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ENGINEERING CHANGE NOTICE

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SDD/DD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐		
Functional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐		
Operating Specification	☐	Interface Control Drawing	☐	Spare Multiple Unit Listing	☐		
Criticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐		
Conceptual Design Report	☐	Installation Procedure	☐	Component Index	☐		
Equipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐		
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Procurement Spec.	☐	Operating Instruction	☐	Computer Software	☐		
Vendor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐		
OM Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐		
FSAR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐		
Safety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐		
Radiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐		
Environmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐	Tickler File	☐		
Environmental Report	☐	Inspection Plan	☐	N/A	☐		
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Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
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1.0 PURPOSE

The purpose of Process Validation is to confirm that nominal process operations are consistent with the expected process envelope. The Process Validation activities described in this document are not part of the safety basis, but are expected to demonstrate that the process operates well within the safety basis. Some adjustments to the process may be made as a result of information gathered in Process Validation. Excluded from the scope of this document are:

- Validation of Fuel Cleaning (which is an element of the safety basis and documented separately)
- CSB Monitoring Activities, which will not be used to make adjustments to the process, and are addressed in Sexton, 2000
- Cold Testing
- Normal Preoperational Acceptance Testing
- Routine Operations and Process Control

Specific objectives of Process Validation include:

- **Surface Area** – Demonstrate that the exposed fuel surface area in the MCO is well within the envelope assumed by models. Surface area directly influences thermal performance and gas generation, and is potentially influenced by retrieval and cleaning operations. This is perhaps the parameter of greatest interest in Process Validation.
- **Gas Generation Rate** – Demonstrate that gas generation rates in the MCO are within the envelope assumed in calculating pressure and gas composition.
- **Reaction Rate** – Determine the total reaction rate in the MCO, demonstrating the actual relationship between fuel surface area and total reaction rate.
- **Scrap to Fuel Ratio** – Determine the rate at which scrap (including whole elements that cannot be loaded into fuel baskets) is generated relative to fuel in fuel baskets. This ratio is important to the acceptability of the MCO and process design, which allows 0 to 2 scrap baskets per MCO, but assumes an average of 1.
- **Coarse to Fine Scrap Ratio** – Determine the volume ratio of coarse to fine scrap. Coarse scrap is greater than 1" in size and must be loaded piece by piece into the scrap basket. Fine scrap is greater than ¼" in size and may be dumped or poured into the fine scrap section of the scrap basket. Fine scrap has been limited to 10% of the volume of the scrap basket, to limit the total surface area feasible in any one scrap basket. The acceptability of this design and the number of MCOs produced with it will depend on the actual ratio of fine scrap created.
- **Particulate** – Confirm that the particulate in the MCO is well within the envelope assumed by models. The inventory of various forms of particulate influences the quantity of water assumed to remain in the MCO after drying. Particulate estimates are also used in dispersion calculations for accident conditions.
- **Aluminum Hydroxide** – Confirm that the inventory in the MCO cannot exceed the bounding value assumed in modeling. No credit is taken in modeling for cleaning of aluminum hydroxide. If cleaning removes the aluminum hydroxide coating, this

should be able to be confirmed through a simple visual examination. Aluminum hydroxide is a contributor to water inventory in the MCO after drying.

- **Radiological** – Confirm dose rates associated with loaded MCOs.
- **IXM usage** – Confirm the rate at which IXMs will require changeout. This rate has been assumed in determining the number of IXMs needed by the project.
- **Sludge Treatment Feed** – Determine the feed to the Sludge Treatment system.
- **Uranium Mass in Knockout Pot** – Determine the rate of accumulation of uranium mass in the knockout pot. Limiting the mass of uranium metal in the knockout pot has been discussed as a possible method of assuring thermal stability of the knockout pot.

