THE NATION'S URANIUM PROCESSING FACILITY

NCS Lessons Learned in UPF Design Presented at the Philadelphia ANS Summer Meeting June 17 – 21, 2018

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Outline

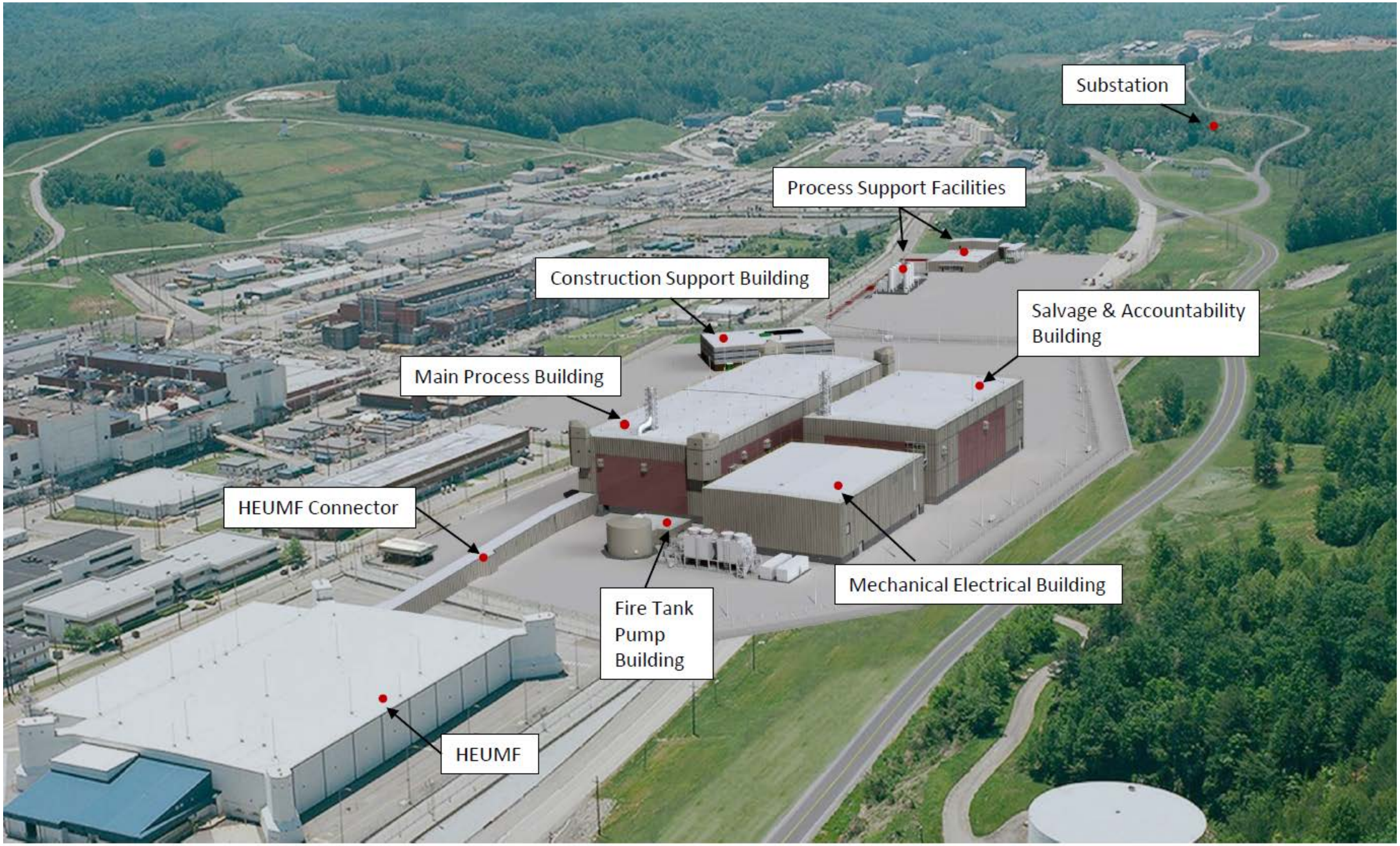
- What is UPF – a short overview of the project
  - Replace Building 9212 Processes (70 years old) with a modern facility
  - Companion to modern Uranium Storage Facility (HEUMF)

