

CNS | consolidated nuclear security, llc
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

Nuclear Criticality Safety Strategy for the Downgrade of the 9206 Facility.

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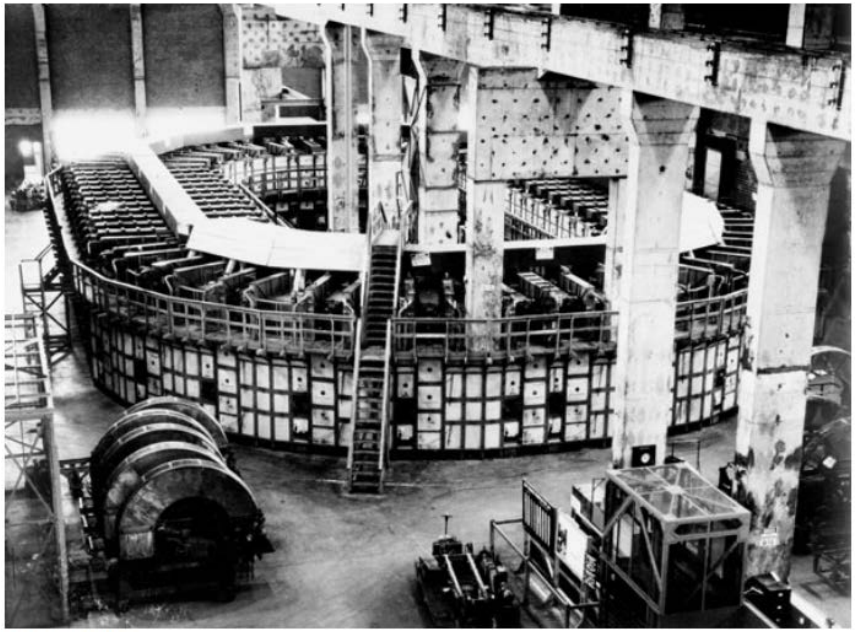
General Y-12

- **History**
  - Constructed as part of the World War II Manhattan Project.
  - Provided the enriched uranium for the “Little Boy” nuclear weapon.
  - Afterward, Y-12 provided lithium separation and key components for the thermonuclear weapons that helped end the Cold War.



Y-12 Calutron

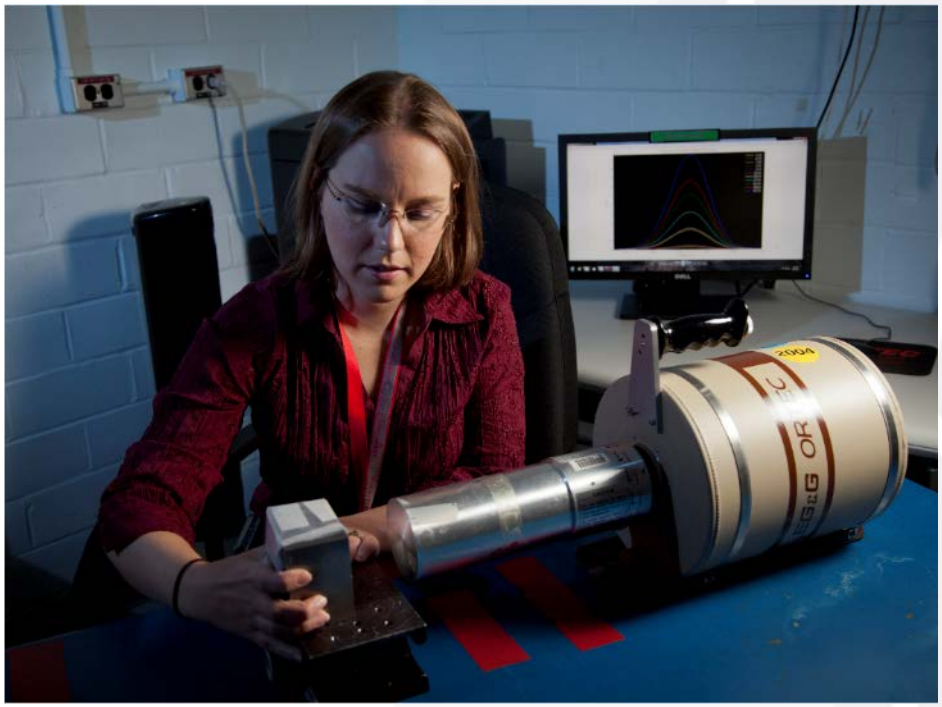
1944 aerial photo of Y-12 under construction

