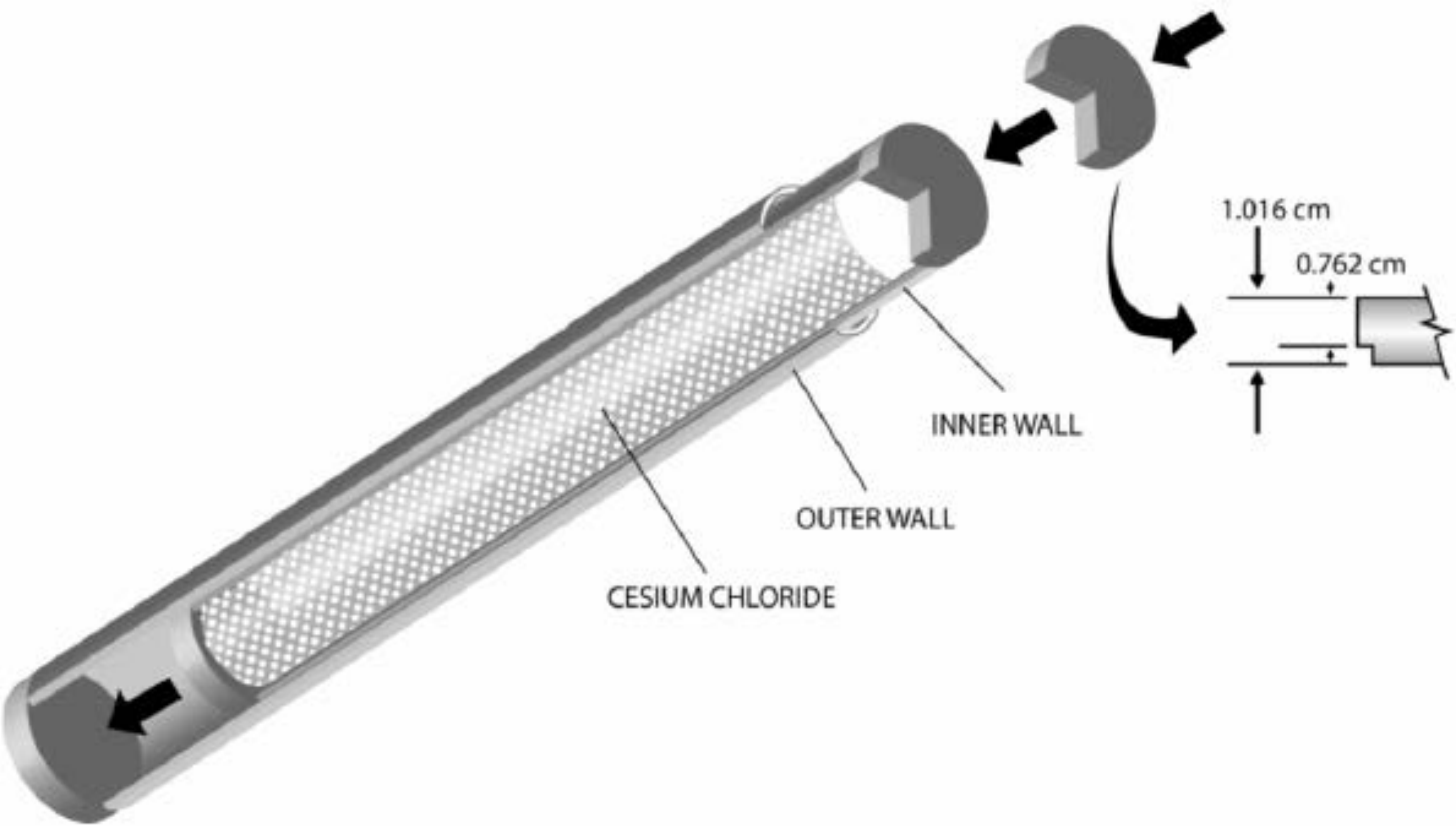
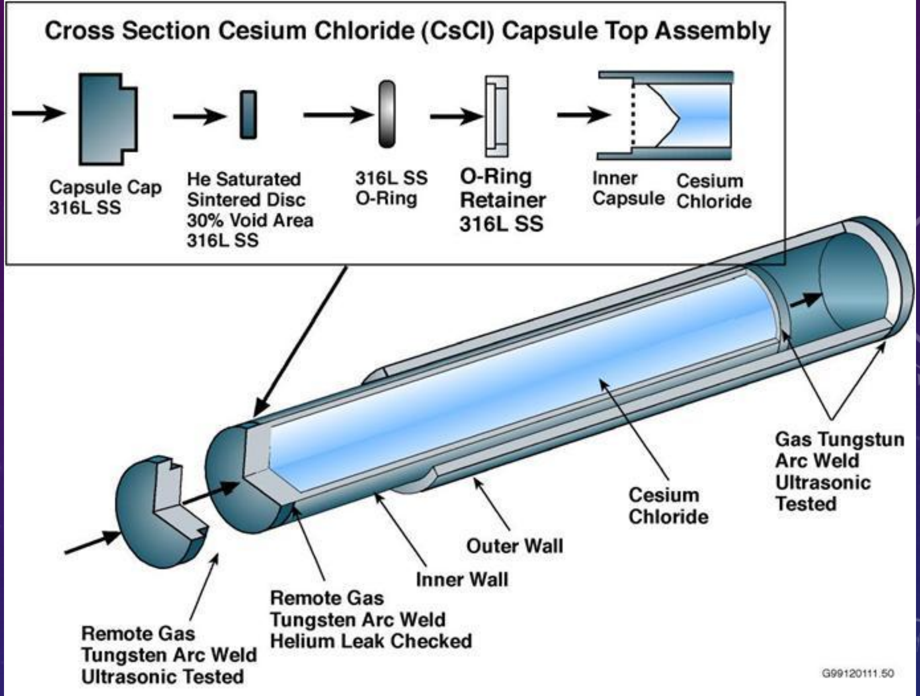
