Near-Term Operational Planning at the Hanford Tank Farms: Link to Execution – 17091

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ABSTRACT

Washington River Protection Solutions, LLC uses an earned value management system to flowdown contractual requirements to operational activities. A Rolling Work Window Schedule Process is then used to plan and coordinate near-term operational activities at the Hanford tank farms for execution. This near-term operational planning process has been extended using a Multi-Year Operating Plan, underpinned with a dynamic simulation model, to better link execution of daily activities with mission objectives.

INTRODUCTION

The U.S. Department of Energy (DOE) manages the Hanford Site in Southeastern Washington State where decades of nuclear materials production for the Cold War yielded a legacy of nuclear waste. Today, approximately 212 million liters (56 million gallons) of radioactive waste liquids, solids, and salts are stored in 177 underground storage tanks. Of these, 149 are aging single-shell tanks (SST); the other 28 are newer double-shell tanks (DST). [1]

The DOE has contracted with Washington River Protection Solutions, LLC (WRPS) to perform the operations and construction activities necessary to store, retrieve, and treat Hanford tank waste; store and dispose of the treated waste; and begin to close the Tank farm waste management areas to protect the Columbia River [2].

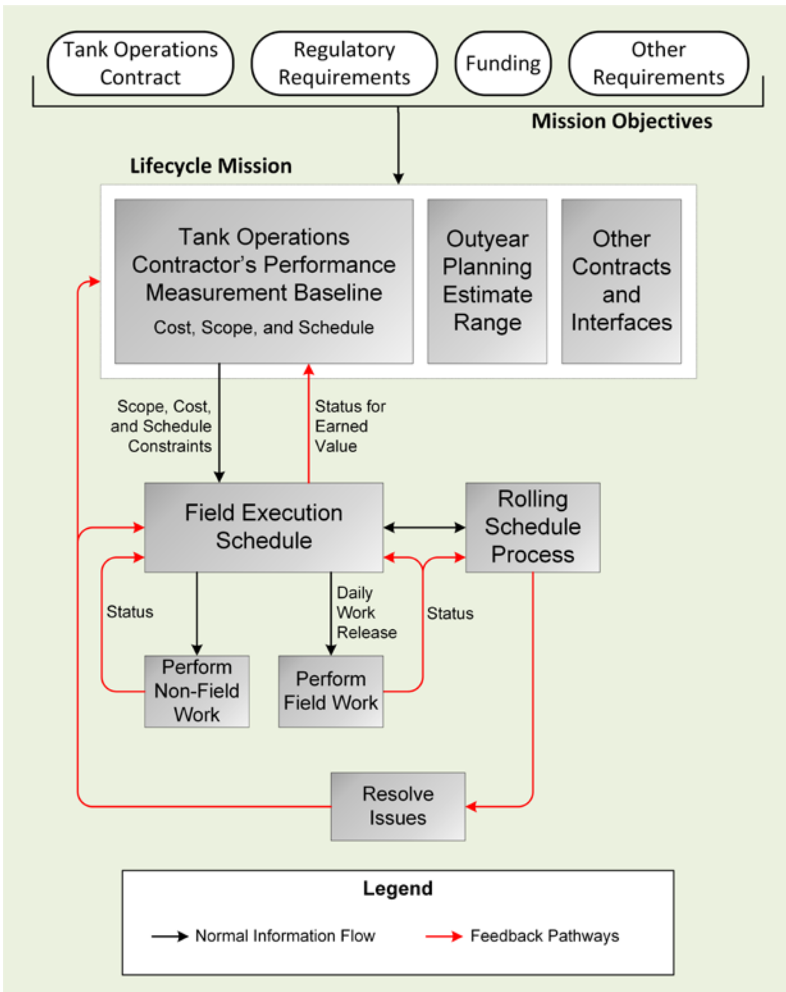
DOE has adopted a phased construction and startup strategy for the Hanford Tank Waste Treatment and Immobilization Plant (WTP) to complete the Hanford tank waste mission [3]. The first phase includes starting pretreatment and immobilization of Hanford tank waste as soon as practicable using the Low-Activity Waste (LAW) Pretreatment System (LAWPS) to directly feed the WTP LAW Vitrification Facility – this is referred to as direct feed LAW (DFLAW) operations. Tank waste supernatant is pretreated at the LAWPS to remove entrained solids via filtration and soluble cesium via ion exchange prior to being immobilized into a durable glass waste form at the WTP LAW Vitrification Facility.