General Y-12

- **Current Mission**
  - Maintain the safety, security and effectiveness of the U.S. nuclear weapons stockpile.
    - Weapon Component Production
    - Surveillance
    - Dismantlement
    - Storage

General Y-12

- **Current Mission**
  - Reduce the global threat posed by nuclear proliferation and terrorism.



General Y-12

- **Current Mission**
  - Provide feedstock to fuel the U.S. Nuclear Navy.
    - Y-12 uranium powers the Navy's Nuclear Powered Aircraft Carriers and Submarines under an agreement with the NNSA's Naval Reactors Office.

9206 Facility Overview

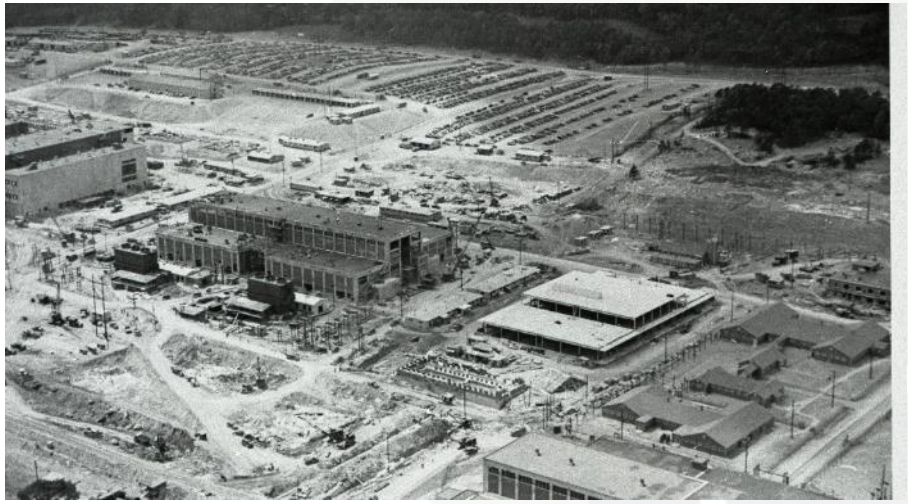
- Built in the 1940's to recover enriched uranium from the electromagnetic separation process.
- After WWII the facility converted intermediate enrichment UF_6 from enrichment plants to metal.
- Converted Savannah River Site material back into metal from 1973 until 1988.
- Operations ceased in 1994.
- Current operations consist of deactivation activities.

9206 under construction on 6/08/1944

9206 Today

9206 Facility Overview

- Residual holdup material remains in the existing systems
- In order to transfer the facility to DOE-Environmental Management (DOE-EM), the facility must transition from its current state to a deactivated surveillance and maintenance (S&M) phase.
- In this phase the risks must be lowered such that a nuclear criticality is declared not credible and no documented safety analysis is needed.



9206 under construction

9206 Today

Strategy Introduction

Provide a Nuclear Criticality Safety strategy for downgrading 9206 from a Hazard Category II Nuclear Facility per DOE-STD-1027-92.

- This will facilitate the eventual transfer of the facility to DOE-EM for final disposition.
- Needs to be completed in such a way that criticality can be declared not credible while considering the resources required to achieve incredibility.
- Designed to allow the downgrading of the facility while considering the capabilities of the facility and resources required.
- Does not include details of future disposal of material that remains after downgrade however the intent is to leave the facility in such a state that harvesting of material will not be required.