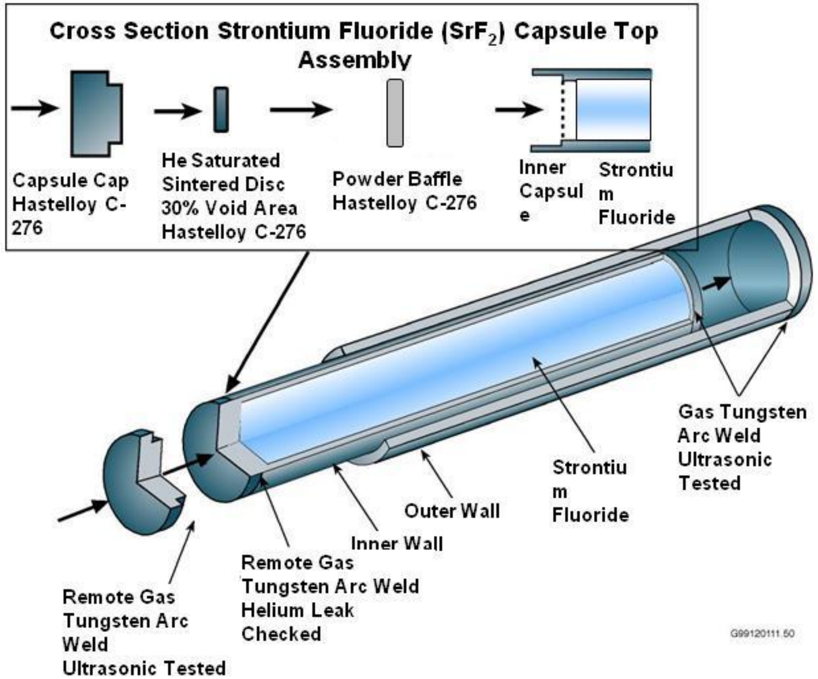
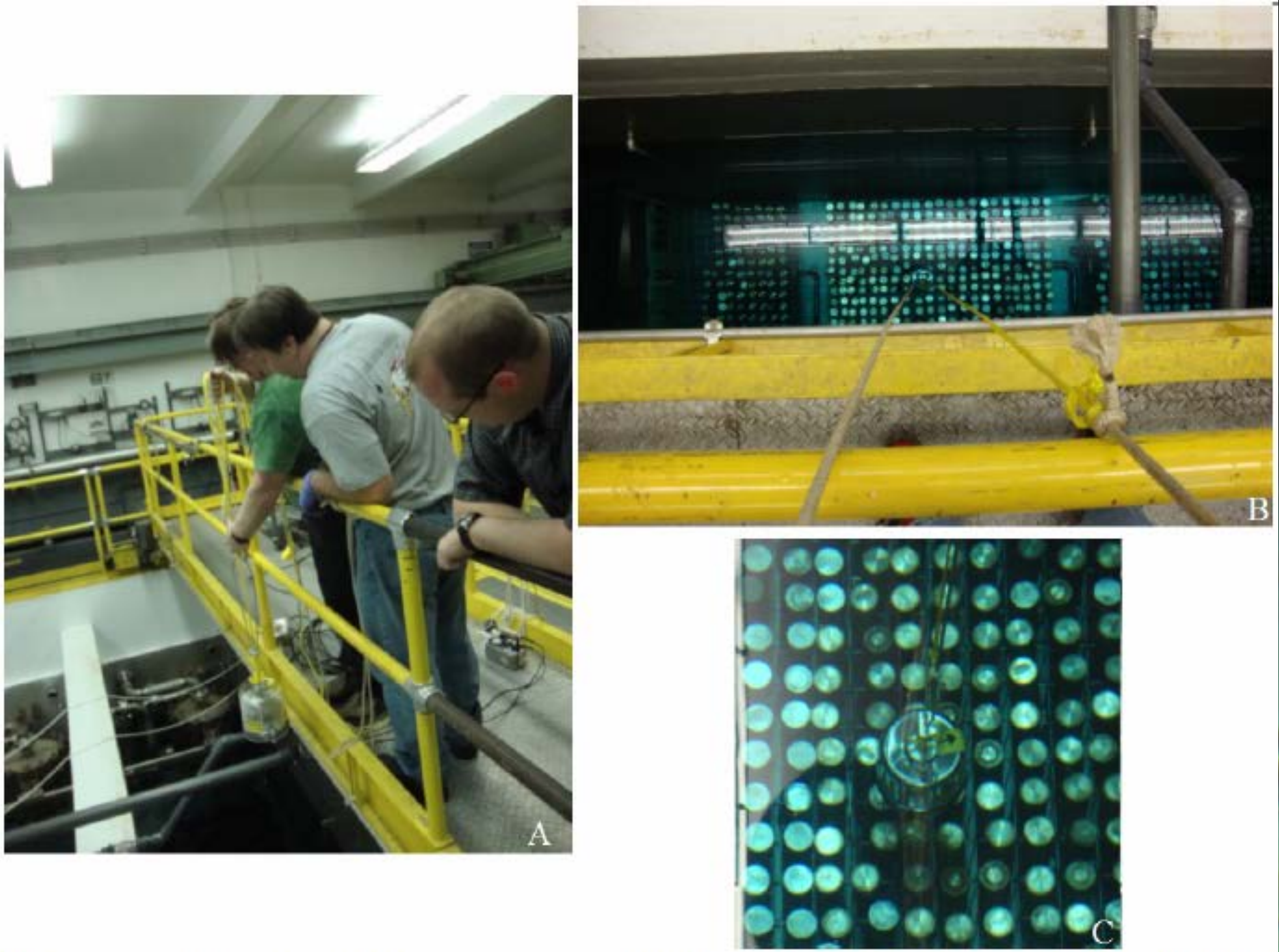


