Alternatives to MOX

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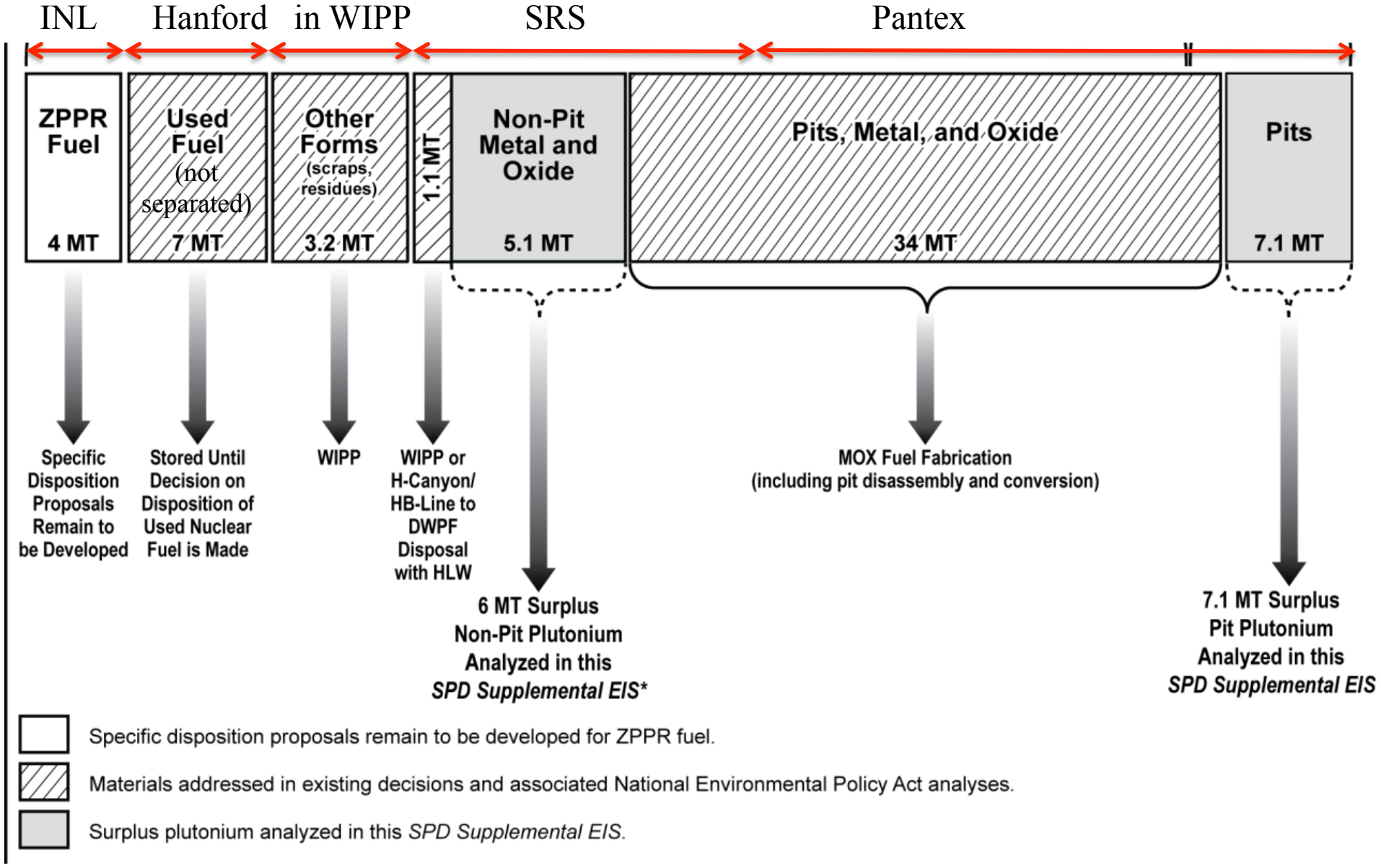
Aiken South Carolina, 29 March 2016

Outline

1. US excess plutonium
2. How did MOX come to be “unaffordable”?
3. Plutonium Management and Disposition Agreement with Russia.
4. Alternatives to MOX
5. DOE’s current favorite: down-blending and disposal
6. Conclusions and recommendations to the CAB and DOE

U.S. excess separated plutonium

(54 metric tons, enough for about 10,000 bombs; 34 are covered by agreement with Russia, 13 tons at SRS, some DOE-EM, some NNSA)



Why did MOX become "unaffordable"?