- Challenges associated with integrating NCS with Design
  - Take Nothing for Granted
  - It's never as simple as you think
  - Just because you both use the same words does not mean you are on the same page
  - Consistency matters
  - It's an opportunity to learn from the past
  - Assume all you want – but you had better protect yourself
  - Margin is your best friend (a.k.a. a little extra conservatism never hurts)

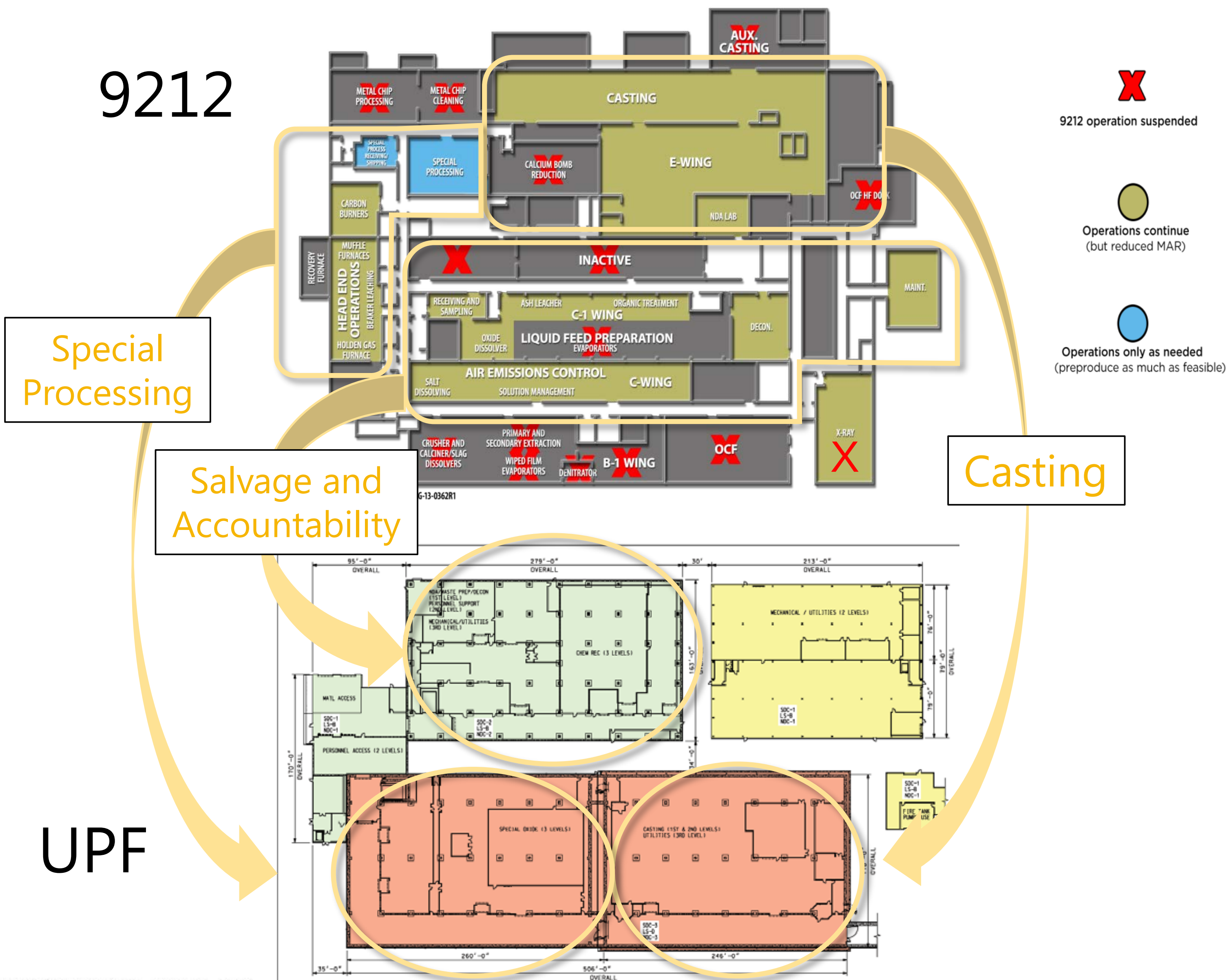
9212 – circa 1945

9212 - Today