Figure 3 - Hanford Site Waste Encapsulation and Storage Facility Capsule [SRNL representation based on Knight's image (1974)].

- Capsules are double-contained
- 20.775 inches long
- Outside diameter 2.625 inches
- Capsules typically weigh ~25 lb
- Heat in a cesium capsule ~15 to 181 watts
- Heat in a strontium capsule ~20 to 462 watts
- The capsules now produce 222 kilowatts of heat.







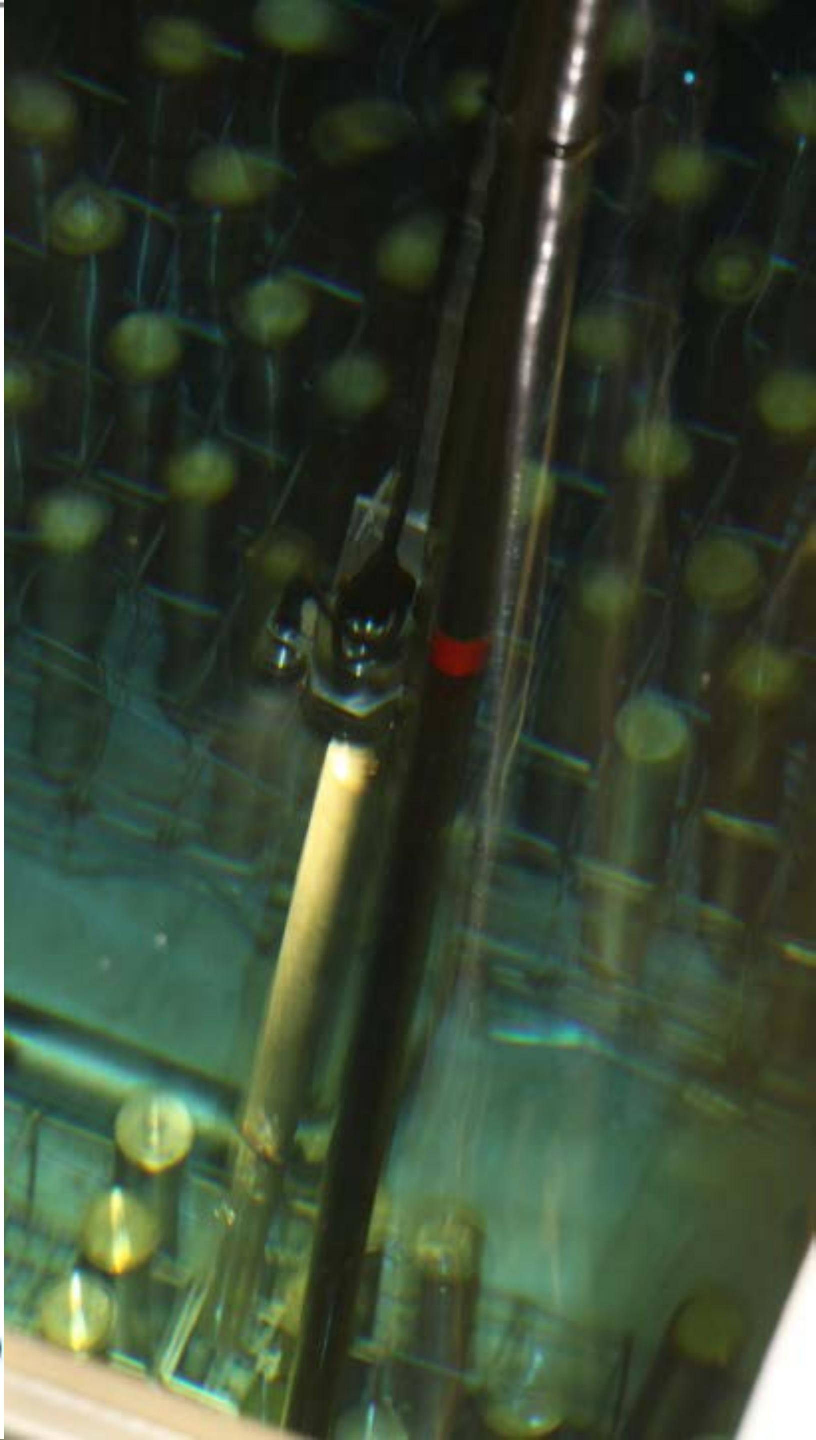


Figure 6 - **A**) RadBall^{TM} deployment into WESF Cell 7. **B**) Submerged RadBall^{TM}. **C**) Directionality indicated by the black arrow on the airtight RadBall^{TM} container.