Year	Report	Cost (Construction + Operations) (Billions 2015$)
2002	NNSA to Congress (34 tons)	**$3 billion**
2014	DOE Plutonium Disposition WG with Army Corps of Engineers	**$18 billion to go** (+$5 billion spent)
2015	Aerospace Corp. (for DOE)	**$30 billion to go** (at $375 million/yr)
2015	Highbridge (for MOX Services)	**$19 billion to go** (unconstrained)
2015	Red Team Report (for DOE)	**Dilute and dispose much less costly**

Some reasons for escalation

- Need to clean the gallium out of the pit plutonium & clean other Pu
- Weak DOE project oversight. Construction before design complete.
- MOX Services and CBI project management
- Scarcity of nuclear-qualified construction workers
- High rework rate

The Plutonium Disposition (Executive) Agreement with Russia
(covers 34 tons each, including several tons currently at SRS)

2000.

Russia to dispose of 34 tons in MOX. U.S. and its allies would pay at least $200 million.

US to dispose of 26.6 tons in MOX, and 8.4 tons with vitrified HLW

2010

Russian MOX program too costly. Russia asked to be able to use the plutonium in its on-going plutonium breeder reactor program.

U.S. agreed, even though it means that the plutonium disposal will not be permanent and will be less secure than in storage.

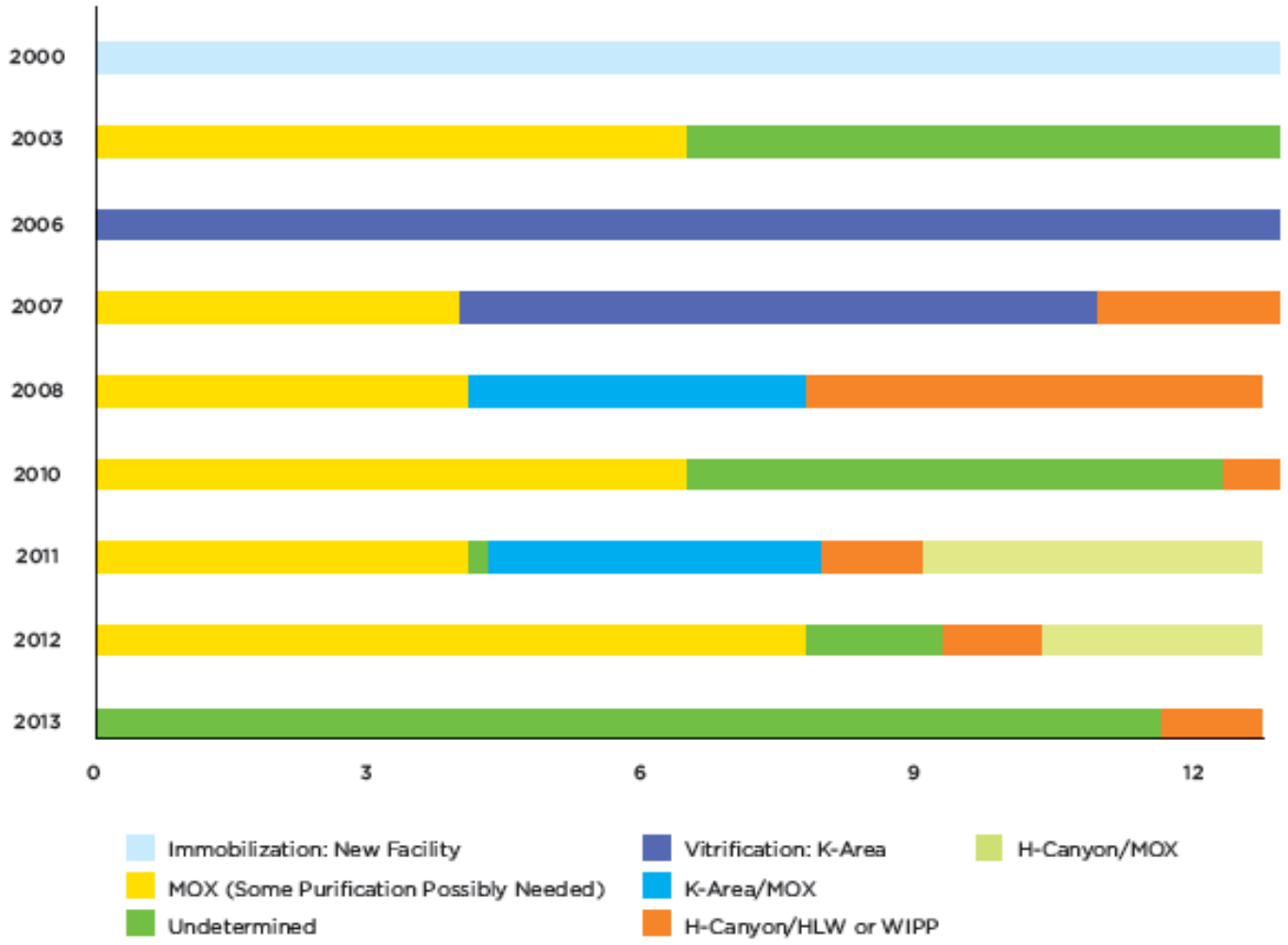
What will Russians say if the U.S. wants to change to direct disposal because *our* MOX program has become too costly?