Strategy

General Approach to Downgrade

- Draining of fissile solutions
- Physical removal of holdup or component
- Isolation to prevent in ingress of water and/or fixative to isolate and prevent movement of holdup
- Final NDA to support downgrade and turnover.
- Some systems may only require NDA.
- Based on these actions coupled with appropriate management to prevent wholesale degradation, a technical basis for downgrade may be argued.

Men working outside of 9206 in the 1940's

Strategy

Identify Systems of NCS concern

- Criteria for identifying systems of concern:
  - Systems which processed fissile material
  - Systems not designed to contain fissile material but may due to previous use or upsets.
  - Systems identified by review of existing process information and NDA.
- Some systems require more data in order to determine if they are of concern.
- Holdup may exist in unexpected places and personnel must remain vigilant and ask questions.

Strategy

Define System End Point Criteria

- Defining system end points will allow determination of actions likely required to achieve deactivation.

- Details will follow later in the presentation.

Obtain Data

- NDA data exists for many systems in 9206.
  - Much of this is 10+ years old.

- High quality data will be required to support a incredibility argument.
  - This may include NDA, destructive testing, documented visual inspection, etc.

Strategy

Remediate Systems as Necessary

- Using the data available, remediate systems in order to meet the end point criteria.
- As part of this effort it is expected that all fissile solutions are drained and all collected fissile material is removed from the facility
- Equipment which is removed from the facility as part of the deactivation process is not required to meet the end point criteria.

Obtain Post Remediation Data

- Obtain post remediation NDA to confirm that the endpoint criteria have been met.
- This provides a record of the mass and distribution of holdup remaining for the S&M phase.

Strategy

Document Basis for incredibility of an inadvertent nuclear criticality in the facility.

- Based on the completion of the previous steps, a basis for the incredibility of a criticality in 9206 may be documented based on :
  - The state of the facility (Cleaned out systems or systems with minimal amounts of material fixed in place).
  - Management of the facility during the S&M phase to prevent wholesale degradation of the facility (e.g., structural collapse, water in-leakage).

Strategy

Important Note

- **While this strategy does not extend past the downgrade, consideration should be taken for steps beyond downgrade when detailed planning is completed for remediating systems.**
- **Systems should be remediated with the potential final disposition (i.e. burial limits) in mind and in such a way that harvesting of fissile material will not be required after downgrade as this could lead to re-categorization of the facility.**

System Endpoint Criteria

Three cleanout options investigated

1. Clean out such that nature can do no worse.
   - Removal all visible deposits
   - Flushing or wiping of fissile systems
   - Final NDA to document remaining fissile material
   - Designed to remove all material from that systems that could be mobilized through water ingress and potentially coalesce as 9206 sits in the S&M phase.
   - Ideal from an NCS standpoint
   - Resource intensive

System Endpoint Criteria

Three cleanout options investigated (continued)

2. Cleanout each system and immobilize fissile material
   - Clean and isolate each fissile system such that no more than no more than 700-g ^{235}U (including uncertainty) is located in any single piece of equipment or any collections of connected equipment.
   - Immobilize any remaining material in place with a fixative.
   - The 700-g ^{235}U limit was chosen because it is the ANSI/ANS-8.1-2014 single parameter subcritical mass limit for uranium systems in mixtures that might not be uniform.
   - The options presents minimal risk of criticality due to a reduced mass in each system and immobilization of material.
   - Risk mitigation strategy may be required in order to minimize the risk of criticality during upset conditions that could challenge the stability of the fissile material such as a large facility fire.

System Endpoint Criteria

Three cleanout options investigated (continued)

3. Cleanout each system and immobilize fissile material
   - Clean and isolate each fissile system such that no more than no more than 700-g ^{235}U (including uncertainty) is located in any single piece of equipment or any collections of connected equipment.
   - Isolate the fissile material in a robust manner (Welded caps, bolted flanges, etc.).
   - Designed to maintain isolation of the fissile material during all but the most extreme upset conditions (facility fire, earthquake).
   - Risk mitigation strategies may be required in order to minimize the risk of criticality during upset conditions that could challenge the stability of the fissile material such as a large facility fire.