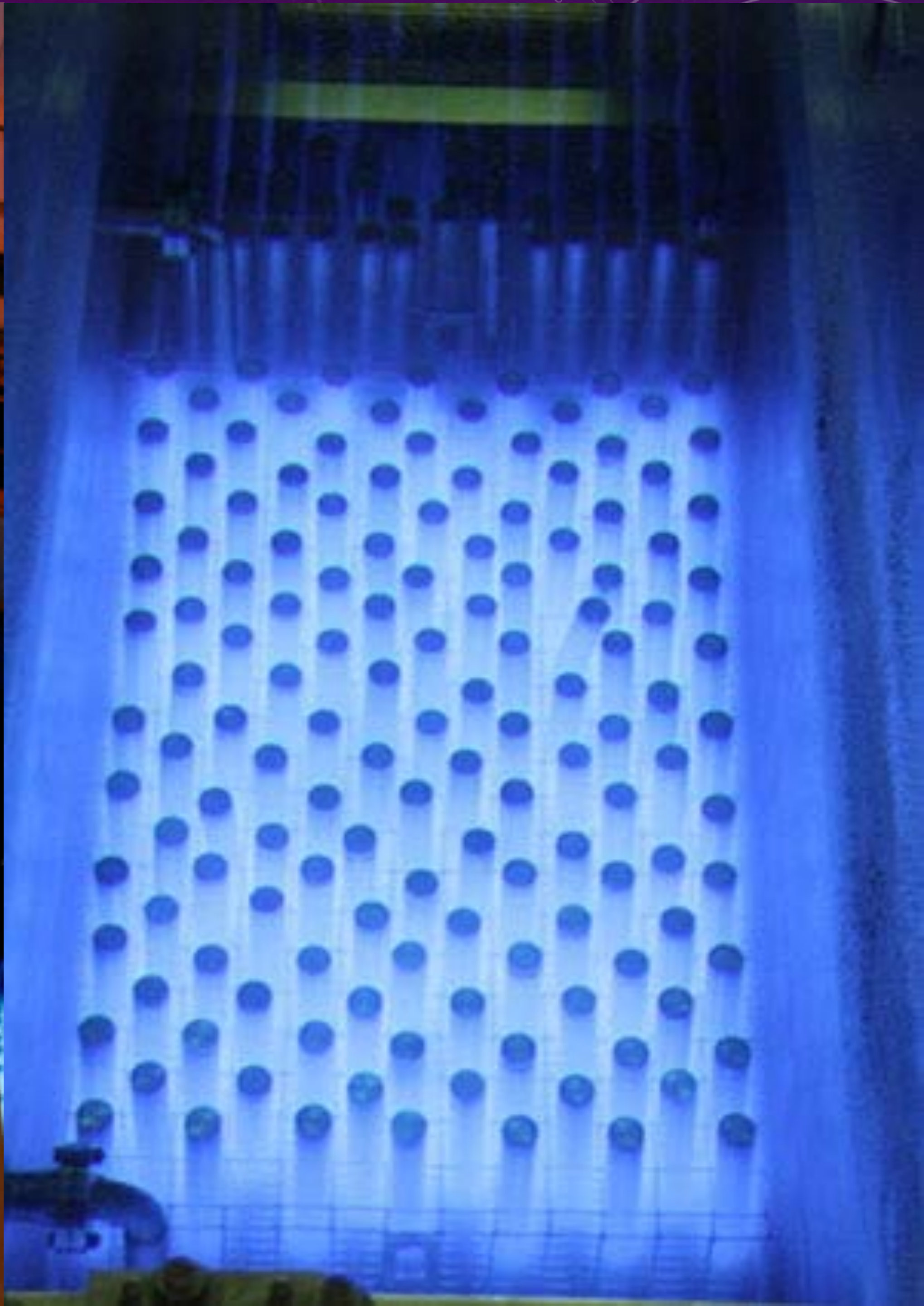
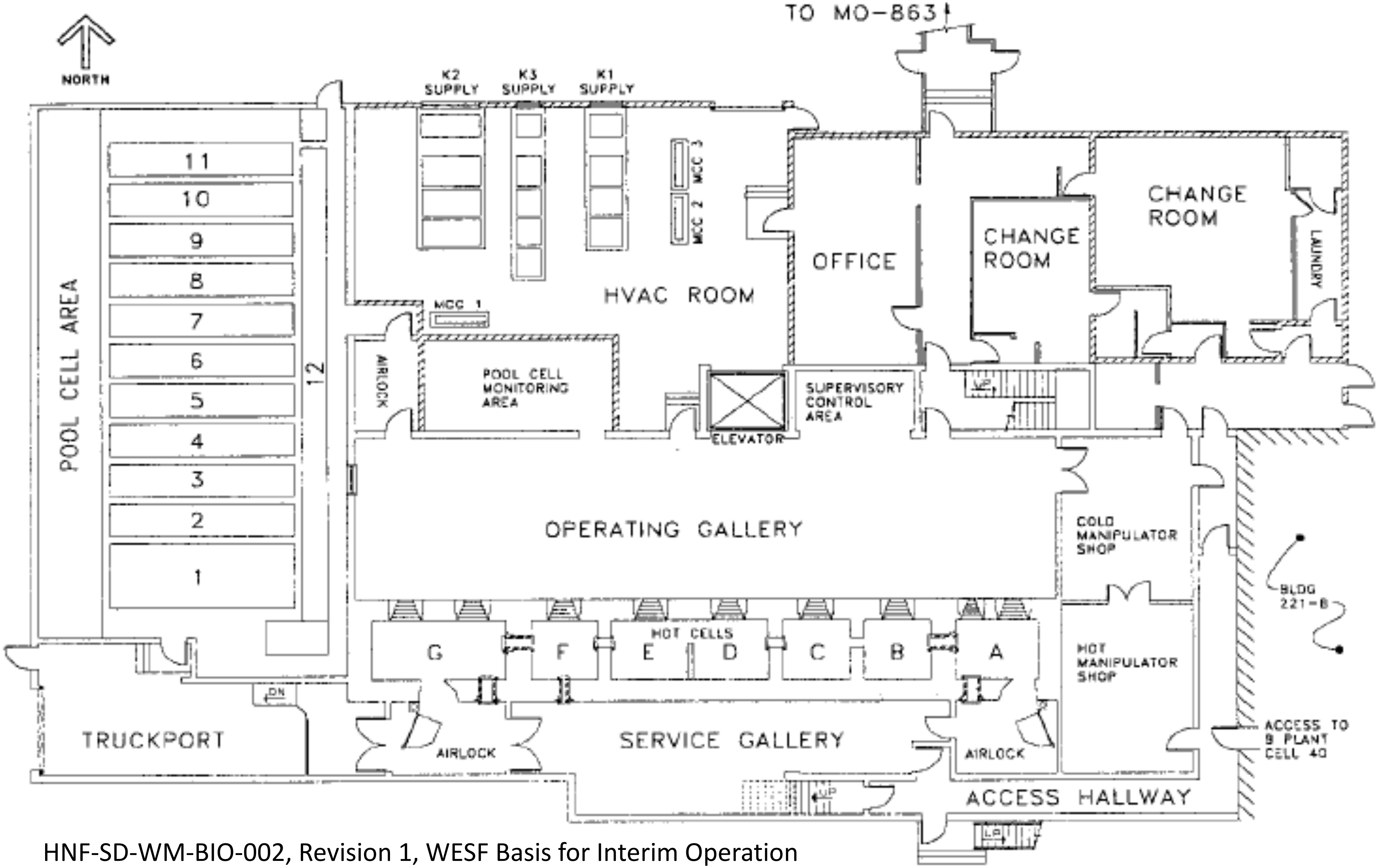
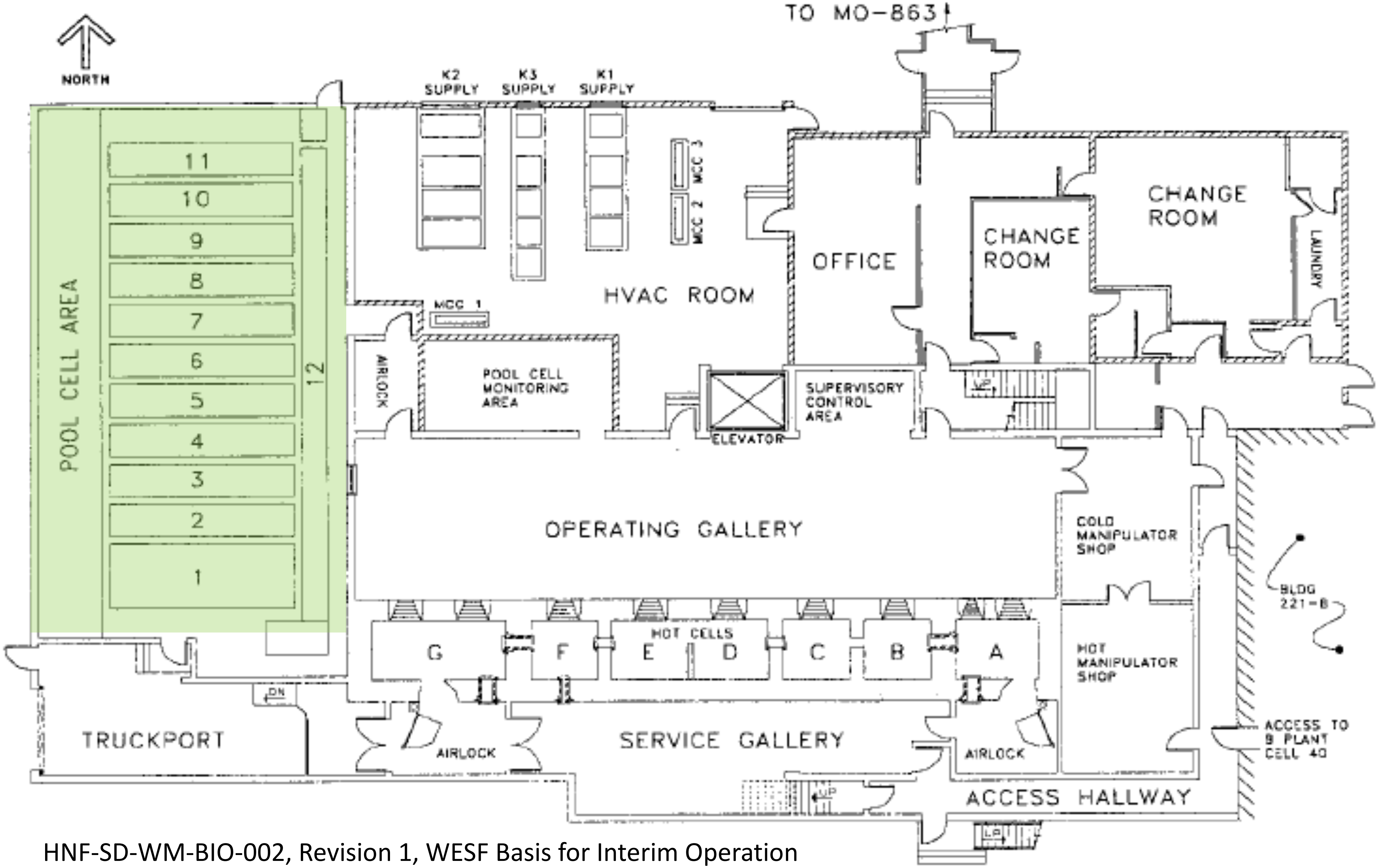


Figure 13 - Cherenkov radiation glow: **A**) Cell 6. **B**) Cell 7.