They will object but can't do much because they are doing what they want to anyway already.

Direct Disposal Alternatives to MOX

Cancellation of the immobilization program in 2002 caused major problems for non-pit plutonium disposal

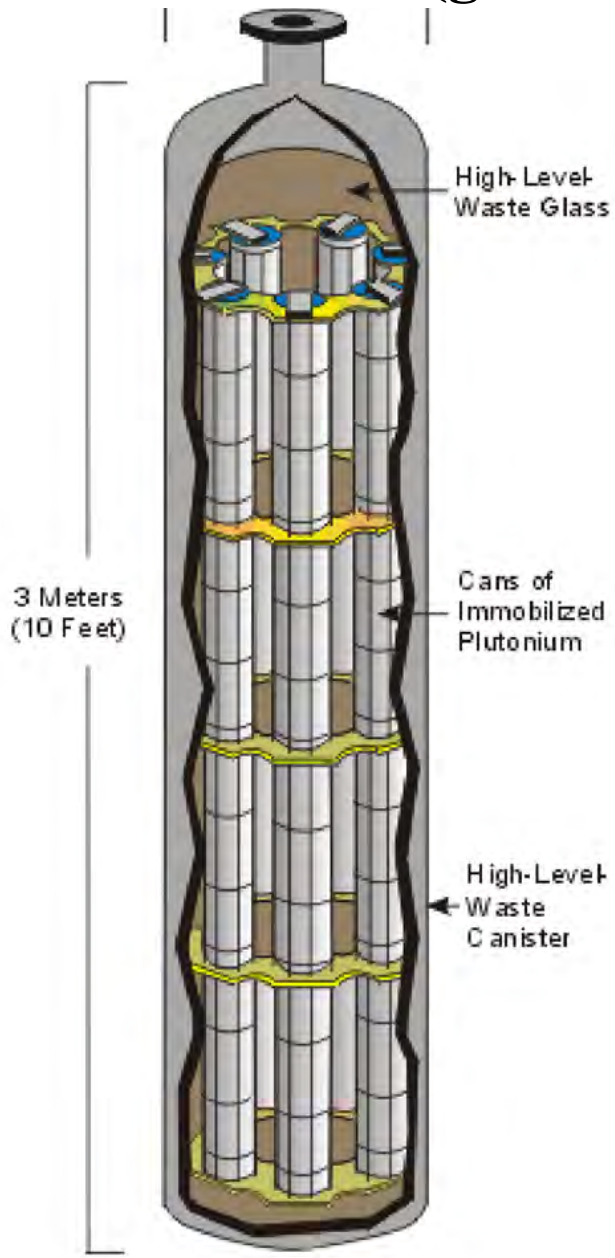
FIGURE 2. Evolution of the DOE's Plan for Disposition of 13 Metric Tons of Non-pit Excess Plutonium



Between 2000 and 2013, the DOE proposed changes to its strategy to dispose of 13 metric tons of plutonium no fewer than eight times.