DISCUSSION

Work Planning Process

WRPS uses an earned value management system [4] to flowdown contractual requirements to operational activities through a hierarchy of documents, plans, and tools including the Tank Operations Contract, Performance Measurement Baseline (cost, scope and schedule), and the Field Execution Schedule. A Rolling Work Window Schedule Process[a] managed by Production Control [5] is then used to flow down activities from the Field Execution Schedule and level-of-effort activities to the point of release for performing field (tank farms and related facilities) work, while integrating and coordinating labor and equipment resources so that work is scheduled and performed efficiently. A simplified representation of the overall flowdown is shown in Fig. 1.

Fig. 1. Work Planning Process.



One of the key elements of the Rolling Work Window Schedule Process is a weekly Project Integration meeting that reviews and confirms that scheduled field activities are free of operational conflicts and can be performed as scheduled (see TABLE I). This meeting is run by the Production Control organization and includes participation by

[a] The Rolling Work Week Schedule Process defines a work management system that uses a graded approach in planning work; the level of planning detail and integration increases as the work is closer to execution. The process begins five weeks before work is scheduled to begin and ends one week after execution.

representatives[b] of the various Production Operations organizations (242-A Evaporator, Waste Services, 222-S Analytical Laboratory, Effluent Treatment Facility, etc.); additionally, personnel from the SST Retrievals organization; Tank Farm Projects; and, supporting organizations such as Process Engineering, One System[c] [6], and Project Integration[d] attend.

TABLE I. Project Integration Meeting Discussion Areas.

- Safety topic
- Crane and rigging needs for the upcoming work week
- Activity review for the upcoming work week – general work scope, potential interferences, and allocation of critical resources
- Activity review for the work planned between the next two - five weeks utilizing the Field Execution Schedule including schedule variances or areas in which Operations needs guidance to establish priorities
- Review of the “Big Picture” schedule
- Progress against business performance goals
- Review of critical procurement status
- Action items
- Work execution feedback from the previous work week

The project summary schedule or “Big Picture[e]” is a tool used at the Project Integration meeting to facilitate planning and coordination of the next one to five weeks of fieldwork and to look ahead at the next one to three years. It places most of the immediate upcoming critical work activities on one page to help identify integration issues or schedule conflicts. If conflicts or significant impacts are identified during the Project Integration meeting, the Production Control organization works with the appropriate line organizations to establish the right priorities, and, if necessary, request changes to the Field Execution Schedule to resolve the conflicts. Formal work planning processes and procedures are then used to execute the work. [7]

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[b] Representatives include management, maintenance, scheduling, and other functional areas as needed.

[c] The One System organization was established in 2011, on direction from DOE, to perform the integration function between the tank farms and WTP necessary to ensure the safe, efficient, and successful start-up of WTP and the execution of the RPP mission. One System is comprised of teams from both the Tank Operations Contractor and the WTP Contactor with high-level primary mission objectives of mission analysis and planning; flowsheet integration; WTP startup, commissioning, and operations integration; and project integration and controls.

[d] The Project Integration organization manages the prime contract and provides traditional planning, scheduling, and budgeting support to the line organizations.

[e] The project summary schedule is colloquially called the “Big Picture” schedule.

Mission Planning Process

WRPS supports the mission planning process by maintaining (i.e., preparing revisions to) the River Protection Project System Plan [8] for DOE. The System Plan, and subsequent planning documents, describe the technical planning for optimizing the waste tank retrieval sequence, waste feed delivery, treatment strategies, storage, disposal options and operations, tank closure, and mission completion projections [9]. Depending upon the specific revision and associated scenarios, the System Plan may be used by DOE to inform decisions regarding the Tank Operations Contract and by DOE and Washington Department of Ecology to inform decisions regarding regulatory milestones. WRPS may also use certain scenarios or key features of a scenario from the System Plan or from other studies to support flowsheet evaluations, definition of mission architecture, and internal decisions.