HNF-SD-WM-BIO-002, Revision 1, WESF Basis for Interim Operation
Figure 204, Page 2-10, plan view of the capsule storage pools



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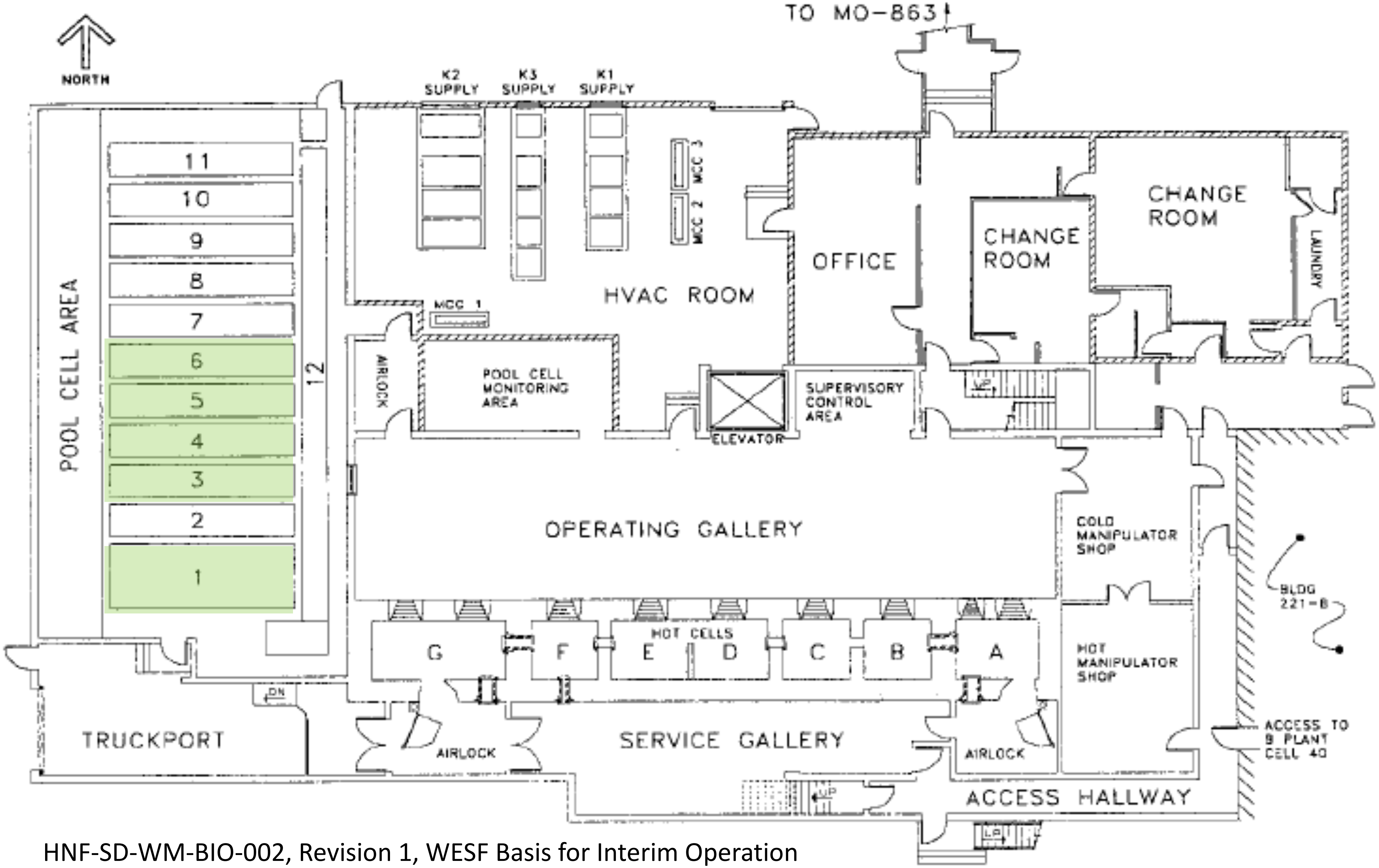


HNF-SD-WM-BIO-002, Revision 1, WESF Basis for Interim Operation
Figure 204, Page 2-10, plan view of the capsule storage pools

THE PROBLEM

- With less than six feet of covering water - radiation levels make human entry **impossible.**
- With the capsules uncovered - humans will not be able to approach within 50 yards of the building due to enormous radiation fields.
- With no cooling - the cesium capsules will overheat, crack, fail, and release their contents to the environment.
- The building temperature will soar to several hundred degrees C or more. The concrete roof and walls will fail - collapsing the structure into the pool.
- No emergency response or recovery is possible – **EVER.**

LOSS OF WATER FROM A SINGLE POOL

However, the immediate hazard from this event is direct radiation exposure due to loss of shielding water. Analyses documented in Hey (2000) indicated that the dose rate due to the direct gamma-ray shine at a receptor 100 m (328 ft) from the nearest WESF outside wall would be 20 mSv/h (2 rem/h). This dose rate would exceed the 0.01 Sv (1 rem) threshold for declaration of a SITE AREA Emergency within a half-hour. Dose field estimates (documented in Hey, 2000) at various locations in and around WESF, that could hamper recovery activities are provided in HNF-SD-WM-BIO-002, Table 3-32.

Today these conditions would occur at about 60 meters (200 feet) from the wall.

The loss of water in a single pool cell creates fatal dose fields within the Pool Cell Area and a field of approximately 120 R/h immediately outside the 225-B structure. Currently there is no control that could be relied upon to terminate this event once capsules have been uncovered. Thus, facility control is effectively lost. Continued progression of the event leads to a gradual evaporative loss of water in the remaining pool cells and thermally induced failure of uncovered capsules. Even though relatively little in the way of airborne release would be expected from capsules initially failed in the single pools, the loss of facility control indicates that this event is a potential initiator to the more severe consequences of loss of water from all pool cells.