Notes: K-Area is at Savannah River Site; H-Canyon is a chemical processing facility at SRS; WIPP is the Waste Isolation Pilot Project in New Mexico; HLW is high level waste. The total amount of plutonium varies from year to year because of the DOE's changing assumptions and uncertainties.

1. Cans containing about 1 kg of plutonium each, embedded in vitrified (glassified) radioactive waste(immobilization)



Vitrification of high-level waste at SRS currently scheduled for completion by 2039. Vitrification scheduled to start at Hanford Site in 2019.

Information from past studies suggests that, if a plutonium immobilization process is started at K-Area by about 2025, disposal of 34 MT would not significantly impact waste vitrification schedule.

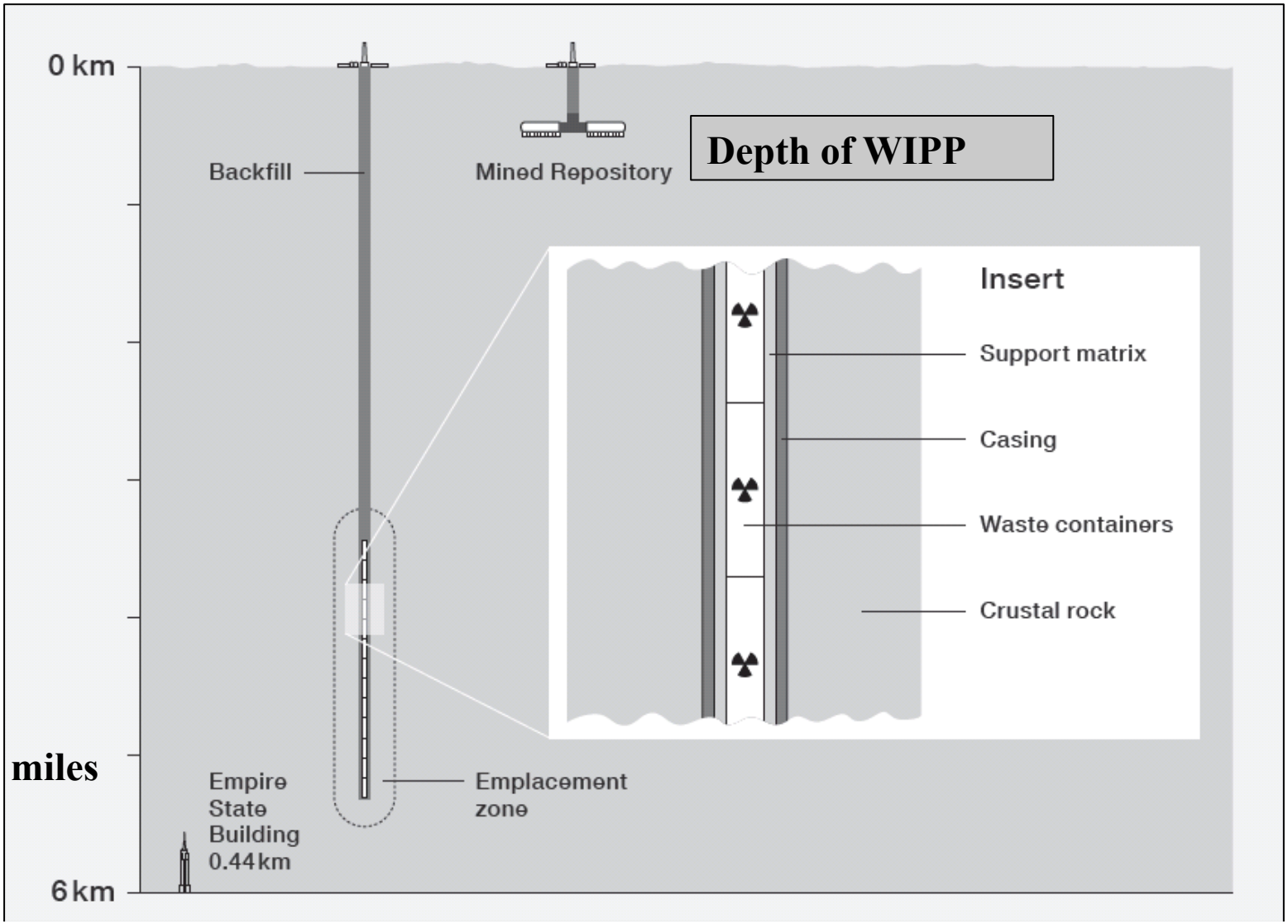
Pu can production at K-Area with vitrification at Hanford probably impractical but should be further analyzed.