UPF Site Aerial View at Completion



9212 Functions—Provided by UPF



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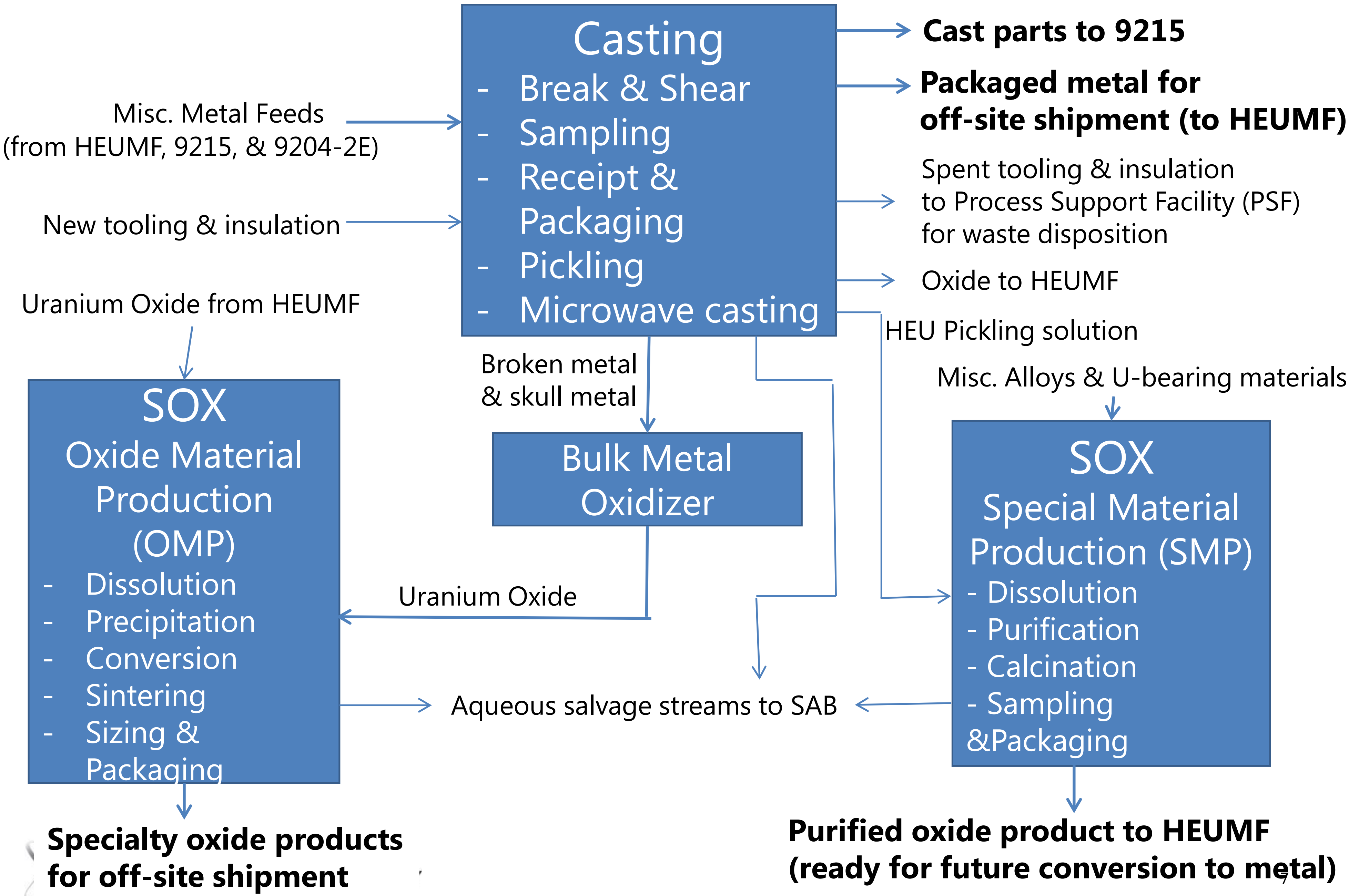
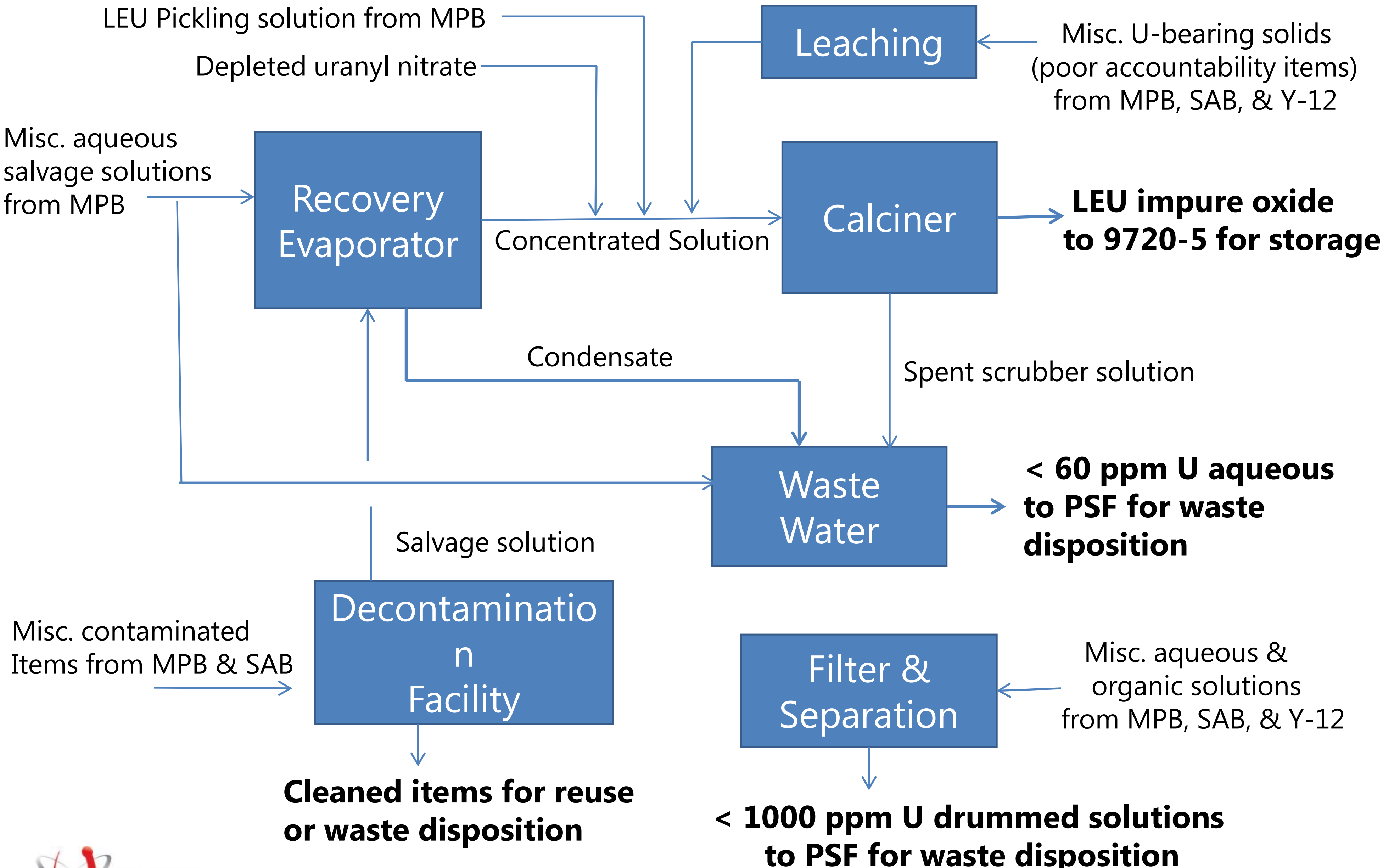
UPF Main Process Building (MPB)