Today this would be an extreme 75 R/h field immediately outside the structure.

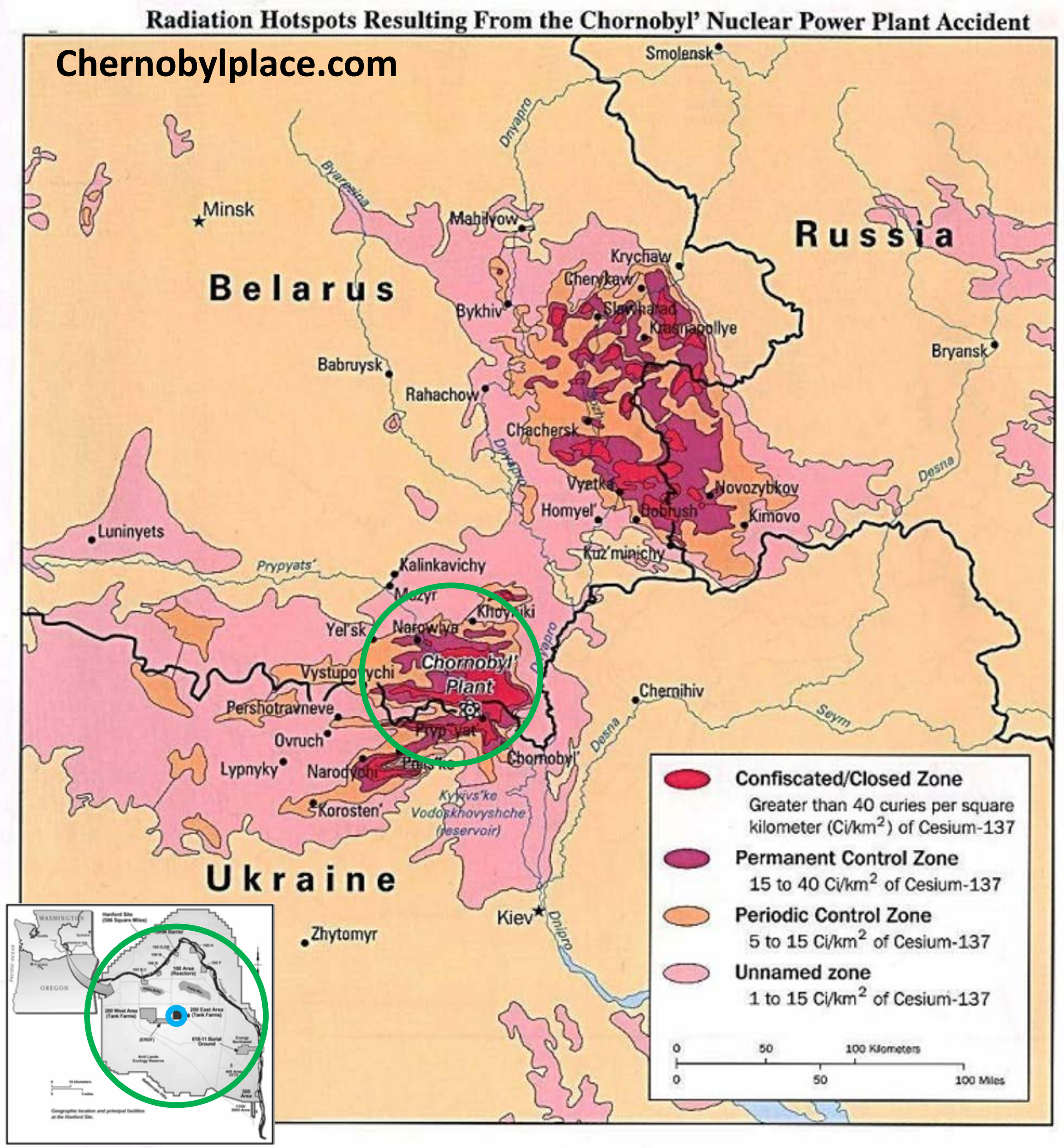
PREVENTION

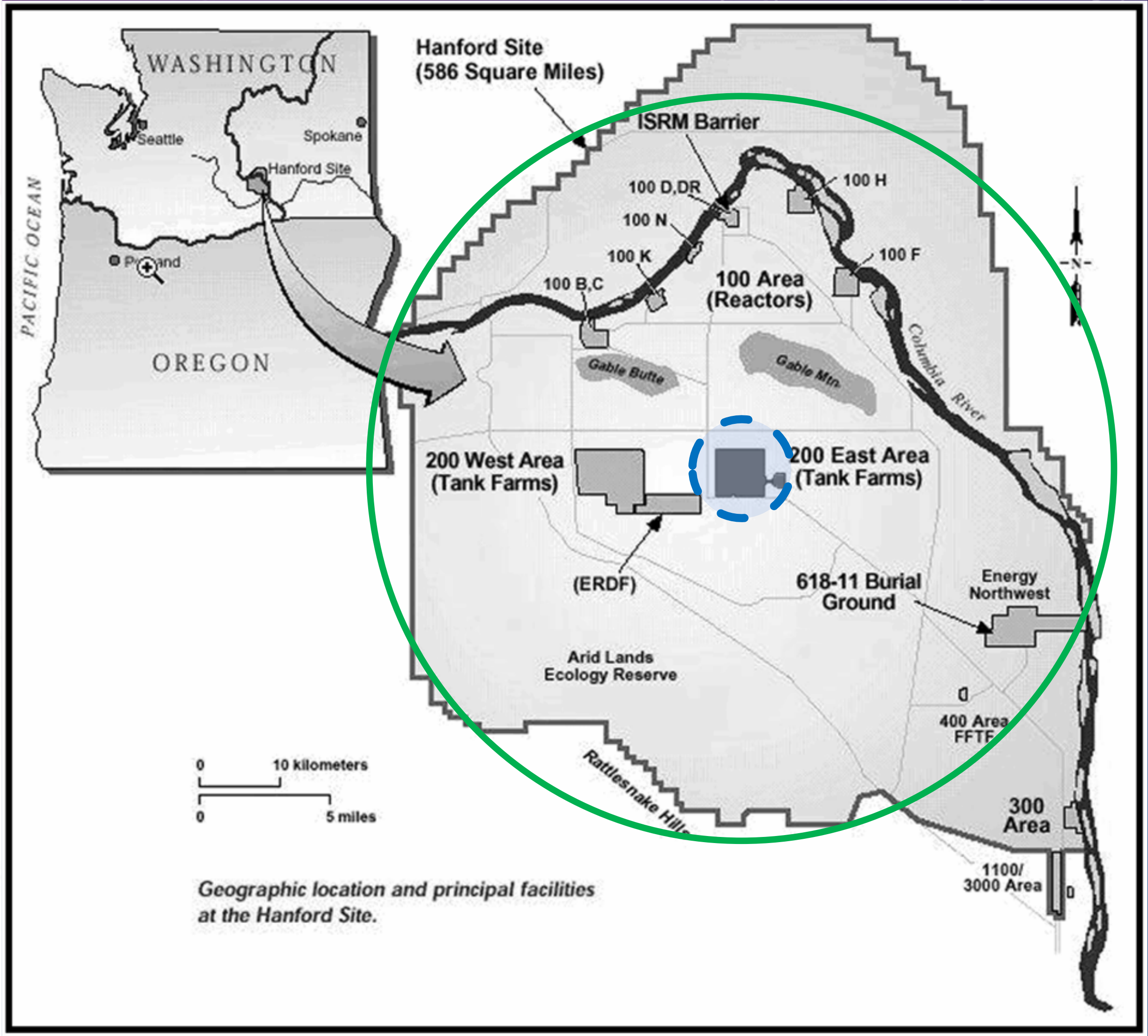
- There is a limited ability to add water to the WESF basin
- To prevent disaster water must be added faster than it leaks out
- There is no easy way to estimate just how much water is required. But it is a lot.
- DOE plans to use water tankers to provide water in the event of an emergency
- However, DOE is often slow to respond. And if the water level drops to within six feet of the capsules before they begin adding water – the plan will not work.