2. Three-mile-deep boreholes

Technique developed for drilling oil and geothermal wells.

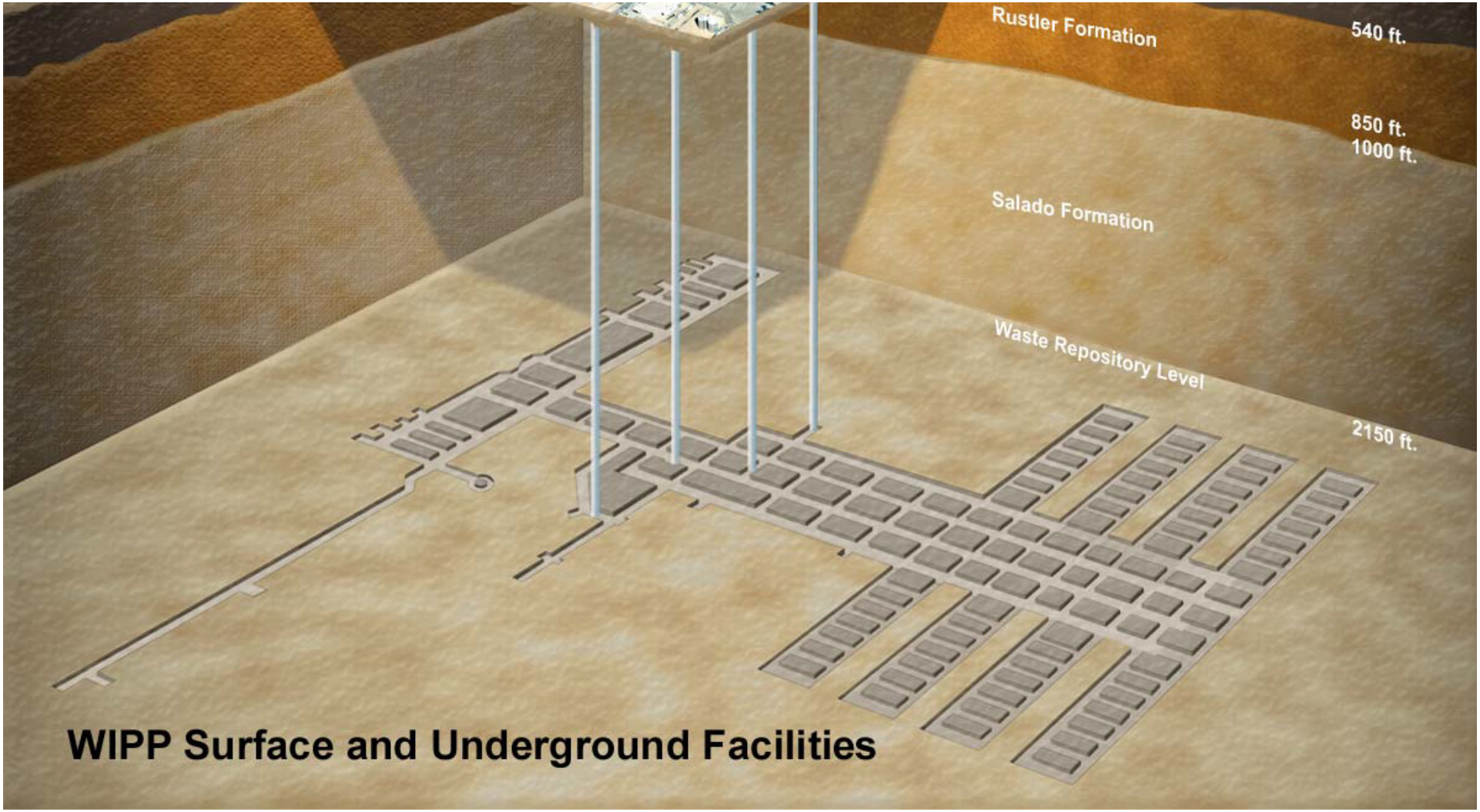
DOE mounting a demonstration project with nonradioactive material.

