

From Criticality Incredible Project Plan to Facility Hazard Categorization Downgrade

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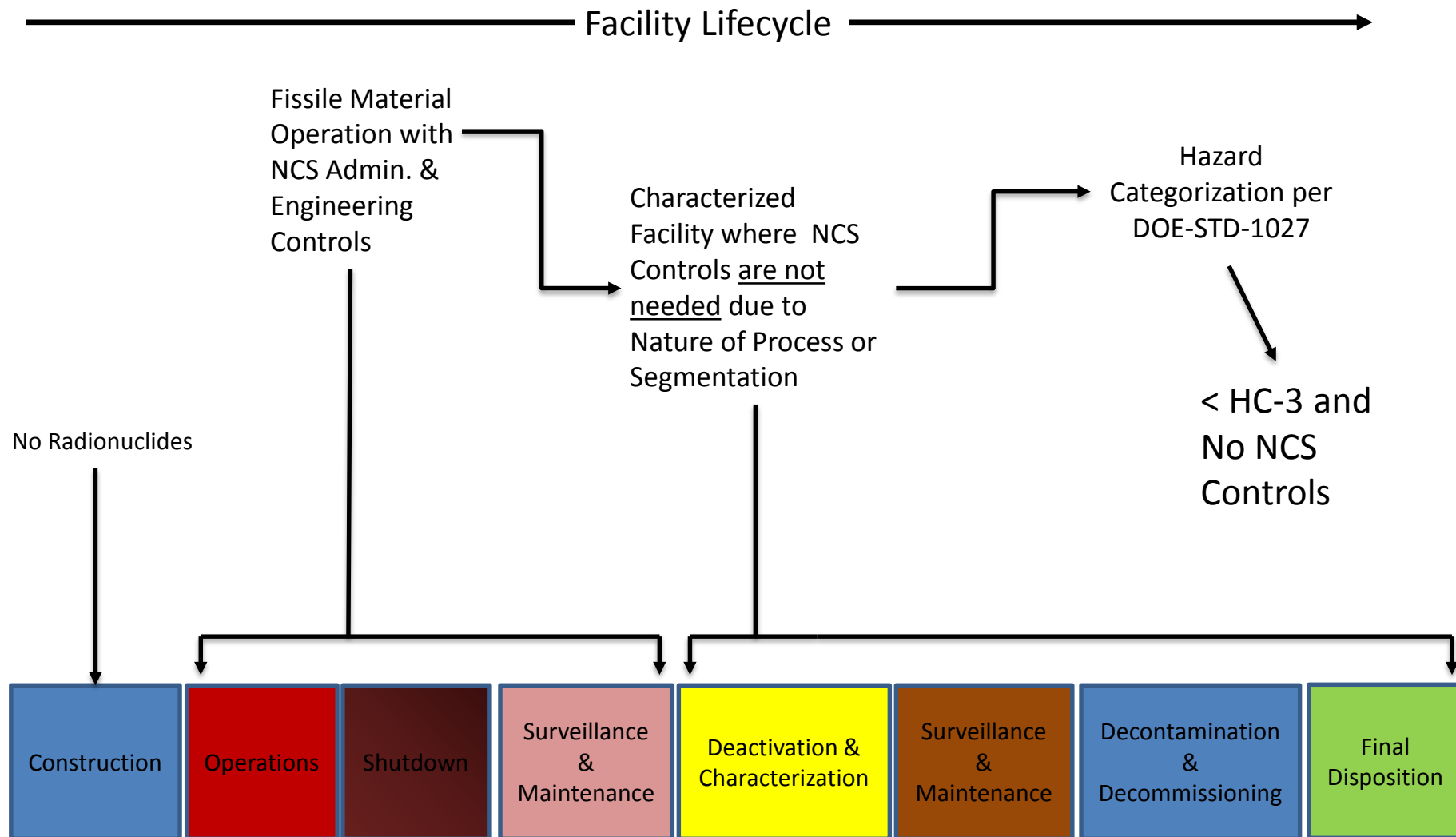
- Portsmouth/Paducah Project Office (PPPO) Mission - To conduct the safe, secure, compliant, and cost effective environmental legacy cleanup of the Portsmouth and Paducah Uranium Enrichment Sites on behalf of the local communities and the American taxpayer.