However, WRPS recognized that many of the mission objectives associated with the mission planning process are difficult to flowdown into tangible, executable, field activities using the existing systems. Those systems are not designed or intended to address complicated waste transfers and mass balances. They do not address how decisions made today can affect the ability to meet future mission objectives, nor are they timely or at the correct time scale (see TABLE II). The primary limitation of the existing process (see Fig. 1) is that flowdown from the Tank Operations Contractor Performance Measurement Baseline to the Rolling Work Window Schedule Process are business constraints – typically cost, scope, and schedule; and that feedback is primarily schedule status.

TABLE II. Planning Time Scales.

Focus	Characteristic Time	Example Elements
Mission	50 – 100 years	• Mission objectives and priorities[a] • Regulatory requirements • System Plan and Integrated Flowsheet • Life cycle cost and schedule
Contract Period	2 – 10 years	• Tank Operations Contract • Summary Life Cycle Schedule • Contract and Baseline Management
Current Fiscal Year	1 month – 1 year	• Fiscal Year Work Plan • Field Execution Schedule • Earned Value Management System
Rolling Work Window Schedule Process	1 week – 1 month	• Weekly Project Integration meeting • Coordination, planning, and status meetings
Execution	1 day – 1 week	• Daily work releases • Daily plan of the day status meetings

[a] Many mission objectives also apply to the contract period or current fiscal year; these are primarily regulatory or legal milestones.

WRPS has developed an extension to the near-term operational planning process to fill that gap by linking daily operations to mission objectives, and a new tool, the Multi-Year Operating Plan (MYOP) graphic, for visualizing and communicating the results. The Strategic and Operational Planning group in the One System organization has been assigned responsibility for the preparation and maintenance of the MYOP.

The Multi-Year Operating Plan

Genesis

The first MYOP[f] was prepared in 2013 at the request of the then-WRPS president. It focused primarily on the next three years of field activities, including some non-field activities such as design and procurement. Over the next several revisions, as an experiment, more non-field activities were added to the MYOP to depict more of the lifecycle baseline. However, this detracted from its usefulness as an operational planning tool and increased its preparation time.

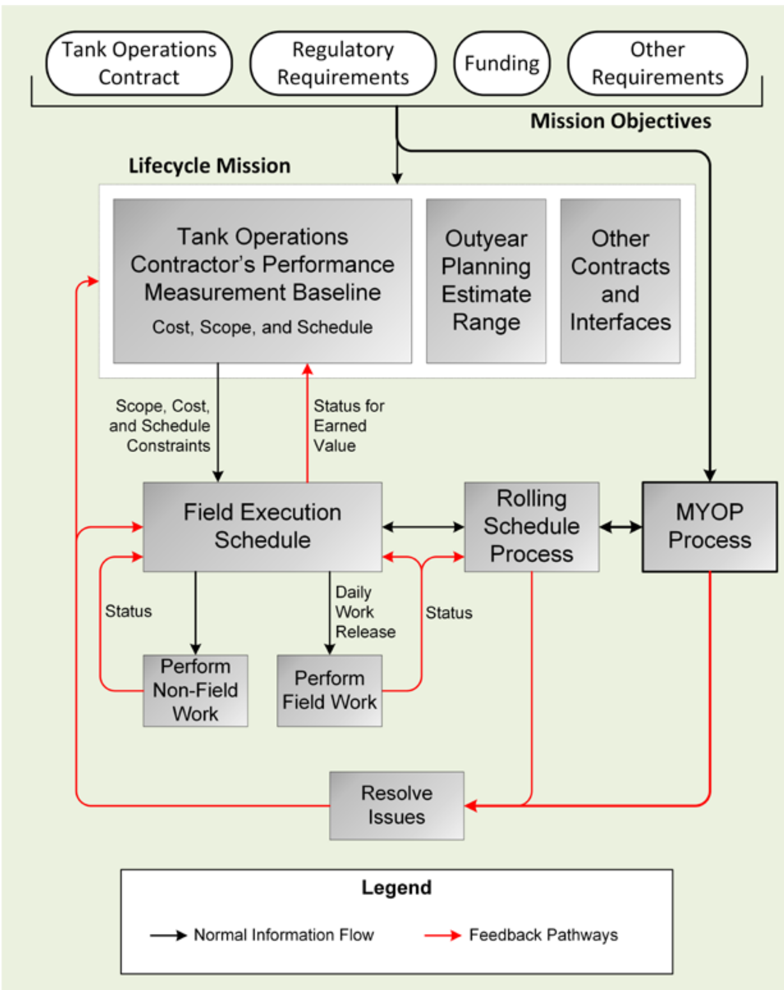
Therefore, the most recent revision [10] refocused the MYOP on field activities and key interfacing activities, covering a nominal five to six year period. An informal survey of end users of the MYOP identified those aspects of our near-term plans that should be depicted on the MYOP. In general, the end users wanted to see waste-affecting activities (e.g., retrieval of waste from SSTs, 242-A Evaporator campaigns, preparation of feed for the LAWPS, managing returns from LAWPS and DFLAW operations, and other supporting transfers of waste between DSTs). Additionally, the end users wanted to see those interfacing activities (e.g., planned outages, sampling, and construction) – generally at least a month in duration or otherwise difficult to schedule as fill-in work. Shorter activities and outages (e.g., video inspections, leak checks, vent and balance) are best handled by the existing Rolling Work Week Schedule Process.