Recommendations for System End Points

- After consideration of the options discussed, engineering recommends the facility cleans out systems as described in options 2 and 3.
- Option 1 is certainly acceptable however the cost involved is likely to be prohibitive when used throughout the entire facility.
  - 9206 has a very limited capacity for handling solutions.
- Systems which were not designed to contain fissile material but may due to previous use or upsets (nitric acid tanks, etc.) would require no further remediation if NDA indicates there is no appreciable amount of fissile material present in an individual piece of equipment and the system is isolated**.**
  - The arbitrary cut-off for determining the presence of appreciable quantities of fissile material is 15-g ^{235}U or less.

Recommendations for System End Points

The floors in 9206 present a unique challenge

- Some rooms in 9206 have floors lined with stainless steel
- Large masses are presumed to be held up under the stainless steel floors
- Potentially difficult to remove this material
- Some floors do not have NDA data
- No end point criteria can be recommended at this time.
- Further testing and planning will be required

Recommendations for System End Points

System	End point
Systems which processed fissile material	1) Less than 700-g including uncertainty of immobilized ^{235}U per piece of equipment or collections of connected equipment. OR 2) Less than 700-g including uncertainty of ^{235}U per piece of equipment or collections of connected equipment which is isolated in a robust manner.
Systems not designed to contain fissile material but may due to previous use or upsets.	Less than 15-g ^{235}U per piece of equipment. If more than 15-g ^{235}U per piece of equipment is present, then the end point is the same as systems which processed fissile material.
Floors	To be determined after further characterization and deactivation planning.

Recommendations for System End Points

Risk Mitigation Strategies

- There are credible scenarios during the S&M phase of the 9206 life cycle that could lead to uncertainties in the final distribution of material.
  - Building degradation
  - Facility fire
  - Seismic events
  - High wind events
- Risk mitigation strategies may be required in order to minimize the risk of criticality during upset conditions that could challenge the stability of the fissile material such as a large facility fire.
  - Surveillance and maintenance of the roof
  - Surveillance and maintenance of the facility structures
  - Limited fire loading

Recommendations

The following recommendations are made in order to gather information in support of the deactivation and downgrade of 9206:

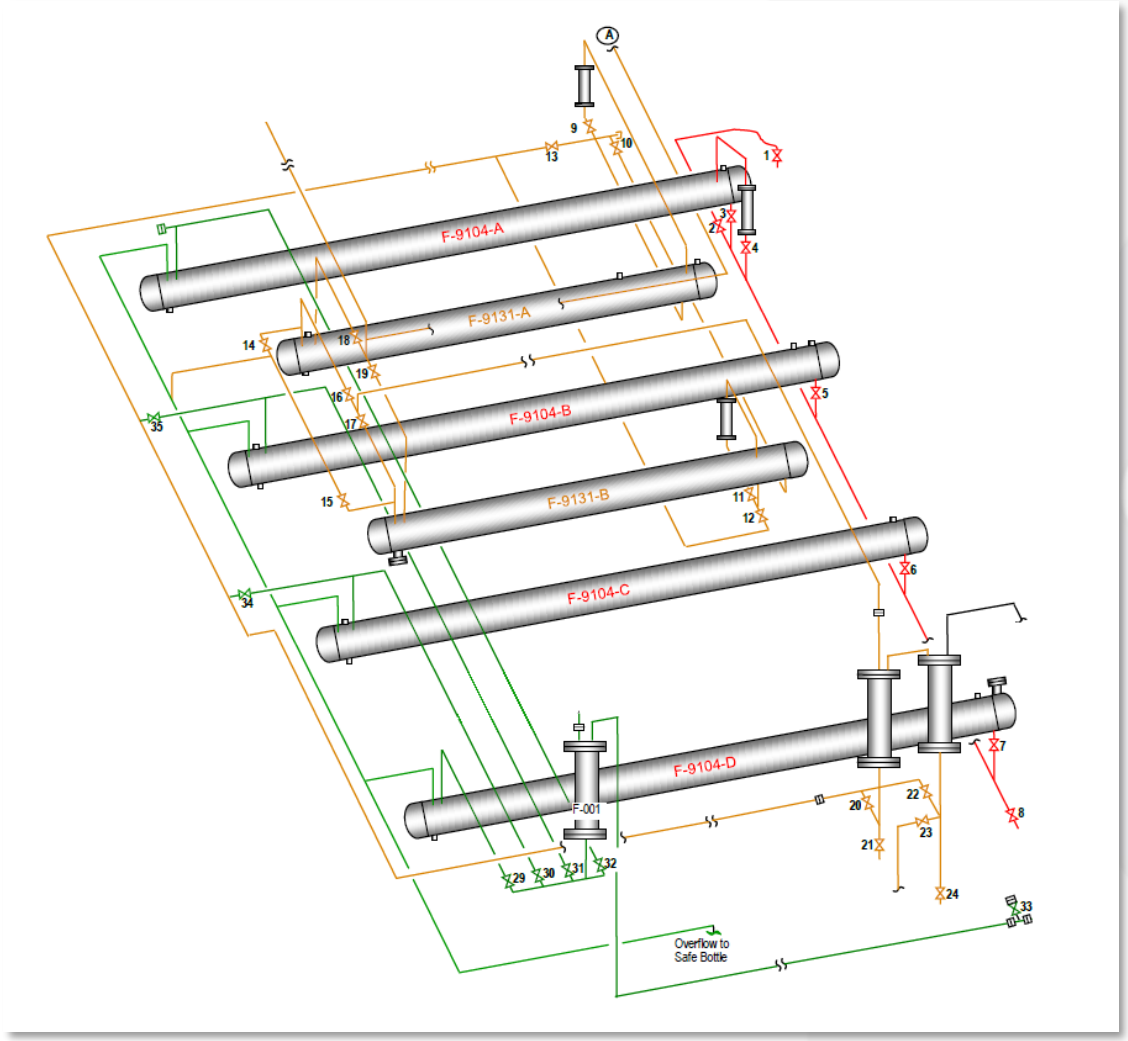
- Potential fixatives used to immobilize fissile material should be investigated from a NCS, Fire Protection, and waste acceptance perspective
- New NDA Surveys should be conducted on systems where new data may impact the details of cleanout planning.
- Characterization should be conducted of the 9206 floor using both modern NDA techniques and destructive testing.

Conclusions

- A strategy was developed to pursue the downgrade of the 9206 facility.
- Several options were explored to allow for different levels of risk and cost.
- Estimates based on the recommended strategy detailed in this presentation indicated large cost savings over the original strategy.
  - The original strategy involved the complete removal or extensive cleaning of all 9206 systems (Option 1) before downgrading.
- This strategy may be adapted to or otherwise provide some value to other facilities that have process enriched uranium.