C-340 Metals Plant Complex



C-340 Metals Plant Complex Slab



➤ Facility Hazard Categorization

- Demonstrating CI will allow the DOE-STD-1027-92 Attachment 1 isotope values to be used for Hazard Categorization rather than the ANSI-ANS-8.1 type limits.

| Isotope | Category 2 Curies | Threshold Grams | Category 3 Curies | Threshold Grams |
|--------------|----------------------|--------------------|----------------------|--------------------|
| U-233 | 2.2E+02*** | 2.3E+04*** | 4.2E+00 | 4.4E+02 |
| U-234 | 2.2E+02 | 3.5E+04 | 4.2E+00 | 6.7E+02 |
| U-235 | 2.4E+02*** | 1.1E+08*** | 4.2E+00 | 1.9E+06 |
| U-238 | 2.4E+02 | 7.1E+08 | 4.2E+00 | 1.3E+07 |
| Np-237 | 5.8E+01 | 8.3E+04 | 4.2E-01 | 6.0E+02 |
| Np-238 | 9.1E+05 | 3.5E+00 | 1.3E+03 | 5.0E-03 |
| Pu-238 | 6.2E+01 | 3.6E+00 | 6.2E-01 | 3.6E-02 |
| Pu-239 | 5.6E+01*** | 9.0E+02*** | 5.2E-01 | 8.4E+00 |
| Pu-241 | 2.9E+03 | 2.8E+01 | 3.2E+01 | 3.1E-01 |
| Am-241 | 5.5E+01 | 1.6E+01 | 5.2E-01 | 1.5E-01 |
| Am-242m | 5.6E+01 | 5.8E+00 | 5.2E-01 | 5.3E-02 |
| Am-243 | 5.5E+01 | 2.8E+02 | 5.2E-01 | 2.6E+00 |
| Cm-242 | 1.7E+03 | 5.1E-01 | 3.2E+01 | 9.7E-03 |
| Cm-245 | 5.3E+01 | 3.1E+02 | 5.2E-01 | 3.0E+00 |
| Cf-252 | 2.2E+02 | 4.1E-01 | 3.2E+00 | 5.9E-03 |

1 For isotopes not listed below, users may refer to LA-12846-MS, Specific Activities and DOE-STD-1027-92 Hazard Category 2 Thresholds, LANL Fact Sheet or to 10 CFR 30.72, Schedule C and adjust the values consistent with the X/Q value described in Attachment 1 of this Standard. (Note that although LA-12846-MS misstates the Category 2 threshold criterion, its use of the proper X/Q negates any effect of the misstatement. See "Radiological Criteria, p A-3 and Meteorological Conditions, p A-7 for clarification)

Any other beta-gamma emitter - 4.3E+05 Ci
Mixed fission products - 1.0E+03 Ci
Any other alpha emitter - 5.5E+01 Ci

2 For isotopes not listed below, users may refer to LA-12981-MS, Table of DOE-STD-1027-92 Hazard Category 3 Threshold Quantities for the ICRP-30 List of 757 Radionuclides, LANL Fact Sheet for threshold quantities of any isotopes of interest.

* At the recommendation of the Tritium Focus Group, the Category 3 tritium threshold value has been increased from 1.0E+03 Ci and 1.0E-01 grams to 1.6E+04 Ci and 1.6E+00 grams, consistent with the methodology of EPA used for the other nuclides.

** Provided as an example to indicate that when a substance such as P₃₂ is used in a solution (i.e., phosphoric acid) for experimentation, medical treatment, etc., it should no longer be considered as highly volatile/combustible.

*** To be used only if segmentation or nature of process precludes potential for criticality. Otherwise, use the criticality lists for U₂₃₃, U₂₃₅ and Pu₂₃₉ of 500, 700, and 450 grams, respectively.

4,185-pounds ²³⁵U
vs.