[f] The first MYOP was called the “Three-Year Plan” and was similar to operating schedules used at the Savannah River Site by Savannah River Remediation from where the prior WRPS president had experience.

Role of the Multi-Year Operating Plan

The MYOP provides a link between our strategy and execution by integrating current operations with upcoming treatment plans (see Fig. 2) and serves as a visual planning, communication, and management tool. The teamwork underlying its development fosters integration and awareness of our five- to six-year site strategy and is a step towards additional discipline in planning and execution. The MYOP is also used to provide the technical basis for annual fiscal year work planning, business proposals, and evaluation of alternatives.

Fig. 2. Improved Work Planning Process with Multi-Year Operating Plan.



The MYOP focuses on integration of waste-affecting activities with other key field activities (such as planned outages, sampling, and construction). Working-level integration reviews and meetings are used to validate and/or refine the proposed set of waste-affecting activities to ensure that they are integrated with major field activities, and are both executable and affordable.

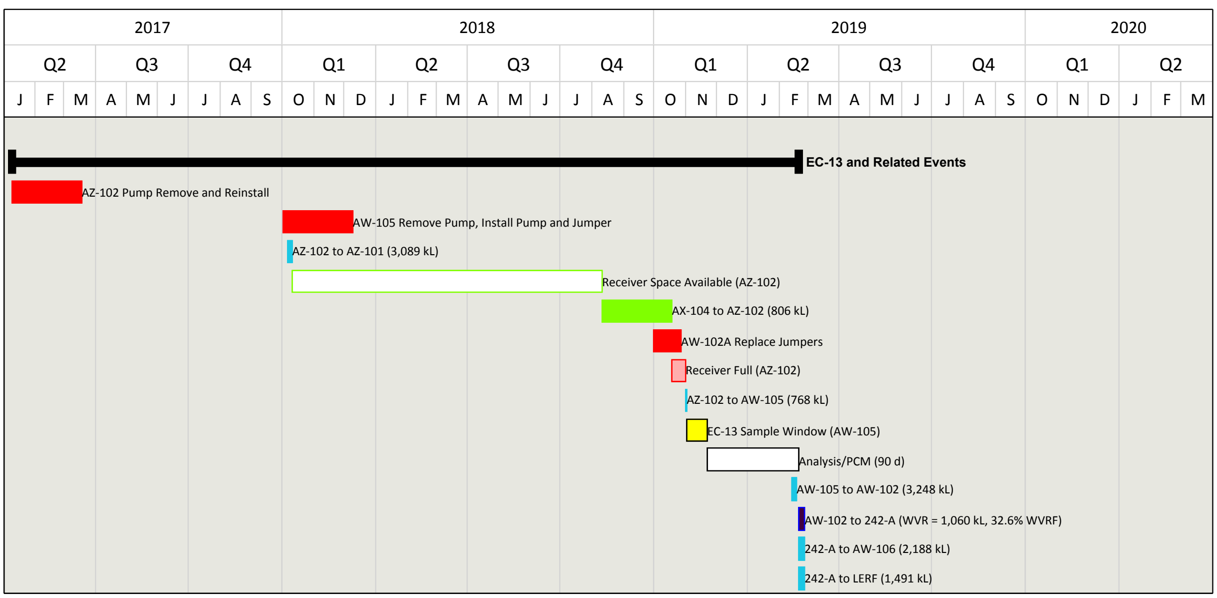
The activities on the MYOP are grouped according to the 242-A Evaporator Campaign[g] or LAWPS feed