Salvage and Accountability Building (SAB)



Other Salvage and Accountability Operations in SAB and MPB West

- NDA/Waste Preparation (SAB and MPB West)
- Recovery Furnace (MPB West)
- Repackaging Glovebox (MPB West)
- Packaging and Shipping (MPB West)
- Clean Maintenance Shop (SAB)
- Contaminated Maintenance Shop (SAB)

Salvage and Accountability Operations in PSF

- Wastewater bulk tanks and tanker loading station
- Bulk nitric acid storage and 30 % supply tanks
- Depleted uranium oxide dissolver
- Staging of waste drums

UPF Key Dates – NCS

- Finish SAB Rev A CSE work – **7/30/2020**
- Finish MPB Rev A CSE work – **6/21/2021**
- Issue CCR Rev A – **6/21/2021**
- Update PSF NCSD – **2/3/2022**
- Finish SAB Rev 0 CSE work – **6/8/2023**
- Finish MPB Rev 0 CSE work – **5/16/2023**
- Issue CCR Rev 0 – **6/8/2023**

UPF Key Dates - Construction

- SAB/PSB Construction Start – **5/8/2018**
- MPB Construction Start – **5/8/2018**
- SAB/PSB Construction Finish – **10/5/2022**
- MPB Construction Finish – **10/18/2022**
- SAB/PSB Construction Turnover Package – **9/1/2023**
  - Start turnover with WW system 3/2020
- MPB Construction Turnover Package – **9/19/2023**
  - Start turnover with PCW system 3/2021
- HCON Construction – **11/21/2023**
  - Start excavation and backfill 5/2021

UPF Key Dates – Operations & Readiness

- PSB CSE Issued Effective – **6/27/2023**
- SAB CSEs Issued Effective – **11/30/2023**
- MPB CSEs Issued Effective - **1/23/2024**
- Prepare DSA/TSR Implementation Plan – **9/26/2023**
- Perform IVR – **3/6/2024**
- DSA/TSR Effective for Facility – **4/10/2024**
- Start Contractor ORR (CORR) – **4/24/2024**
- DOE Conducts ORR – **9/18/2024**
- SAA Review/Approves SA Letter/Issue Startup Authority – **11/27/2024**
- UPF CD-4 (Forecast) (09/29/2025) – **11/27/2025**

Take Nothing for Granted

- NCS analysts are constantly having to decide if the design options they are presented with are safe.
- Often the documentation used in the decision making process is DRAFT or worse "representative".
  - By representative I mean that the design team at UPF has used a variety of publicly available, non-proprietary information from vendors to contain the broad strokes of the design.
- The fissile material processes and the building they will reside in are not yet real.
- The design team members likely have no real knowledge of the fissile material processes that are being designed and therefore have no real appreciation of the consequences of the design decisions they are making.
  - LL#1: Provide basic NCS training to the design team members, the vendors, and the construction craft.
  - LL#2: Document in detail the basis for any decision made – most importantly assumptions
  - LL#3: Controls must be established to protect assumptions and design basis

It’s never as simple as you think

- Every detail of the as-yet built fissile material processes must be thought through and documented.
  - Material inputs and outputs
  - Human interactions and the associated needs
  - Gloveboxes and equipment designs
  - System representations on P&IDs are not physical
- Writing a control on paper is easy – actually implementing it in the design can be complicated.
  - While it might seem obvious a control that imposes a mass limit will quickly require a scale to be available, along with infrastructure to keep it maintained and tools and fixturing to permit getting the material onto the scale.
  - An NCS control that says a spacing requirement must be maintained during and after a seismic event for example requires a lot of detailed engineering from non-nuclear disciplines to demonstrate.
- LL#1: This is a team effort that requires constant communication and documentation of decisions.
- LL#2: Look for implied design requirements in controls
- LL#3: Ensure your “requirement” is achievable by relying on other engineering disciplines on your team.

Just because you use the same words does not mean you are on the same page

- Words can have many different interpretations
- The NCS analyst understanding what is meant by the control language is the LEAST important.
  - The design team's understanding is MOST important
- An Example:
  - **BEFORE:** DC-2-302.1.12 The maximum loss of spacing due to seismic deflection during a seismic event shall be one inch for items with spacing requirements that are required by the criticality safety process study to be maintained during a design basis seismic event.
  - **AFTER:** DC-2-302.1.12 If a minimum spacing is required by the criticality safety process study or design criteria and the spacing is required to be maintained during a design basis seismic event, then the minimum spacing during the seismic event shall be the required limit minus one inch, unless otherwise specified (i.e., unless a specific limit during the seismic event is given).
  - **EXAMPLE CONTROL:** 6.1.3.2 Racks shall be capable of maintaining at least 18 in. edge-to-edge spacing among stored cans during and following either a design basis seismic event or a design basis fire event (i.e., no seismic motion shall result in spacing less than 18 in. edge-to-edge).