1.5-pounds ²³⁵U

upgrade

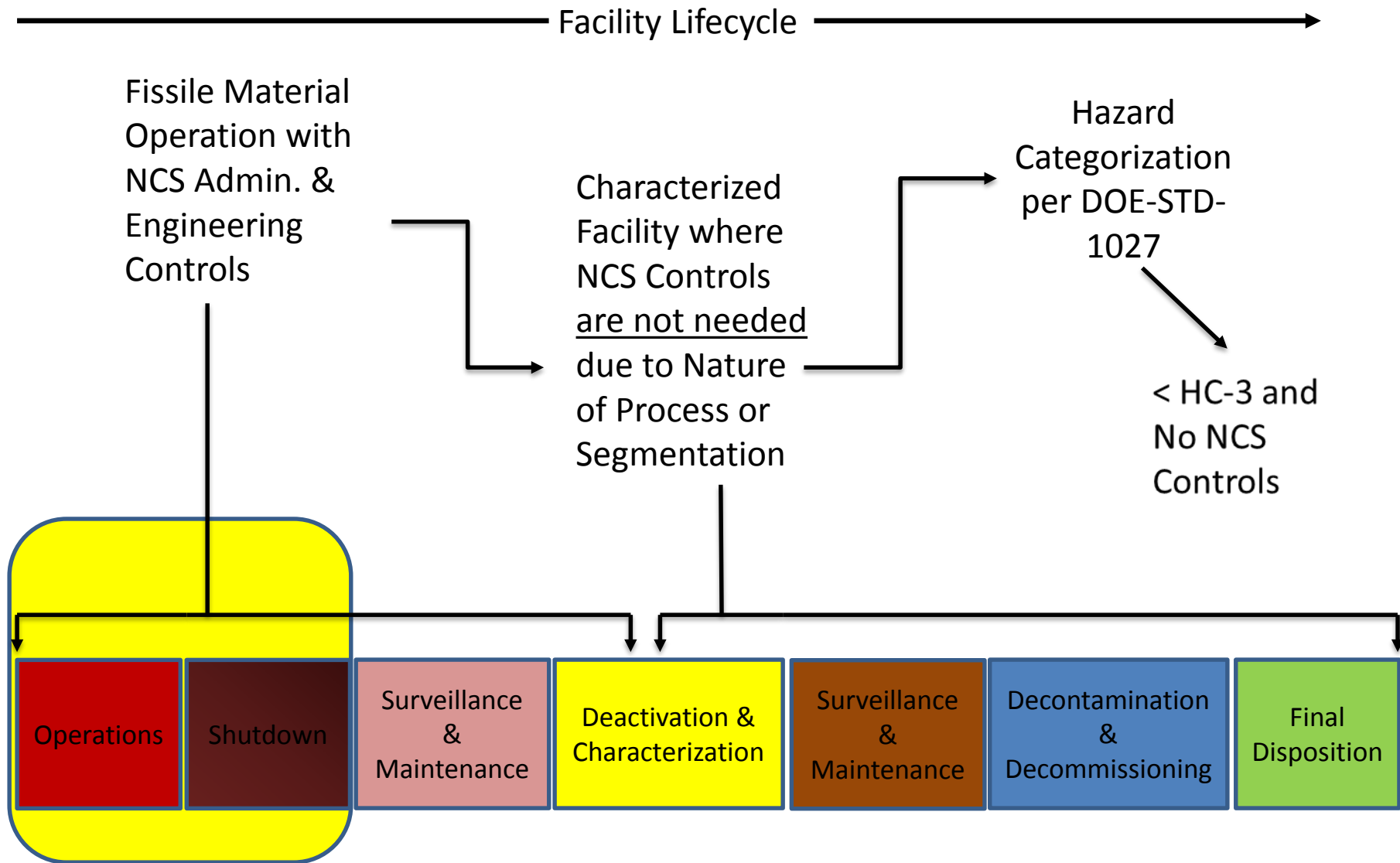
Factoid:

4,185-pounds of
²³⁵U at 5 % assay
equals 54-tons
uranyl fluoride

➤ Facility Hazard Categorization

- Current Condition – Most Gaseous Diffusion Plant facilities are HC-2 because of history and lack of characterization





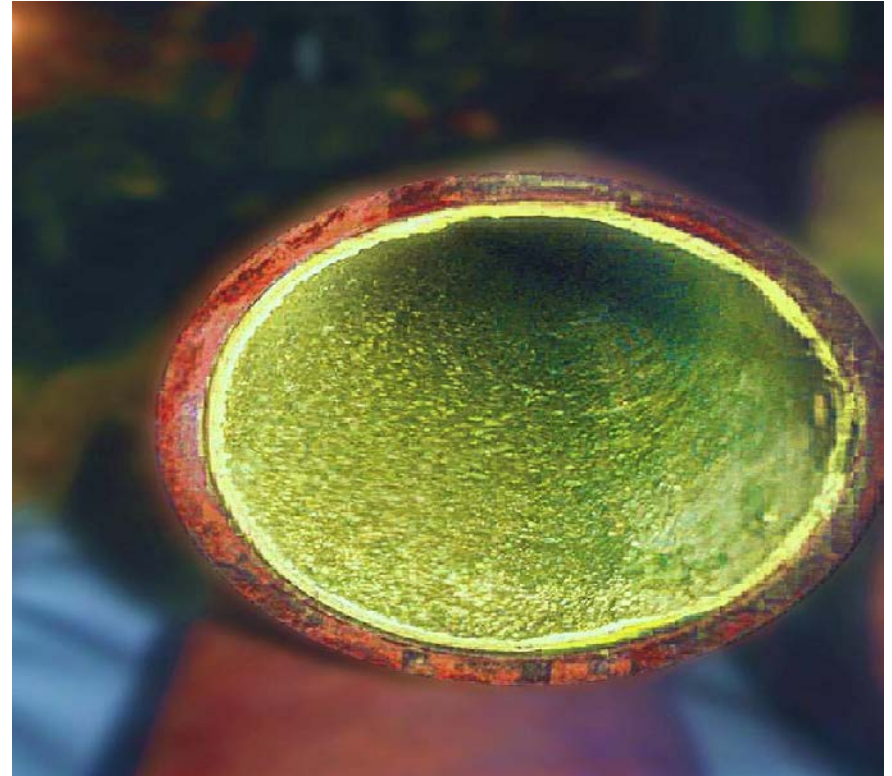
- Residual quantities over very large systems can represent a significant inventory of fissile material.