[g] The 242-A Evaporator is operated on a campaign basis, typically consisting of approximately 2.8 ML (750 kgal) of liquid waste feed that has been staged and sampled. Once laboratory analyses are completed and the waste is approved for processing, the waste is fed to the 242-A Evaporator from feed DST 241-AW-102. After some of the water is removed by evaporation, the product (concentrated waste) is returned to the DST system. A typical campaign has a processing time of 10 days to two weeks.

campaign[h] most closely supported, making it easier to see how those activities are interrelated. Future MYOPs might include other groupings or organizing schemes, tailored to the needs of specific organizations; for example, grouping activities according to each SST undergoing retrieval may be more useful to the SST Project.

Fig. 3 shows a portion of the MYOP for 242-A Evaporator Campaign EC-13. In addition to the actual waste transfers (light blue) needed to perform the campaign (dark blue), the MYOP shows the planned outages (in red) for replacement of pumps and jumpers needed to perform these transfers, the retrieval of waste from the SST named 241-AX-104[i] (green) which provides a portion of the waste to be processed by the evaporator, a window (in yellow) for taking a waste sample needed to plan the campaign, and the period during which laboratory analysis and hot boil-downs support the development of the process control plan for the campaign (white).

Fig. 3. Portion of the Multi-Year Operating Plan Showing an Evaporator Campaign.



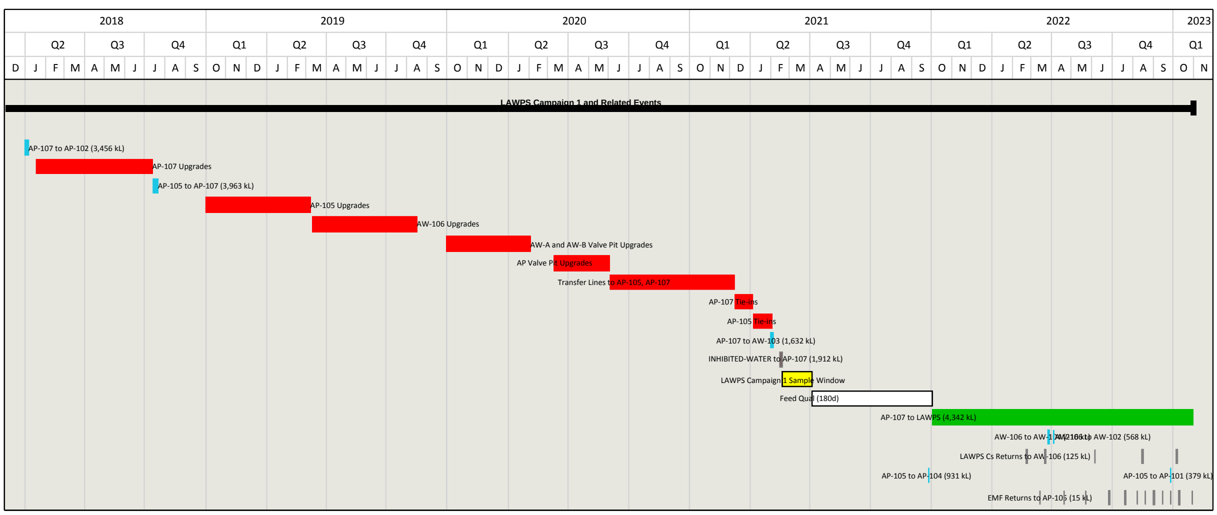
[h] The LAWPS / DFLAW will be operated on a campaign basis, typically consisting of approximately 4 ML (1 Mgal) of liquid waste feed that has been staged and sampled. Once laboratory analyses are completed and the waste is approved for processing, the liquid waste is fed to the LAWPS from feed DST AP-107[i]. After removal of most of the Cs-137 and entrained solids, the pretreated waste is fed to the WTP LAW Vitrification Facility for treatment.