The scope of this document will include:

- Define the Process Validation steps required to gather the above information
- Identify the stages in Phased Startup Initiative and Fuel Processing Campaigns where Process Validation is required
- Identify any additional equipment that will be needed for Process Validation
- Identify any new procedures required and provide the basis for procedure preparation
- Identify other administrative activity needed to prepare for Process Validation
- State the number of measurements required for each step or the basis for determining that number in process

2.0 CAMPAIGN SEQUENCE

Opportunities for Process Validation will be available during the Phased Startup Initiative (PSI) of the Fuel Retrieval System (FRS) and the Integrated Water Treatment System (IWTS), (Pajunen et. al., 2000) and during normal operations.

The PSI will process fuel through canister selection, fuel cleaning, sorting, inspection, and loading of baskets

Process Validation data will also be taken at selected points during full operations. Pajunen and Sexton 2000 divides the loading of MCOs into the following groups.

K West Basin

- Mk1A MCOs (146)
- High Pu Blend MkIV MCOs (9)
- Other MkIV MCOs (48)
- SPR MCO (1)

K East Basin

- High Pu Blend MkIV MCOs (101)
- Other MkIV MCOs (101)

The PSI will be the most advantageous time for Process Validation activities that involve examination of individual fuel elements or fuel canisters. The fuel selected for the PSI is believed to represent the range of fuel damage to be experienced throughout the basin population. Fuel damage is related to surface area, particulate, and scrap ratios. The fuel for PSI will be taken from both aluminum and stainless steel canisters, providing the ability to observe the presence and behavior of aluminum hydroxide coatings, and fuel without the coating.

Process Validation activities that observe loaded MCOs will be done primarily during the processing of the first three MCOs. However, some observation of other fuel and other MCOs, including MCOs from the K East basin, will be required to complete process validation.

Some Process Validation data will be taken for MCOs that have also been selected for CSB monitoring. The following target MCOs will be selected for monitoring, and will thus also have some Process Validation data taken. The low surface area MCO is expected to be the first MCO removed from KW Basin.

- 1) The first K West MCO is expected to have minimal exposed fuel surface area and no aluminum hydroxide
- 2) The first MCO from KW which contains a scrap basket
- 3) One K West MCO with minimal exposed fuel surface area, but high in aluminum hydroxide
- 4) An MCO selected from the Pu blend campaign

5) One MCO from KE high in exposed fuel surface area and scrap

6) SPR Fuel

NOTE: Additional MCOs could be included in the monitoring activity, if there are loadings of special interest identified, such as an MCO with two scrap baskets.

3.0 DATA SELECTION

Table 1 lists the data collection steps that have been considered in support of Process Validation. Included in the table is an indication of how each of these possible data collection steps could be used to address the objectives of Process Validation. Lastly, the table recommends which steps should or should not be pursued as part of Process Validation.

Table 2 the data collection steps that will be used for each of the first three MCOs and for those MCOs which have also been selected for monitoring in the CSB.

Following is a discussion of the recommended approach to providing the desired data for each of the major objectives of Process Validation.

3.1 Surface Area

Detailed visual examination of the fuel and scrap after cleaning during the PSI will provide an assessment of surface area. This examination should be correlated with a visual examination of the top of the canister after cleaning to determine the extent to which fuel damage can be assessed from the top of the canister. This will then be used to assess fuel damage during operations by visual examination of the top of loaded fuel. These assessments, in turn, will be compared to results from the gas generation rate during CVD (see Section 4.7.1), which provide an indication of the total reaction taking place in the MCO. Detailed examination of fuel elements will be performed for all fuel included in the PSI. Only limited detailed visual examination of elements will be required after that. Examination of loaded baskets and gas generation testing are recommended until a range of values is demonstrated. All MCOs also selected for monitoring in the CSB will be included in these tests.

Visual examination of the fuel prior to cleaning will be limited to looking at the top of the canister and to those lift and look observations that have already been made. This is due to the fact that separating elements prior to cleaning may influence the cleaning performance that needs to be assessed during the PSI.