For example:

Given:

30-inch diameter header that is 500-feet long

CI limit is 22-grams ^{235}U /foot



Total ^{235}U mass in example pipe section could be as much as 11-kgs

(MUCH MORE THAN A CRITICAL MASS IF IT ALL GOT TOGETHER)

- Residual quantities over very large systems can represent a significant inventory of fissile material (continued)



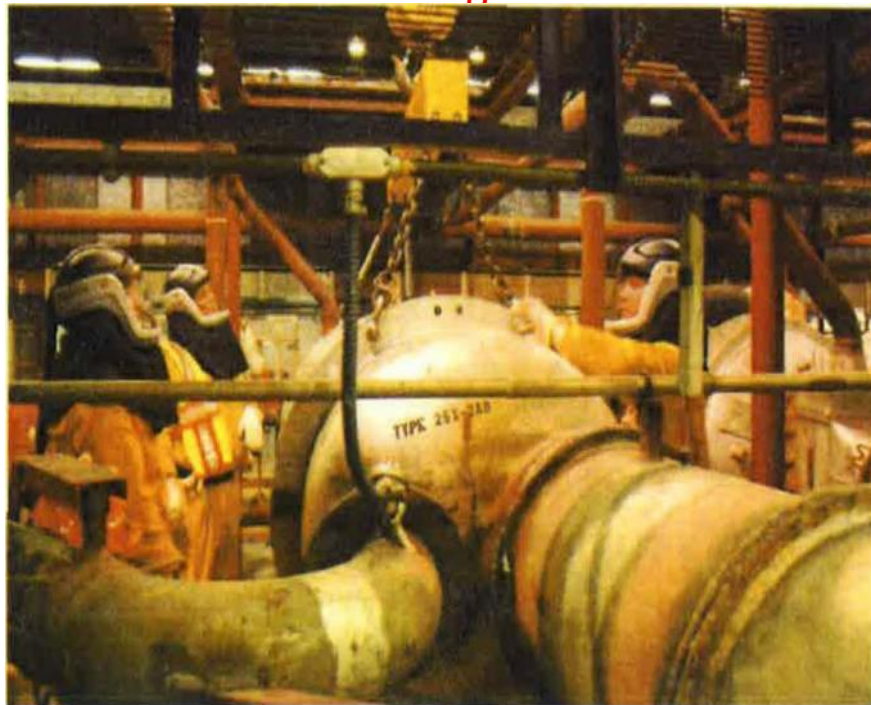
Inside of a 12" G-17 Valve Body with
a Uranyl Fluoride (UO₂F₂) coating



Equipment Size Perspective

- Residual fissile material in large and complex systems present many challenges!!!

One Stage



Cell



Difficult to find and measure residual radionuclides.

Inside process equipment

Surface area can be very large and complex (e.g., converters)

Not easily observed (e.g., visual examination is not conclusive)