[i] Hereinafter, the “241-” prefix in the official tank names for the SSTs, DSTs, and tank farms will be omitted for readability purposes (e.g., AY-102).

Fig. 4 shows a portion of the MYOP supporting preparation of the first LAWPS feed campaign. In addition to the waste transfers (light blue) directly supporting the campaign (green), the MYOP shows the outages (red) for the upgrade projects needed to ready the DST and transfer system to support the initial LAWPS / DFLAW operation, a window (yellow) for taking the feed qualification samples, the period during which the feed is qualified and approved for processing (white), projected returns (grey) to the DST system of cesium eluate from LAWPS, and returns (grey) of WTP LAW Vitrification Facility offgas when the Effluent Management Facility is not available[j].

The most recent revision of the MYOP from which Fig. 3 and Fig. 4 were extracted depicted 21 evaporator campaigns; the first two LAWPS feed campaigns; retrieval of waste from 11 SSTs; over 100 waste transfers; more than 30 planned outages; and related sampling, analysis, and feed qualification events.

Fig. 4. Portion of the Multi-Year Operating Plan Showing a LAWPS Feed Campaign.



Technical Underpinning

The Hanford Tank Waste Operations Simulator (HTWOS) [11] underpins and confirms the viability of the MYOP using a dynamic flowsheet simulation of the mission. HTWOS allows for evaluating a proposed set of waste-affecting activities against a variety of constraints and considerations, including DST space, evaporator feed staging and operations, the timing of SST retrievals, support of LAWPS and DFLAW operations of the WTP LAW Vitrification Facility, waste composition and

[j] For modeling purposes, the returns were modeled as multiple, frequent, small batch transfers of concentrated offgas (the assumption in effect at the time) rather than infrequent, large volumes of dilute offgas (a more current assumption).

mass balances, waste acceptance criteria, support of regulatory milestones, and the ability to transition to future operations.

When used for near-term operational planning purposes, many of the initial DST waste transfers are fully or partially[k] "scripted" to take advantage of subject matter expertise and to keep as close as possible to the desired sequence of events. This avoids the need to reprogram HTWOS to find a sequence of events that satisfies all of the criteria and metrics used to assess the viability of the projected operations, many of which are subjective evaluations. Additionally, during the years leading up to the startup of LAWPS and the first few years of LAWPS operation, DST space management and transfer logistics are complicated by limited flexibility and often require creative thinking to find a suitable solution; in other words, it is difficult to establish and program a robust strategy for all possible situations.

The HTWOS model switches to non-scripted (its normal "automatic" mode) around the time the LAWPS starts operating and is allowed to run until LAWPS / DFLAW operation has completed (about ten additional years). This allows us to evaluate how well the decisions and actions being made today influence the ability to transition to and maintain full LAWPS / DFLAW operations in the future.

The One System organization has developed and is transitioning to a new dynamic simulation model for mission planning. This software application, called TOPSim [12], is used to host and simulate models of the Hanford tank farms and associated plants and facilities. TOPSim will supplant HTWOS for system planning and mission simulation purposes. A decision has not yet been made on whether the MYOP will transition to TOPSim or continue to be underpinned by HTWOS while waiting for a new near-term operational planning tool (see the section New Planning Tool).

Preparation of the Multi-Year Operating Plan

The need to update the MYOP may be triggered by a variety of considerations:

- Business (adjustments to funding, contractual work scope and schedule, annual fiscal year planning process)
- Regulatory (changes to milestones)
- Legal (consent decrees, settlement agreements, court orders)
- Engineering (flowsheets, waste compatibility assessments, flammable gas controls, feed preparation strategy, waste acceptance criteria)
- Operational (equipment status, resource availability, planned and unplanned outages, testing and inspection, SST retrieval progress)
- Facility availability (242-A Evaporator, 222-S Analytical Laboratory, Liquid Effluent Retention Facility, Effluent Treatment Facility, Effluent Management Facility)

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[k] Partial scripting allows the model to determine the volume of waste to be transferred to meet specified conditions, such as transferring enough waste from tank A to B to fill tank B to its operating limit, rather than specifying the volume to be transferred.