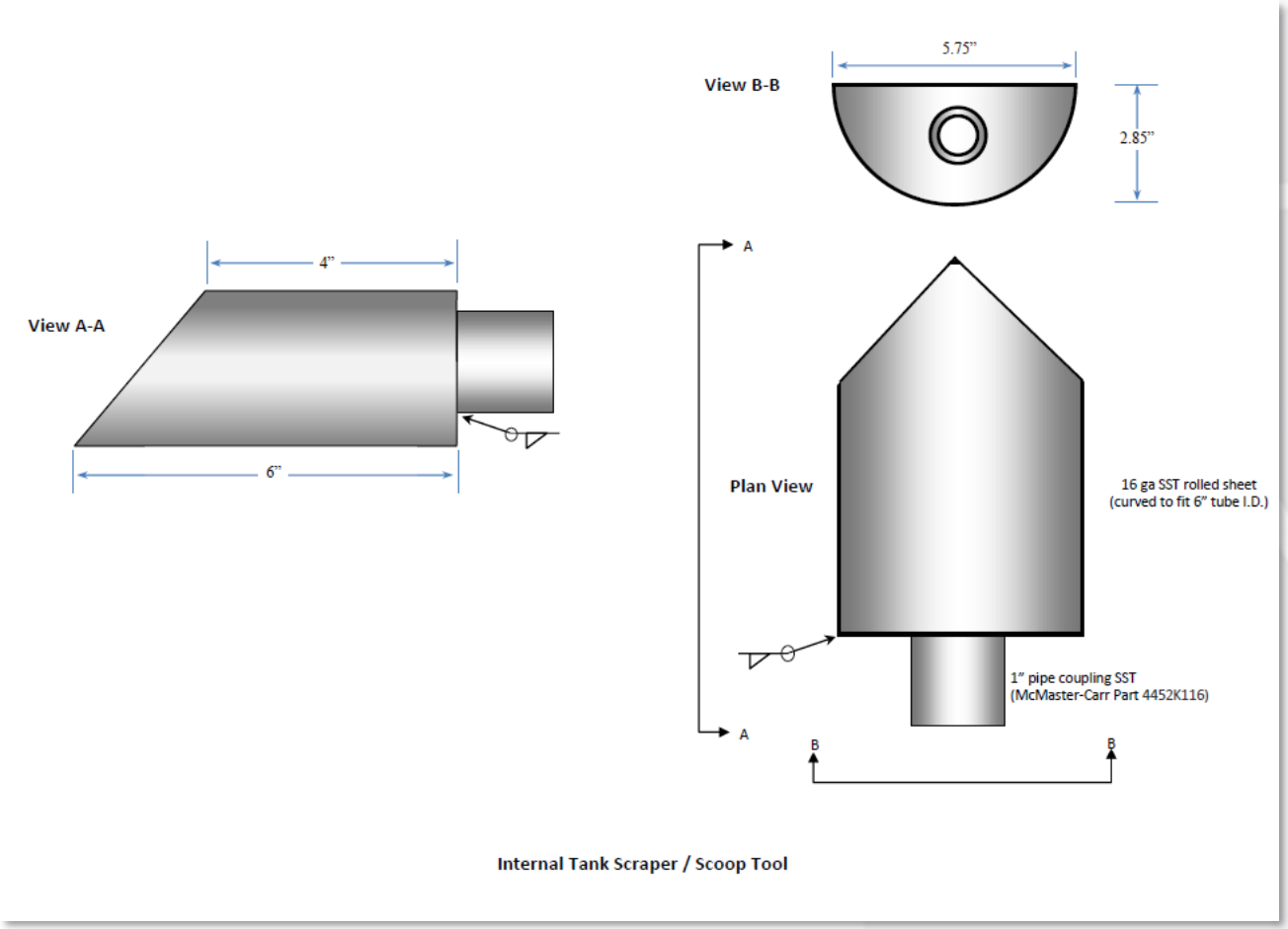
Initial Cleanout Efforts

Uranyl Nitrate Tank Cleanout



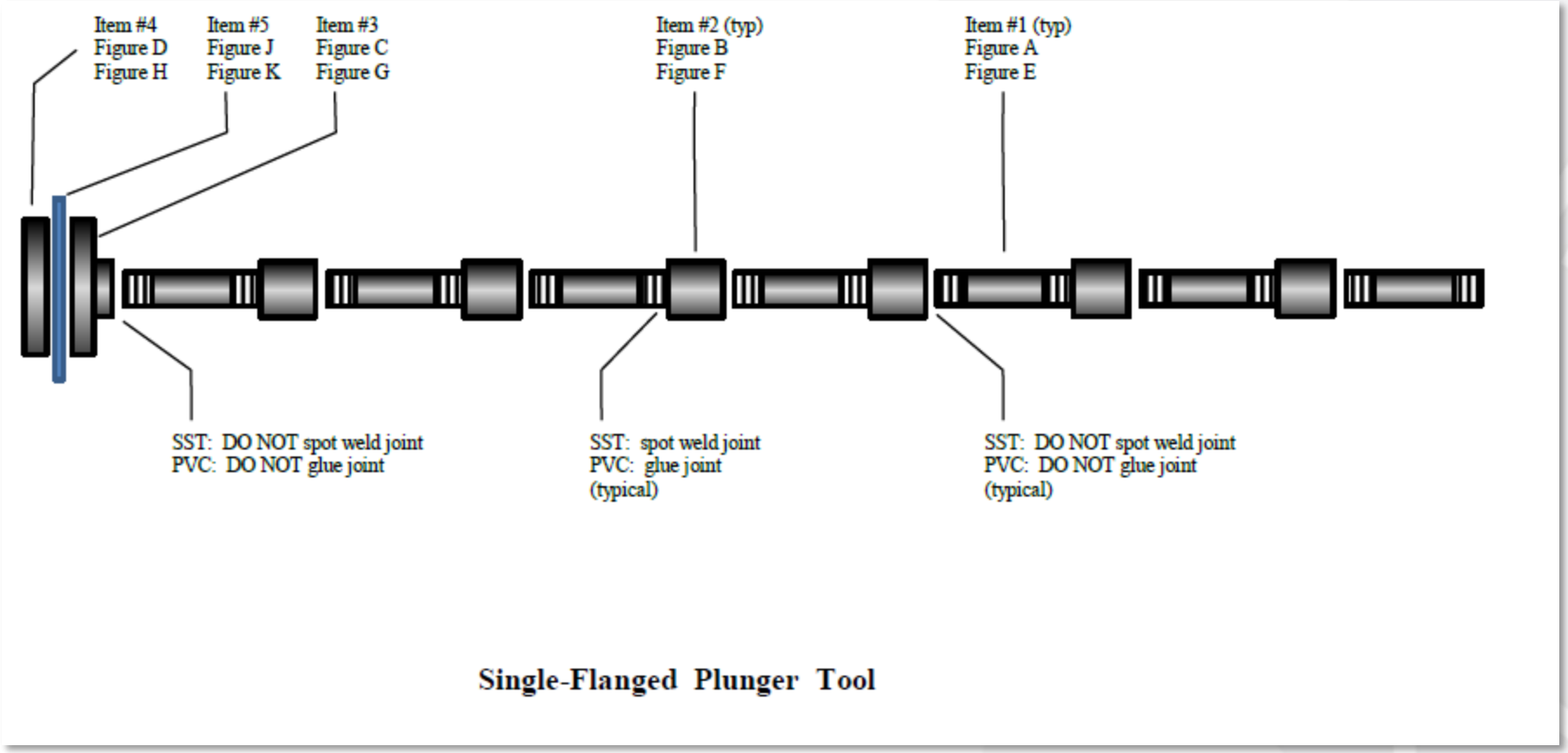
Initial Cleanout Efforts

Uranyl Nitrate Tank Cleanout



Initial Cleanout Efforts

Uranyl Nitrate Tank Cleanout



Single-Flanged Plunger Tool

Initial Cleanout Efforts

Uranyl Nitrate Tank Cleanout

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Uranyl Nitrate Tank Cleanout

Initial Cleanout Efforts

Uranyl Nitrate Tank Cleanout

Pre-Cleanout ^{235}U mass:

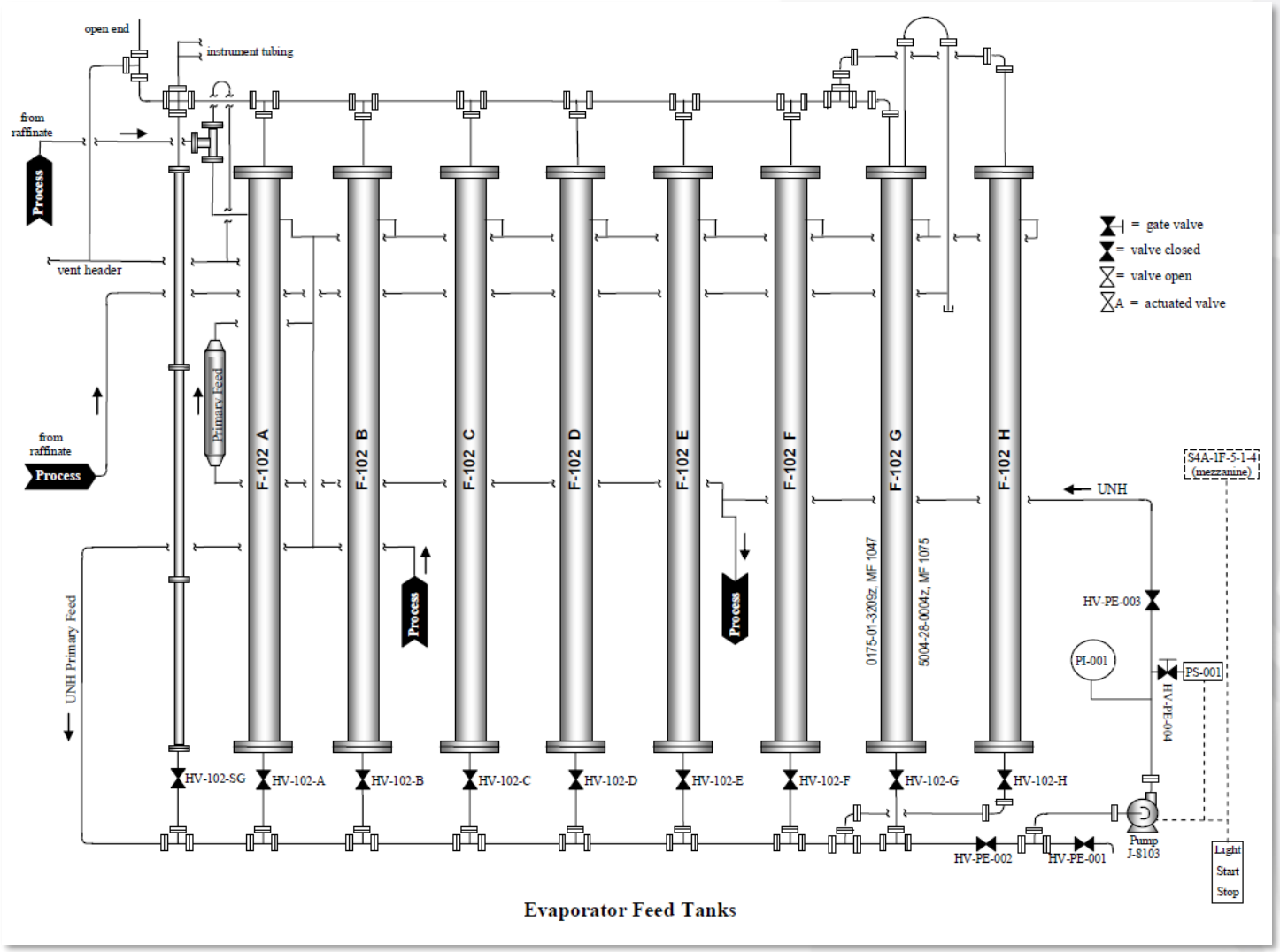
2600-g

Post-Cleanout ^{235}U mass:

620-g with no individual tank having more than 230-g.

Initial Cleanout Efforts

Evaporator Feed Tank Cleanout



Initial Cleanout Efforts

Evaporator Feed Tank Cleanout

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Initial Cleanout Efforts

Evaporator Feed Tank Cleanout

Pre-Cleanout ^{235}U mass:

606-g

Post-Cleanout ^{235}U mass:

360-g with no individual tank having more than 100-g.

DISCLAIMER