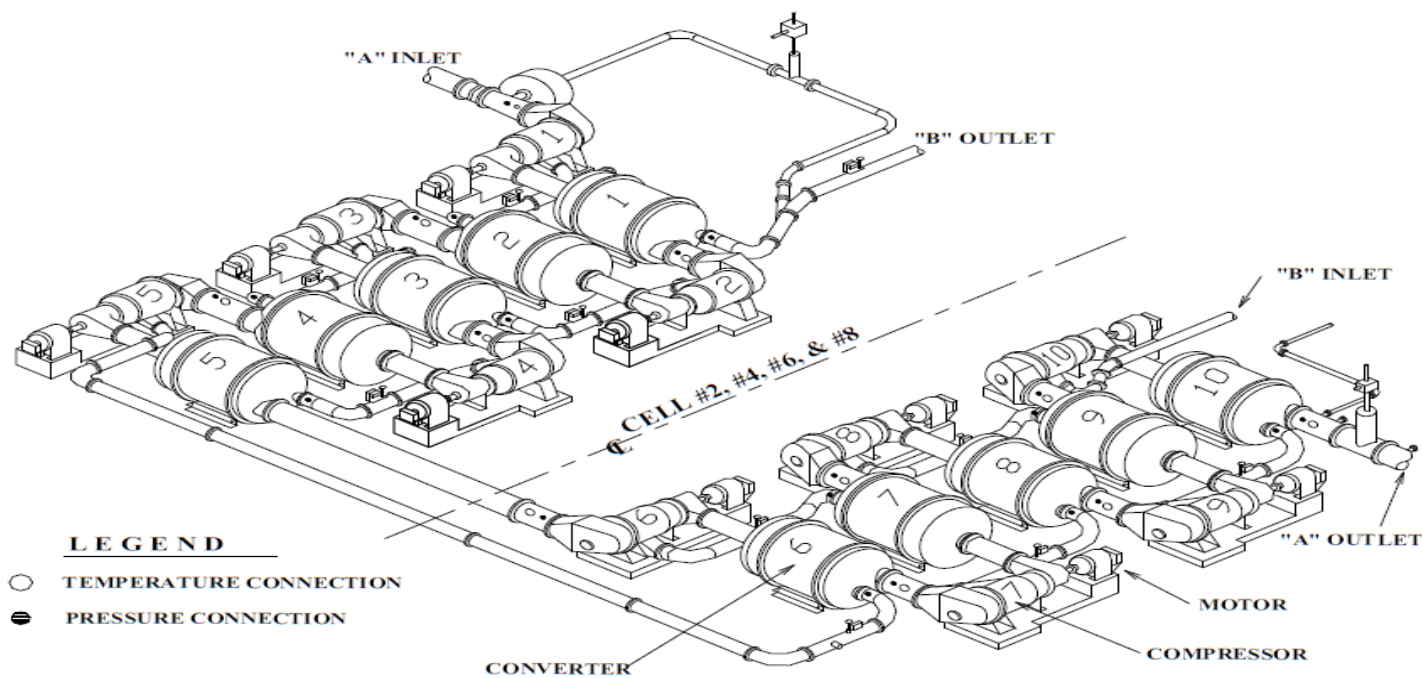
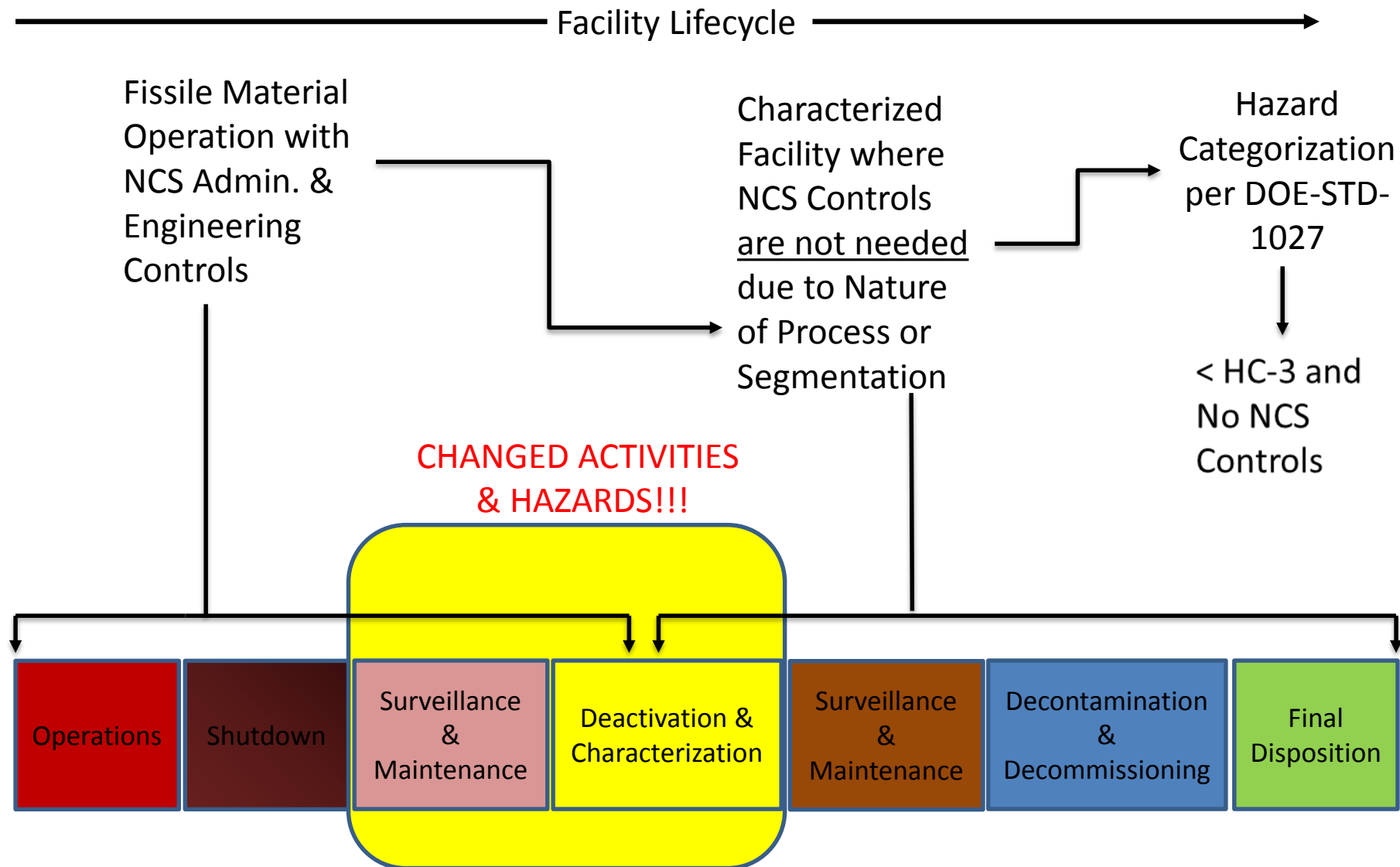