Consistency matters

- Control statements for repeated features among different processes need to consistent.
- Design criteria can be used to your advantage to drive consistent requirements for large pieces of the design.
- Develop a manual (we called it a data book) of assumptions for all analysts to use in performing calculations for the design.
  - The design criteria can be leveraged to have controls to support the data book.
    - Distance from the floor of a glovebox to the floor or wall of the facility
    - Spacing between pipes containing fissile material
    - Wall thicknesses and compositions
    - Permitted Insulation types
    - Pipe diameter limits
    - Tank orientations

It’s an opportunity to learn from the past

- Use past deficiencies or problems to drive design solutions to prevent new occurrences (if possible) or to ensure consequences are minimized.
- Use lessons learned from other facilities – not just yours
- Examples at UPF:
  - All tanks are oriented in the vertical with sloped bottoms
  - All piping systems are designed as favorable geometry unless robust concentration control is utilized to permit otherwise – even systems that would only have fissile present under upset conditions
  - Containers have been standardized with consistent fissile material limits
    - #3 – Wet Can – 10 kg net weight limit
    - #5 – Dry Can – 20 kg net weight limit
  - Storage Racks have been designed to allow any of the standard containers to be stored in any rack position
  - Ensuring piping systems are sloped and drained to prevent hold-up in inacessable locations
  - Generous use of spool pieces and clean-outs to permit inspection and cleaning of piping and ducting systems

Assume all you want – but you had better protect yourself

- Imposed a formal method of documenting and protecting assumptions.
- NCS adopted Bechtel Engineering practice of using Design Analysis Calculations to document all NCS related calculations.
- Impact of this was rigorous identification of input information identified either as "input" (not subject to change) or "assumption"
- Further – assumptions were categorized as permitted engineering judgement or as needing confirmation along with actions needed to confirm.
- Assumptions linked directly to NCS controls by imposing an action to implement an NCS control to protect the DAC assumption.
- All assumptions tracked in a database and categorized as open (still need confirmation) or closed
- Take the design documents with a grain of salt – it isn't physical yet. Impose as many controls as necessary to ensure the final product remains consistent with the information you reviewed.
  - The corollary is – don't say to yourself, oh that looks fine I have no issues with that and quit. Design evolves and if you don't write a control you will not get the same set of information upon your return review.
- Silence on your part means the design team can do whatever they want. They won't think to ask about whether or not insulation can be used or if the number of tanks in a location is limited or if the size of heaters on a tank should be controlled if you as the NCS analyst don't tell them you care via control language.

Margin is your best friend

- Standard administrative margin for all NCS calcs at Y-12 is 2%.
  - UPF has used larger margins to ensure margin is available for design evolution and construction/installation error
  - Maximum k-eff for "normal" case calculations is 0.85
  - Maximum k-eff for "upset" case calculations is 0.90
  - These are "design targets" and can be exceeded with permission
- All calculations model uranium as 100% enriched
- All solutions modeled as optimum concentration
- Concrete floors and walls are modeled as effectively infinite (18 inches thick)
- All walls modeled as concrete – even when the design calls for something else like gypsum wall board.
- All models used 6 sided reflection – usually accomplished with offset reflection rather than tight fitting reflection
- All models include at least two operators in proximity to the equipment (modeled as "water boxes" with standard dimensions

Conclusion

- In design nothing is stable and so constant communication and rigorous documentation of assumptions is necessary.
- Consistent model inputs for calcs are needed to ensure a consistent basis of safety across the entire design. Also allows judgements to be made easily regarding whether or not it is appropriate to reduce margins in the calculations due to knowing everyone is starting from the same basis.
- Non-NCS engineers will NOT understand our concerns – don't assume they do.
- Be patient. Be prepared to explain yourself multiple times.
- Be flexible where possible but be firm when necessary.
- Nothing is real until it is built (UPF is not there yet but we are progressing)