- Projects (AY-102 recovery, SST retrievals, DST and transfer system upgrades, infrastructure upgrades)
- System planning (mission objectives)
- Deviation of actual operations from the current MYOP.

Once it has been determined that conditions warrant an update, the MYOP is prepared using an iterative process, starting with the most recent set of planned waste-affecting activities, hereinafter referred to as "projected operations."

The line organizations and key weekly Project Integration meeting participants are solicited for other changes that need to be considered during the update or issues that need to be resolved, in addition to the specific changes triggering the update.

A new set of proposed projected operations is developed and screened using a spreadsheet to manually model the DST waste volumes, transfer volumes, and 242-A Evaporator waste volume reduction; for this screening, volumes and durations are approximate and waste composition is not explicitly addressed to allow for rapid turnaround. These are then informally reviewed by Process Engineering and other key participants of the weekly Project Integration meeting and adjustments are made as needed.

Next, the proposed projected operations are simulated by the HTWOS model and extended to the end of LAWPS / DFLAW operations. The model results are reviewed with the line organizations and key participants of the weekly Project Integration meeting using the criteria and measures shown in TABLE III. Adjustments to the projected operations are made, if necessary, including potential trade-offs between competing criteria.

The above steps are repeated until the set of projected operations are acceptable and agreed to by the line organizations and key participants at the weekly Project Integration meeting. At this point in the preparation of the MYOP, the agreed to projected operations are incorporated into the Big Picture and provide the basis for updating the MYOP.

The final steps are to prepare the MYOP graphic itself and supplemental information. The projected operations from the HTWOS model are imported into a Microsoft® Project®[l] schedule, merged with other interfacing activities, and arranged for presentation purposes. Chronicle Graphics® OnePager®[m] Pro is then used to create the graphical representation of the schedule. Notes are added using

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[l] Microsoft, Excel, Project, Visio, and Word are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

[m] OnePager is a registered trademark and trade name of Chronicle Graphics, and Chronicle Graphics is a registered service mark of Chronicle Graphics, Inc.

Microsoft® Visio®, and Adobe® Acrobat®[n] is used to convert the final MYOP into a portable document format (PDF) for distribution. Supplemental information[o] is prepared using Microsoft® Excel® and Microsoft® Word® and converted into a PDF for distribution.

TABLE III. Criteria for Evaluating Proposed Waste-Affecting Activities.

Criteria	Measures
Executable	• Production Operations can support the plan • Line organizations own the plan • Plan coordinated with construction activities (upgrade projects) • Plan integrated with other field activities (planned power outages, etc.) • Needed equipment will be available (e.g., pumps) • Resources are level-loaded to the extent possible
Affordable	• Budget is available
Schedule	• Plan supports regulatory and legal commitments (e.g., Consent Decree, HFFACO, settlement agreements) • Other contractual or legal requirements are met
DST Space	• Emergency space is maintained • Operating space is adequate • Waste transfers meet compatibility requirements[a] • Evaporator feed is in-specification; campaigns achieve reasonable waste volume reduction
Waste Feed Delivery	• Initial LAWPS / DFLAW feed is available on time • Feed is projected to meet waste acceptance criteria
Transition to Future Operations	• LAWPS / DFLAW operates at target rates • DST space is available to manage returns

[a] Proposed waste transfers are informally screened against a subset of waste compatibility rules to increase confidence that those transfers will pass the formal waste compatibility assessment immediately prior to execution.

Monitoring and Adjustments

Members of the Strategic and Operational Planning group regularly attend the weekly Project Integration meeting to stay aware of the status of planned work and learn of emerging issues and concerns. Proposed or actual deviations resulting

[n] "Adobe" and "Acrobat" are either registered trademarks or trademarks of Adobe Systems Incorporation in the United States and/or other countries.

[o] Supplemental information currently includes 242-A Evaporator Campaign and DST Transfer Summary tables, Available Operating Space plot, Emergency Space plot, DST System Inputs and Outputs plot, and projected DST volumes and use.

from emerging conditions are evaluated to determine the impact to the mission objectives, using a graded approach; the criteria and measures in TABLE III continue to apply.