Gas and liquid sampling from the canister, which were done to pinpoint damaged fuel during characterization, are not recommended as part of Process Validation, as they provide less information than visual examination of the fuel. Measuring the sludge depth in the canister is also not recommended, as the data provided is of limited value.

3.2 Gas Generation Rate

The surface area observations described above will provide some correlation to gas generation in a loaded MCO. In addition, pressure and temperature rise after cask transfer to CVD, and a gas sample after cask transfer to CVD, should be taken to confirm the gas generation rate during shipping.

Table 1. Process Validation Requirements Matrix

Unit Operation	Data Collection Opportunities		Done Before	Existing Equip.	Needed Information										Recommendation			
					Surface Area	Gas Generation	Reaction Rate	Scrap to Fuel Ratio	Scrap – Coarse to Fine Ratio	Particulate	Aluminum Hydroxide	Radiological	IXM Usage	Sludge Treatment	Uranium in Knockout Pot	PSI	MCOs	Not Required
Delidding	Gas sample from canister		yes	no	4	3	5											X
	Liquid sample from canister		yes	no	4		5											X
	Visual examination prior to cleaning	Top of fuel	yes	yes												X	X	
	Lift and look		yes	yes	1					2	1							X
Fuel Cleaning	Weigh fuel prior to cleaning		yes	yes							2			3		X		
	Measure aluminum hydroxide film thickness prior to cleaning		yes	no								1						X
	Measure sludge depth in canister		yes	no	4													X
	Measure radiation of effluent during cleaning and decapping		yes	yes	5			5		5						X		
	Weigh canister after cleaning		yes	yes							2			3		X		
	Measure aluminum hydroxide film thickness after cleaning		yes	no								1						X
	Visual examination of elements after cleaning		yes	yes	2					3						X	X	
	Top of canister		yes	yes	1					1	1					X	X	
	Fuel as dumped on table		yes	yes	1					1	1					X	X	
	Disassembled elements		yes	yes	1						1					X	X	
	Visually inspect canister after dumping fuel		yes	yes							5			5		X		
	Loading of Baskets	Weigh canister after dumping		no	yes							4		4		X		
Visually quantify sludge released by disassembly after cleaning		yes	yes							1					X	X		
Visually inspect coarse scrap		no	yes	1											X			
Weigh and measure volume of coarse scrap		no	yes				1								X			
Visually inspect fine scrap		no	yes	1											X			
Weigh and measure volume of fine scrap		no	yes												X			
Visually inspect fine scrap in cleaning machine screen		no	yes				1		1						X			
Weigh fine scrap in cleaning machine screen		no	yes						1						X			
Observe gas bubbles from scrap canisters after cleaning		no	yes	3	3	4											X	
Weigh scrap		no	yes				1									X		
Weigh coarse and fine scrap		no	yes													X		
Loading of MCO		Visual examination of loaded fuel and scrap baskets		no	yes	3			3		3							X
	Observe gas bubbles from loaded baskets		no	yes	4	4	4										X	
	Measure centerline temperature of loaded MCO		no	yes	2												X	
	Measure radiation levels of loaded MCO		no	yes									1				X	
	Radiation level survey prior to transfer to CVD		no	yes									1				X	
	Measure temperature rise after cask transfer to CVD		no	yes	3	2	2										X	
Bulk Water Removal	Measure pressure rise after cask transfer to CVD		no	yes	3	2	2										X	
	Gas sample after transfer to CVD		no	yes	3	2											X	
	Corrosion power test before bulk water drain		no	no	1	1	1											X*
	Neutron/gamma of cask before/after MCO drain & cask drain		no	yes									1				X	
Drying	Neutron/gamma of PWC tank before/after MCO drain		no	yes									1				X	
	Gas generation rate during CVD		no	yes	3	1	1										X	
	Neutron and gamma survey before shipment from CVD		no	yes													X	
	Neutron and gamma survey at CSB receipt		no	yes									1				X	
CSB IWTS	Weigh knockout pot		no	yes														X
	Sample IXM inlet and outlet		no	yes										1		X	X	
	IWTS effluent water clarity evaluation		yes	yes											2	X		
	Radiation levels in IWTS		yes	yes											2	X		
	Piping		yes	yes											2	X		
	Knockout Pot & Settlers		yes	yes											2	X		