Figure 3.3-4. Typical "00" Cell

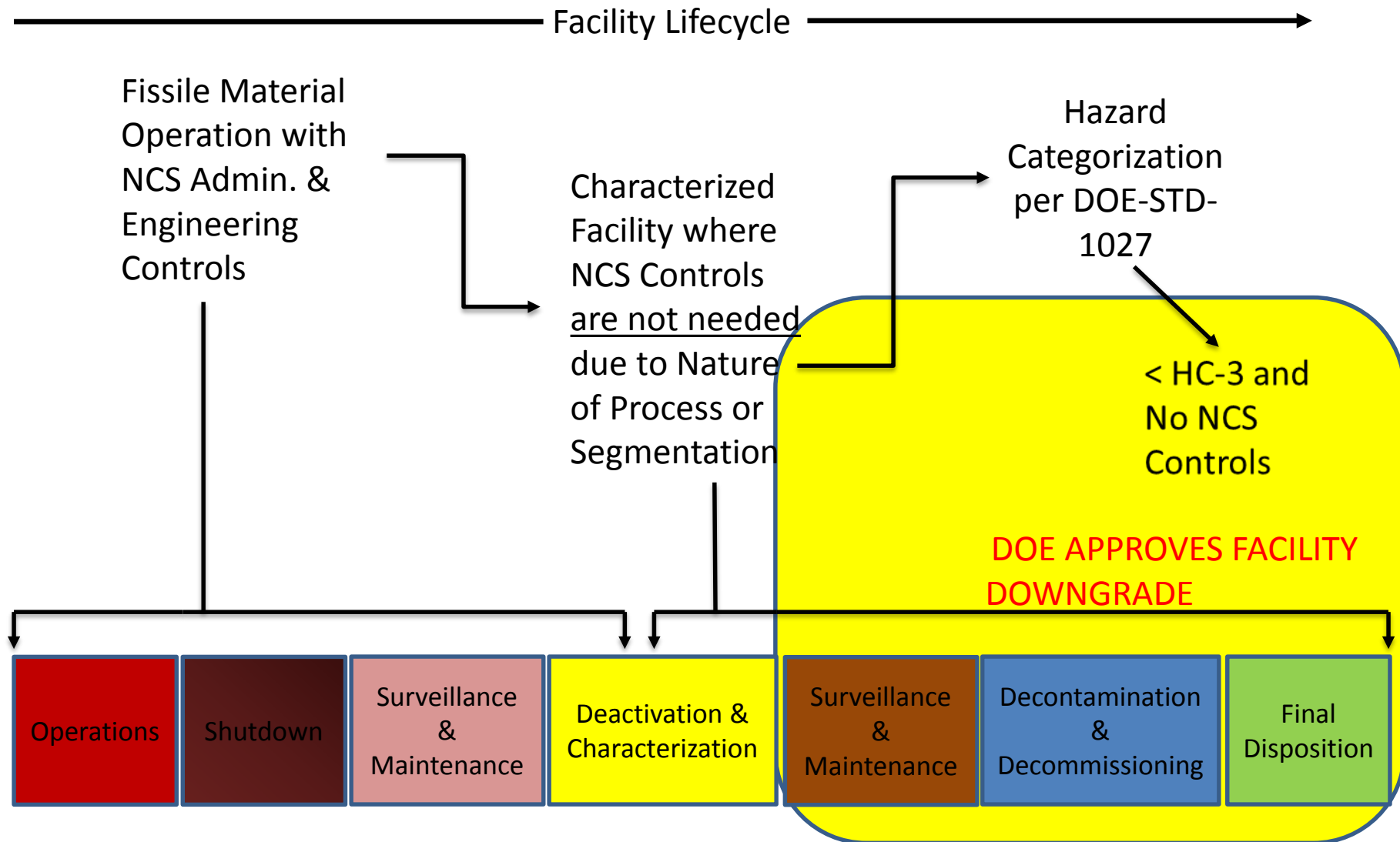
There are 1820 Stages at Paducah and 4080 Stages at Portsmouth with miles of process piping.
Characterization will take many, many measurements!