Cost comparable with WIPP but borehole siting will be a consideration.

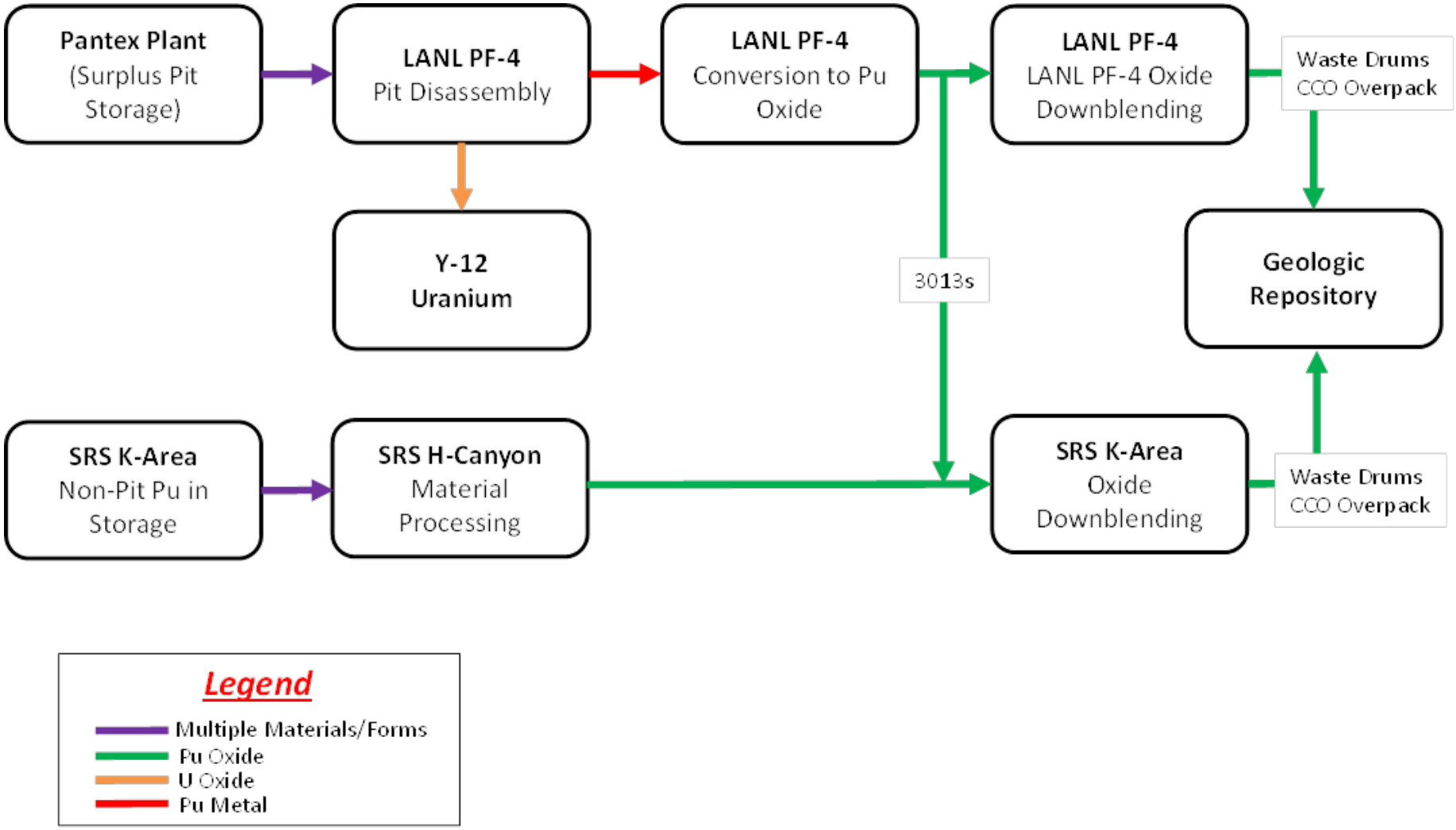


3. Plutonium downblending and disposal

Waste Isolation Pilot Plant (WIPP), New Mexico designed to dispose of transuranic wastes.



Dilute and dispose process (from Red Team plutonium-disposition report)