Changes to the Big Picture that do not materially affect the projected operations require no further evaluation by Strategic and Operational Planning. This includes most short-duration integration activities that are best managed by the existing Rolling Schedule Process procedure (e.g., minor electrical outages, electrical cord inspections, HEPA filter testing, transfer line leak checks, video inspections, and emergency drills).

Limited material changes to the projected operations (e.g., new sequences of waste transfers or minor schedule changes) are evaluated by inspection or by using the screening spreadsheet to manually evaluate and adjust projected operations; this is the same screening process used when preparing a new MYOP. If the new set of projected operations is viable and accepted, it becomes the new reference for future evaluations after integration with other activities. The Big Picture and Field Execution Schedule would then be aligned to match the new projected operations.

More significant changes to the projected operations may require evaluation using the HTWOS model. If the new set of projected operations is viable and accepted, it becomes the new reference for future evaluations after integration with other activities. The Big Picture and Field Execution Schedule would then be aligned to match the new projected operations. Additionally, if conditions warrant, this may trigger the release of a new MYOP.

Some of the above evaluations may require involvement of upper management if the projected impacts necessitate trade-offs between mission objectives, contract modifications, or changes to mission execution strategy.

Path Forward

Formal Implementation

Now that key features of the extended near-term operational planning process (the MYOP and its relationship to the existing Rolling Work Window Schedule Process) have been successfully demonstrated, it is time to formalize the process by updating affected plans and procedures.

The River Protection Project System Integration Management Plan [13] provides an overview of the system planning process. It describes the tools and processes used to integrate and achieve alignment between the Tank Operations Contract and upper-tier planning documents for completion of the mission. The System Integration Management Plan contains language that anticipates the need for an operating plan such as the MYOP and should now be updated to show how the MYOP and existing Rolling Work Window Schedule Process fit into the overall system planning process.

The Rolling Schedule Process procedure should be updated in conjunction with the System Integration Managed Plan to formalize the role that the Strategic and Operational Planning group has been playing in the Rolling Work Window Schedule Process.

The Strategic and Operations Planning group has informally begun to review the tank waste compatibility assessments for upcoming waste transfers to assure consistency with the MYOP or projected operations. A waste compatibility assessment is a formal evaluation of proposed waste transfers within the DST system for compliance with safety, operational, regulatory, and programmatic controls and requirements; determines if the transfer is allowable as proposed; and establishes bounding conditions for that transfer. Updating the procedure for performing tank waste compatibility assessments [14] to include Strategic and Operations Planning in the review process would provide early notice if the waste transfer could not be performed as planned.

New Planning Tool

While both HTWOS and TOPSim were designed to support and excel at long-term system planning and mission simulation, neither provide the rapid turnaround required for near-term operational planning. Both require the use of scarce modeler (programmer) resources since neither tool is designed to be operated directly by the end user (in this case, Strategic and Operational Planning).

A new near-term operational planning tool is being developed to underpin the MYOP and support near-term operational planning with the goals of providing rapid turnaround, eliminating the need for a modeler as a middleman, and eliminating the use of manual spreadsheet calculations to develop and screen transfers and evaporator campaigns prior to modeling. The tool would include a “scripting” language that allows for standardized entry of waste-affecting activities with user-defined goals and would provide immediate feedback of potentially problematic conditions (e.g., less than required emergency space is available, waste compatibility screening may preclude a transfer or require further evaluation, solids and/or supernate levels are not consistent with installed equipment).

CONCLUSIONS

The participation of the Strategic and Operational Planning group in near-term operational planning and the MYOP itself have been well received by the WRPS Chief Operating Officer and the Manager of Production Operations. While difficult to measure, they have recognized the value added by linking the existing Rolling Work Window Schedule Process at the field level to mission objectives at the upper-management level via the MYOP and of using models such as HTWOS or TOPSim to provide the technical underpinning.

Members of Strategic and Operational Planning have been working collaboratively with Production Control and other Production Operations organizations on a day-to-day basis; each organization earning the mutual respect of the others.

WRPS needs a new near-term operational planning tool which enables Strategic and Operational Planning to more easily and rapidly respond to proposed or actual deviations to projected operations and to prepare new MYOPs, while maintaining the technical rigor of HTWOS or TOPSim.

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