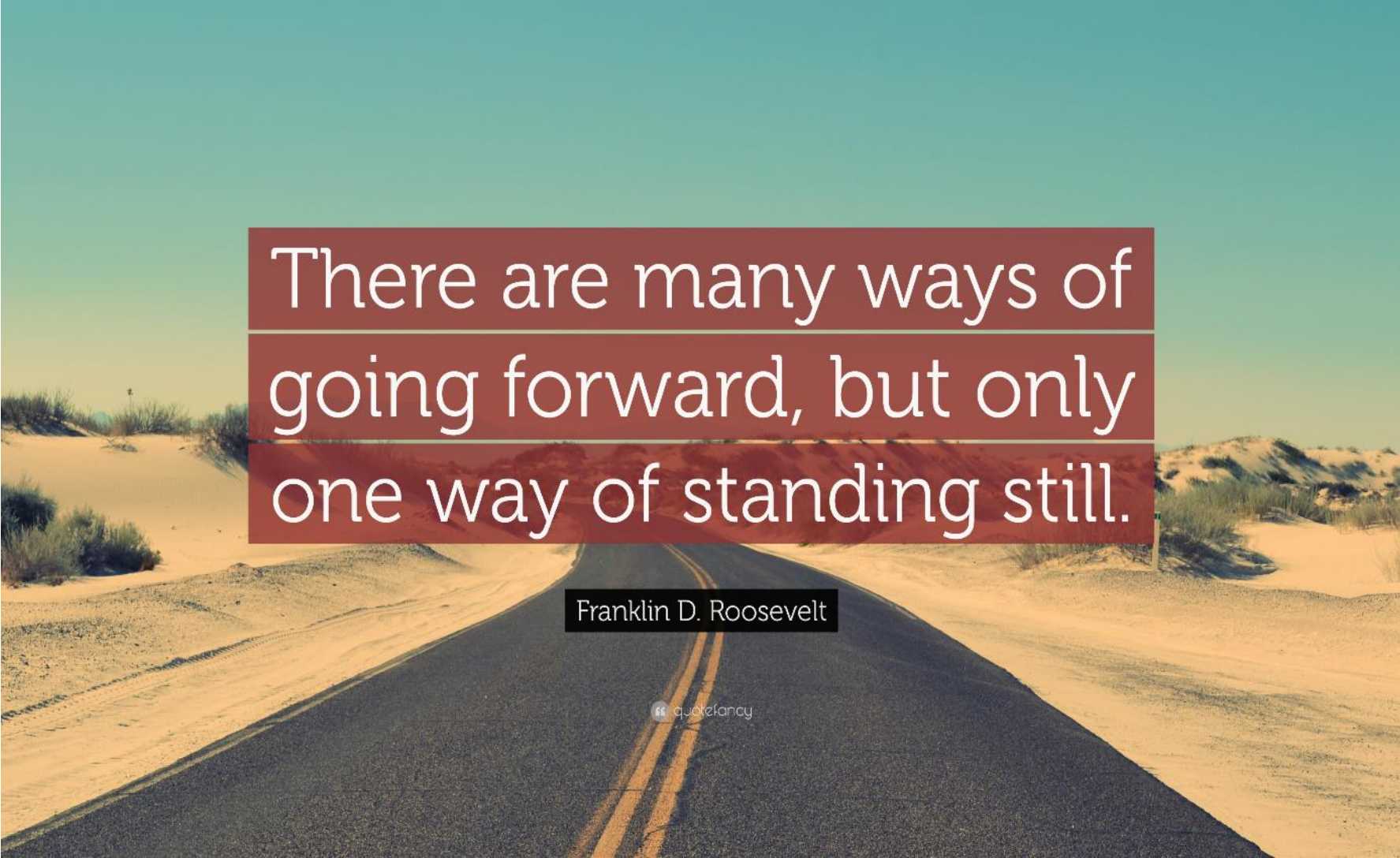


So How Does a Facility Get to CI?

How much fissile material is left?
Mobility of fissile material?
How clean does it need to be?
Segmentation needed? Where?
What is the facility end-state?
Will the residual FM remain CI
thru the end state?







There are many ways of
going forward, but only
one way of standing still.

Franklin D. Roosevelt

quote fancy

Examples of a path to CI that is **being used** at a facility at Portsmouth and a path to CI that is **being used** at a facility at Paducah.