THE RESULT

- As the cesium capsules over heat, corrode, crack and fail, they will release their contents into the rubble.
- Original analysis estimated five capsules would fail in a month. With no cooling, the temperatures in the capsules rises and the cesium chloride causes the 316L stainless steel capsule walls to rapidly fracture, corrode and fail.
- Cesium is highly volatile. It will release from the pile as vapor to become particles on the surface. As rain water infiltrates the pile, steam will drive the release.
- If only 10% of the cesium rises to the surface, **it will equal the release of radioactive cesium from the Chernobyl disaster!**

Hanford to the same scale as Chernobyl's contaminated zones (lower left corner)





THE ULTIMATE RISK

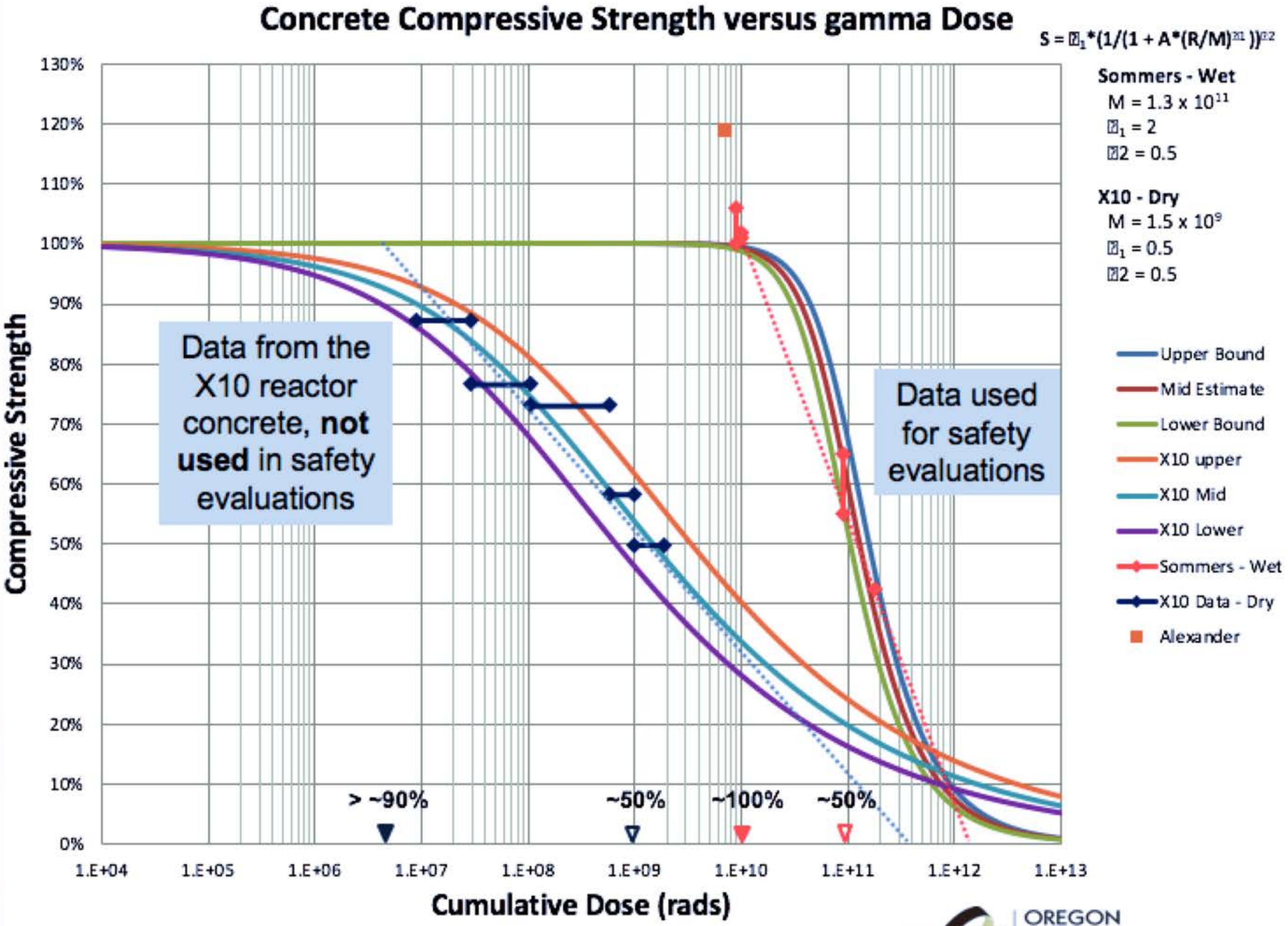
- **When WESF fails, no response will be possible for centuries**
  - Failure can happen in many ways (pipe corrosion or break, earthquake, roof collapse, drone attack, or even simple failure of the concrete from radiation among them)
  - 24 reactor sites suffered 57 industrial drone incursions during 2015-2019 !
- **Failure at WESF can and likely would lead to complete failure of Hanford cleanup and the uncontrollable spread of radioactivity across the region.**
  - Contamination spread may contaminate the Waste Treatment Plant rendering it unusable, as well as making tank retrievals and other cleanup impossible.
- These same problems may exist at any/every nuclear spent fuel storage pool.

THE CLOCK IS TICKING!
THE RESULT MAY BE A BEYOND CHERNOBYL CATASTROPHE
WHAT TO DO?