Needed Information: 1 - Observation directly related to needed information 2 - Parameter used in calculating desired information 3 - Secondary method confirming desired information 4 - Indirect method implying desired information 5 - Potentially provides data

Shading in table is for visual alignment only and has no other significance.

]* The corrosion power test has been consolidated with gas generation measurement during CVD

Table 2. Process Validation of Selected MCOs

The minimum set of process validation MCOs are chosen as indicated below.

Step	MCO							
	1 st KW (low SA)	2 nd KW	3 rd KW	1 st KW with scrap	KW (Pu blend)	KW (high AlOH ₃)	KE With scrap	SPR
MCOs Designated for Monitoring	x			x	x	x	x	x
Visual examination of top of fuel prior to cleaning (*)	x	x	x	x	x	x	x	x
Of top of canister after cleaning (*)	x	x	x	x	x	x	x	x
Of fuel as dumped on table (*)	x	x	x	x	x	x	x	x
Of disassembled elements (*)	x	x	x	x	x	x	x	x
Of empty canister (*)	x	x	x					
Weighing of canisters before cleaning (*)	x	x	x					
After cleaning (*)	x	x	x					
After dumping (*)	x	x	x					
Visually quantify sludge released by disassembly (*)	x	x	x					
Scrap generation ratios: Visually inspect coarse scrap (*)	x	x	x					
Weigh and measure volume of coarse scrap (*)	x	x	x					
Visually inspect fine scrap (*)	x	x	x					
Weigh and measure volume of fine scrap (*)	x	x	x					
Inspect fine scrap in cleaning machine screen (*)	x	x	x					
Weigh fine scrap in cleaning machine screen (*)	x	x	x					
Weigh loaded coarse scrap		x	x	x	x	x	x	x
Weigh loaded fine scrap		x	x	x	x	x	x	x
Visual examination of loaded baskets	x	x	x	x	x	x	x	x
Observation of gas bubbles from loaded baskets	x	x		x	x	x	x	x
Measure centerline temperature of loaded MCO		x						
Radiation level: of loaded MCO	x	x	x					
Prior to transfer to CVD	x	x	x					
Neutron/gamma of cask before/after MCO drain & cask drain	x	x	x					
Neutron/gamma of PWC tank before/after MCO drain	x	x	x					
Neutron/gamma before shipment from CVD	x	x	x					
Neutron/gamma at CSB receipt	x	x	x					
Cask measurements after transfer: temperature rise	x	x	x					
Pressure rise	x	x	x					
Gas sample	x	x	x					
Gas generation during CVD	x			x	x	x	x	x
IWTS: Weigh knockout pot (*)	x	x	x					
Sample IXM inlet and outlet (*)	x	x	x					
IWTS effluent water clarity evaluation (*)	x	x	x					
Radiation levels in sand filter (*)	x	x	x					
Radiation levels in piping (*)	x	x	x					
Radiation levels in knockout pot & settlers (*)	x	x	x					

(*) These activities are included in the PSI. Fuel from PSI will be loaded into the first 3 MCOs.

3.3 Reaction Rate

The testing described above will define the surface area for the MCO. Gas generation during CVD will also be used to assess the total reaction taking place in the MCO. This total reaction is a function of both the surface area and the reaction rate.

3.4 Scrap to Fuel Ratio

A ratio can be established during the PSI, by weighing fuel and scrap. The ratio then will be reviewed during the loading of actual MCOs to verify that the total number of MCOs projected will be within the allocated number of storage positions.