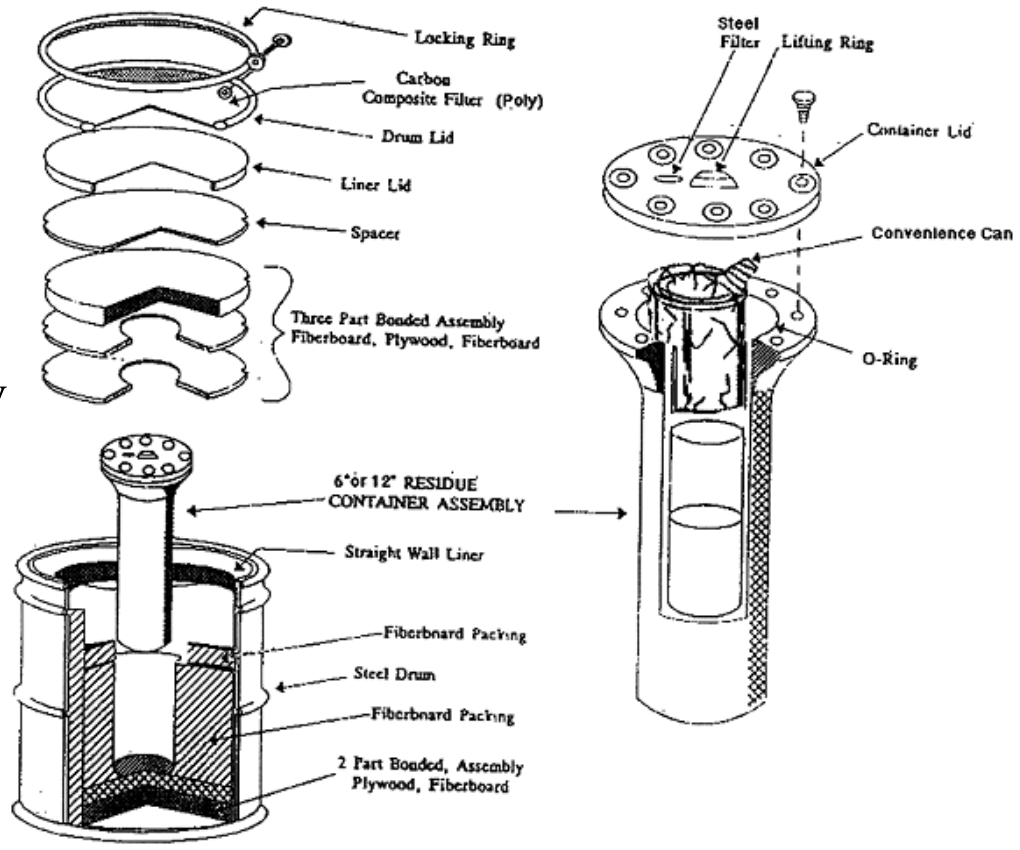


Basic Flow Diagram for the Dilute and Dispose Approach: This figure shows the major material flows for the base Dilute and Dispose approach as well as one variant, described later. Under this variant, LANL also dilutes material as a second production site, working in parallel with SRS.