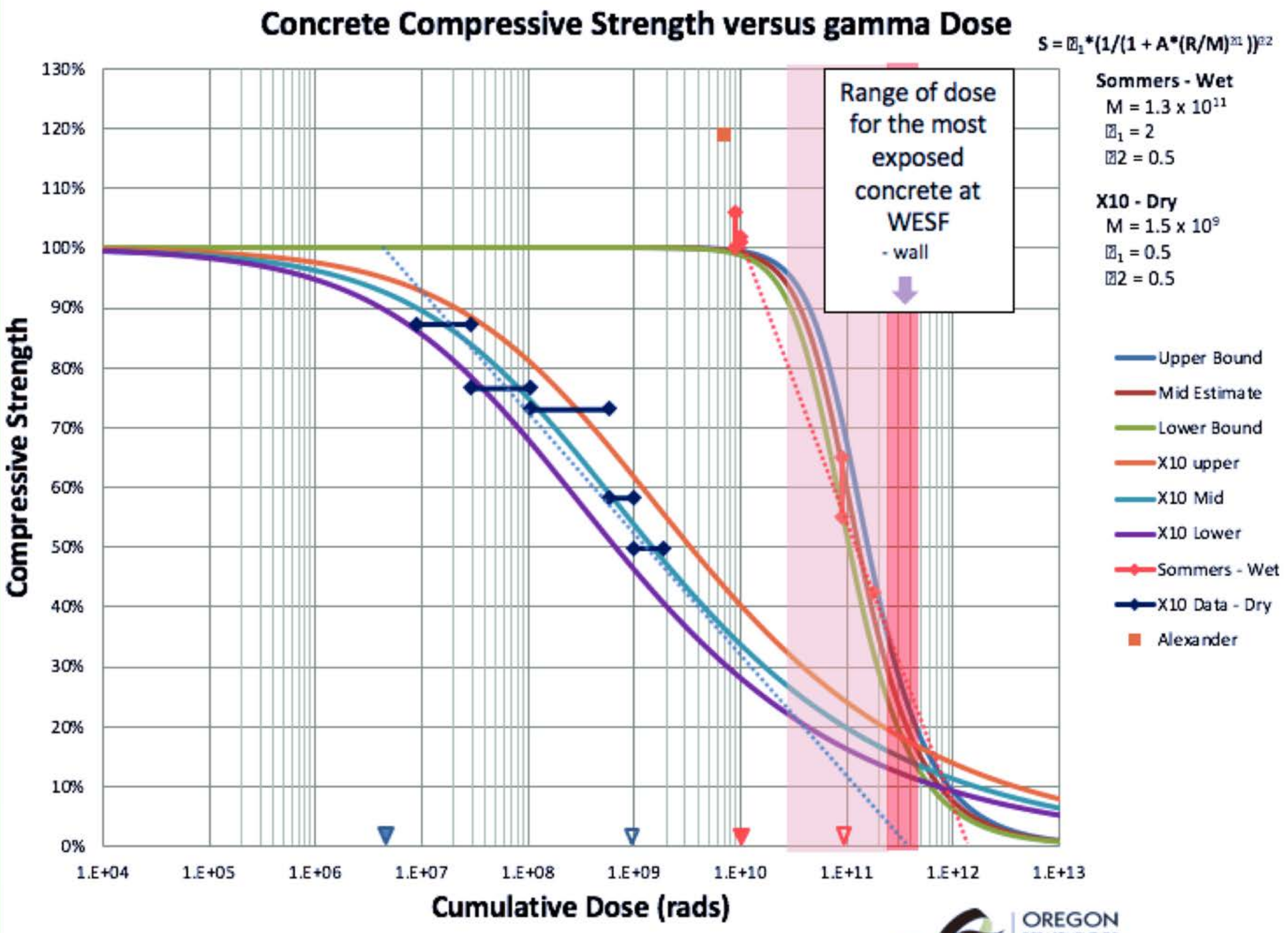
- **The capsules must be urgently moved to dry storage.**
  - **DOE is currently planning to delay the project.**
- **The Basin walls must be destructively examined to develop real data on the condition of the pool walls and to determine how high dose radiation impacts concrete under real world conditions.**
  - **DOE has failed to make a firm commitment to obtain and publish this crucial data.**

TECHNICAL ISSUES

- **The Safety Basis for WESF did <u>NOT</u> consider radiation dose to the concrete at all !**
- Very little data on how concrete responds to radiation dose.
  - Strong differences based on composition, wetting, and temperature
  - First data on gamma damage to concrete in the 1940s and 50s.
  - Data on how dry concrete responds was **excluded** (X10 & Temelin reactors)
  - Dry concrete ~100 – 2,000 times more sensitive than wetted concrete
  - <u>The concrete at WESF is dry!</u>



OREGON DEPARTMENT OF ENERGY



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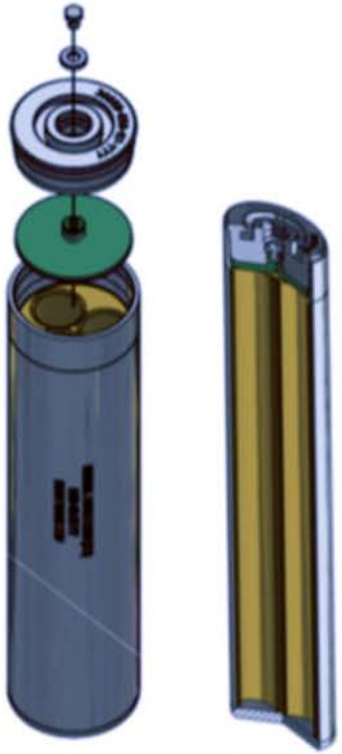
Cesium/Strontium Capsule Project

Glenn Konzek
DOE Richland Operations Office

January 8, 2019

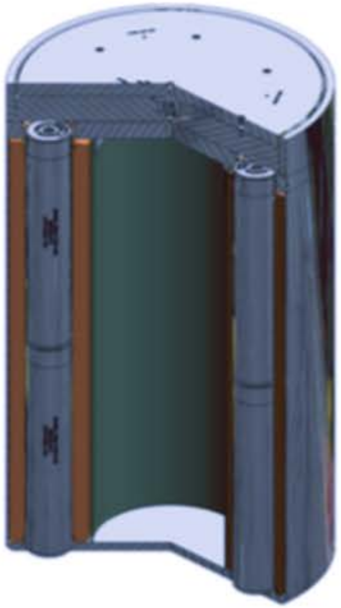
Update to the Hanford Advisory Board
RAP and HSEP Committees

Planned Storage Configuration



Universal Capsule Sleeve (UCS)

Transportable Storage Canister (TSC)



TSC – Loaded
Max. Capacity:
132 Capsules

Planned Storage Configuration (cont.)

Cask Storage System (CSS)

Planned Storage Configuration (cont.)

Capsule Storage Area (CSA)

QUESTIONS