PORTS (X-326)

- Remove and ship off-site the major equipment (converters, compressors, coolers)
- Develop CI limits based on nature of process for remaining equipment (primarily piping and valves)
- Characterize equipment (~ 1.3 million measurements)
 - If < CI then leave in building
 - If > CI, decontaminate to < limit, or remove



Paducah (C-400)

- Remove and ship off-site most processing equipment
- Characterize what remains
- Characterization demonstrated remaining fissile material in facility is less than 700 grams ²³⁵U

Planning

For the PORTS X-326 cascade facility, a “plan” has been developed.

The plan includes and discusses in length:

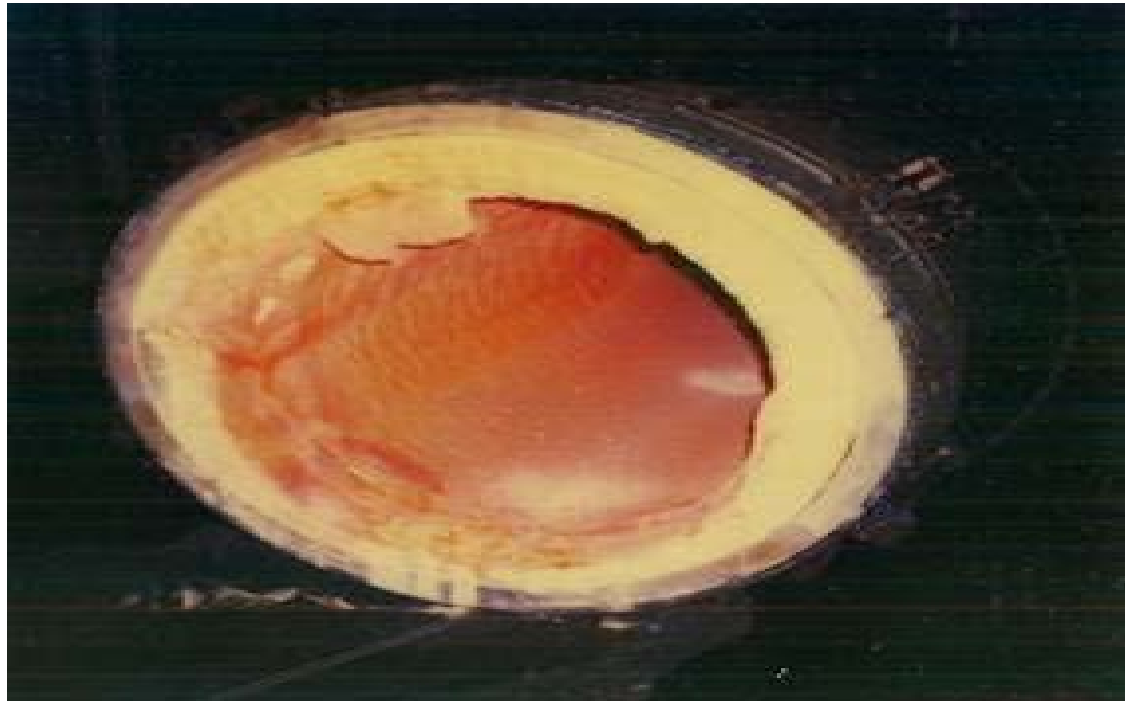
- Facility History
- Current Facility Status
- Strategy for Achieving CI
- Characterization Approach
- Project Completion Criteria
- Data Management System
- Schedule

This plan is required to be approved by DOE via the contract!!!

Characterization – The process used to determine and document the type and quantity of radionuclides in an item of interest.

- Deposit material
- Media sampling
- NDA
- Metal coupon
- Visual verification
- Etc.....

Enrichment (wt. % ^{235}U , $^{235}\text{U}/^{234}\text{U}$ ratio)
Transuranic content
 ^{99}Tc



Challenges of Data Gathering & Analysis

Evaluate sample data

- Collection
- Analysis
- Raw Data
- Uncertainty
- Interpretation
- Range of Applicability
- Validation

If data is wrong, how
wrong can it be?

Process Knowledge

Confirmatory sampling considerations
Exceptions should be anticipated



Evaluation

1. CCIPP contains the initial CI limits based on an NCSD
2. Compare the CI limits to the collected data
3. Margin of Safety is the difference between the initial limit and the measured fissile material content
4. Technical basis for Facility Downgrade – DOE needs to know that CI is met and that the Margin of Safety is determined



Documentation

- Documentation is the complete facility data and evaluation records with supporting information that demonstrates the status of the facility.
- Provides the basis for DOE approval of the facility hazard categorization downgrade



Conclusion

- A consensus standard for a criticality incredible definition and how to implement does not exist that provides guidance for the methodical downgrade of facilities.
- PPPO has established its definition and method for implementing CI.
- The PPPO method could be used as a starting point for a consensus standard.

Questions/Open Forum