3. Plutonium downblending and WIPP disposal

DOE proposes to dispose of at least 6 tons of excess plutonium in WIPP by dilution to below 10 wt-% and packing in pipe overpack containers.

- Procedure allows termination of safeguards on disposal packages.
- Advanced packaging options may enable disposal of all excess Pu in WIPP without changing Land Withdrawal Act.
- DOE will have to resolve WIPP safety issues and obtain NM consent. WIPP security may have to be increased.
- Likely to be least risky and cheapest option, as well as quickest if WIPP reopens as scheduled.
- Program will require about $400 million annually through the 2040s.



Downblending variants

- How much plutonium can be loaded in a single waste drum?
  - Conventional pipe overpack container (POC): 200 fissile gram (Pu-239) equivalent (FGE) maximum
  - Criticality control overpack (CCO): 380 FGE maximum
  - Variants of up to 1 kg plutonium per package under consideration
- Monolithic concrete waste form is another possibility to achieve greater dilution, stability and plutonium loading

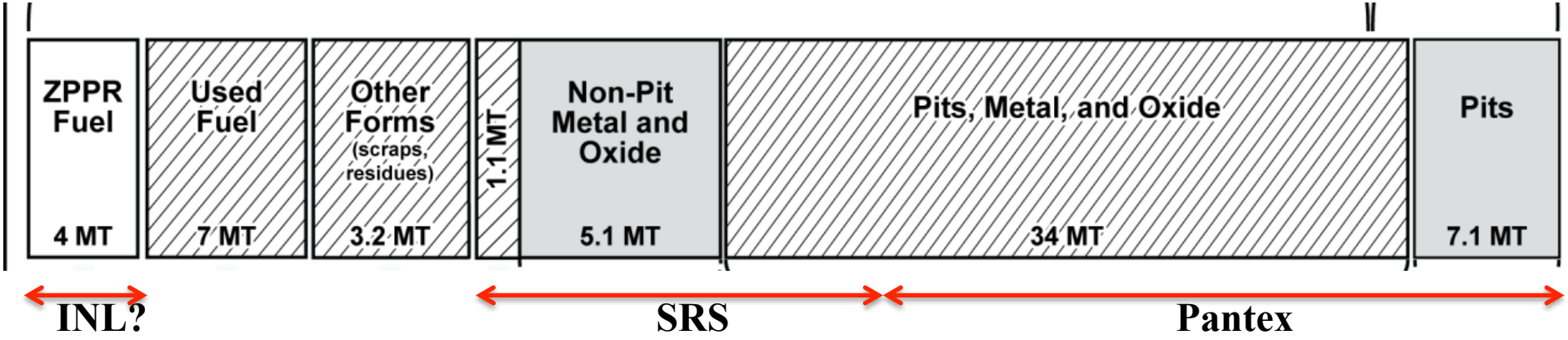
Safety and waste generation

- Compared to the MOX option, downblending will pose fewer safety risks and generate less waste
  - Room-temperature process
  - No “aqueous polishing” (dissolution and purification) required; no high-alpha liquid waste stream (and hence no need for Waste Solidification Building)
- Safety and environmental impacts of the additional plutonium inventory in WIPP (e.g. criticality) may merit further examination but are likely to be modest

Additional considerations

- Existing infrastructure at SRS can be leveraged to support all three alternatives, although upgrades or some new construction may also be needed:
  - K-Area Complex
  - Defense Waste Processing Facility
  - H-Canyon/HB-Line
  - Waste Solidification Building
  - Repurposed sections of the unfinished MOX facility
- Security issues associated with alternatives need to be addressed, both for domestic requirements and for international assurances.

Conclusions and recommendations



Step-by-step approach

DOE proposes to down-blend 6 tons of plutonium at SRS and send to WIPP.

If two more glove-box lines are installed in KAMS, at 300 grams of plutonium per 55-gallon container, would take about six years – perhaps less if the HB line is used as well.

In the meantime, DOE should examine the other direct-disposal options as well as WIPP for the remaining 41+ tons of excess plutonium.