Questions

Back-Up Slides

UPF: Where were we ………?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The CSB………

January 2018

March 2018

October 2018

October 2019

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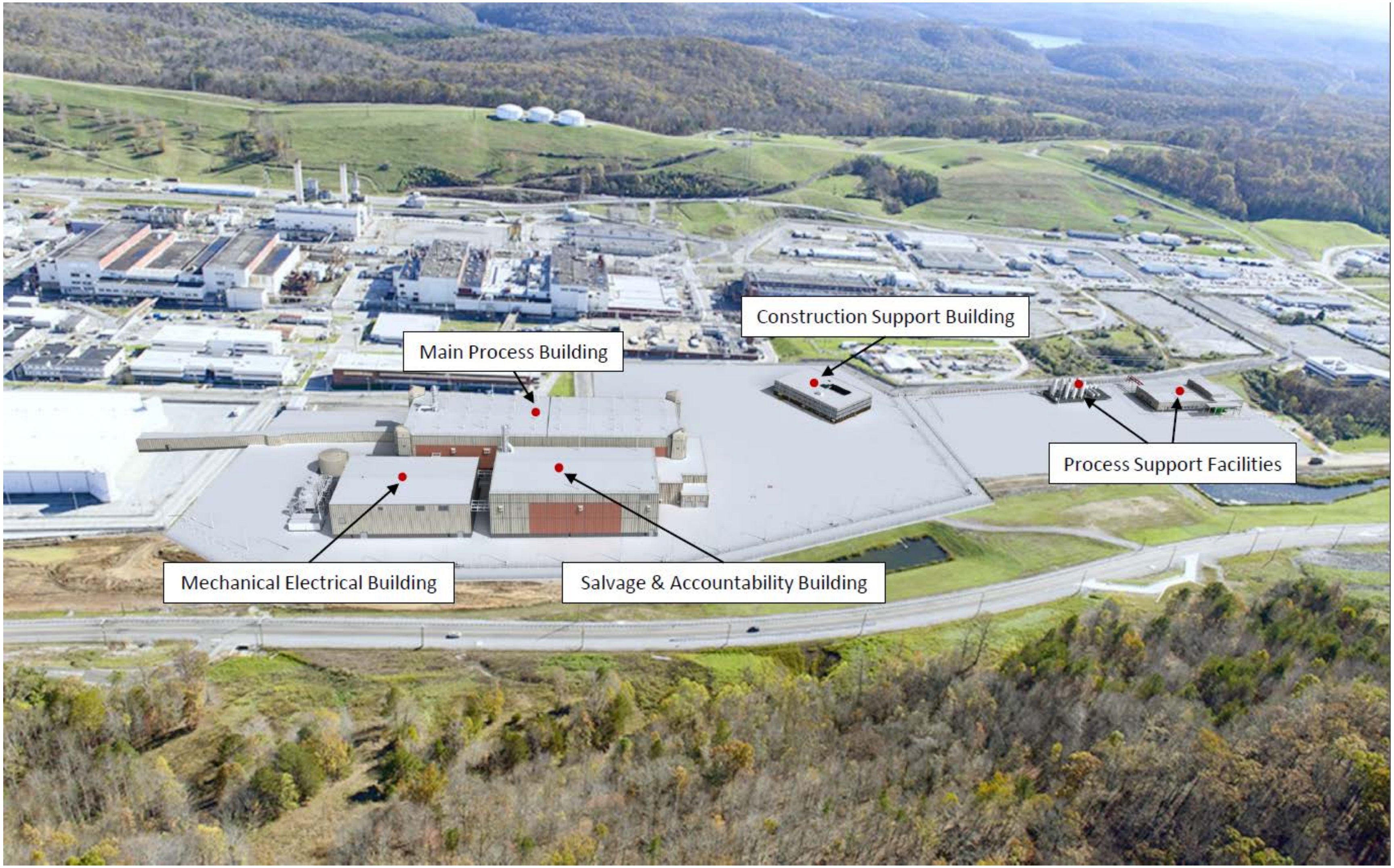
October 2020

October 2021

October 2022

UPF Site Aerial View at Completion



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