3.5 Coarse to Fine Scrap Ratio

A ratio can be established during the PSI, by weighing fine and coarse scrap returned to canisters after cleaning. The ratio then will be reviewed during the loading of actual MCOs to verify that the fines capacity of scrap baskets is sufficient to support predicted routine operations.

3.6 Particulate

The quantity of particulate loaded into the MCO and that removed from the fuel will be estimated during the PSI by visual examination of fuel assemblies, weighing of the fuel before and after cleaning, and validation of the cleaning process by disassembly of the assemblies. It is anticipated that validation activities during the PSI will establish that particulate inventories are well within the expected envelope and that additional validation during operations will not be required. Periodic disassembly is required as part of the cleaning process validation procedure during routine operations.

A mass balance will be performed during the PSI by weighing the canister before cleaning, after cleaning, and after dumping. Scrap canisters will be weighed after additions of coarse scrap, fine scrap from the table, and fine scrap from the cleaning machine screen. The knockout pot in the Integrated Water Treatment System will also be weighed.

3.7 Aluminum Hydroxide

Visual examinations after cleaning, during the PSI, will indicate whether or not aluminum hydroxide coatings are removed during cleaning and whether any remaining coatings observed are consistent with those observed during characterization when measurements were taken. No additional validation during operation is planned.

3.8 Radiological

Modeling was used to determine dose rates for design and planning. Radiological readings of loaded MCOs will be taken at each step of the process to confirm modeling predictions.

3.9 IXM Usage

The IXM usage will be projected by sampling the inlet and outlet of the IXMs during key process steps during the PSI, and by analyzing water drained from MCOs. IXM inlet and outlet sampling will also be done during the other phases of the project.

3.10 Sludge Treatment Feed

An assessment of the feed that will be sent to sludge treatment will be provided by the mass balance described above and by measuring the radiation levels of IWTS components.

3.11 Uranium Mass in Knockout Pot

Weighing the knockout pot during the PSI will provide a basis, if needed, for controlling accumulations in the knockout pot. This weighing will also be used in the mass balance discussed above.

4.0 DETAILED SCOPE

4.1 Delidding

4.1.1 Visual Examination Prior to Cleaning

Sequence – No lift and look observations will be made beyond what have already been made. This is to avoid skewing the results of cleaning validation, since the separation of elements may displace particulate within an assembly. Visual examination of the top of each canister of fuel will be done after delidding, for all fuel included in the PSI. No visual observations of fuel prior to cleaning are planned after the PSI.

Method – A hard copy, taken from a video camera, will be made of the top of each canister.

Criteria/Data Use – Photographs and video records will be used by the Data Evaluation Team to establish the following correlations:

- Precleaning view of top of canisters to pre-cleaning lift and look records (to attempt to make an estimate of fuel damage and particulate)
- Precleaning view of top of canisters to post cleaning view of top of canisters (to evaluate the effect of the cleaning machine)
- The post cleaning view of the top of canisters will in turn be compared with more detailed visual examinations following cleaning.

Expected Range – The bounding value for exposed fuel surface area for a fuel basket is 7,900 cm². This equates to 146 cm² per fuel assembly. The geometric surface area of an intact full length, Mark IV, fuel assembly is 3156 cm². The expected result of visual examinations is that at least 50% of outer elements and 85% of inner elements will be intact before and after cleaning. For pre-cleaning observations to be useful, there must not be significant fuel damage during cleaning, and there must be good correlation between damage observable from the top of the canister to total damage observable from detailed visual examinations.

Requirements – Equipment will need to be in place to take the videos and hard copies. There are no new requirements associated with this step.

4.1.2 Weigh Fuel Prior to Cleaning

Sequence – During the PSI, each canister of fuel will be weighed prior to cleaning.

Method – A scale accurate to within less than 1% will be used to weigh each canister.

Criteria/Data Use – The weight of the canister will be used to produce a mass balance for each of the canisters during the PSI. Estimates of particulate collected in the IWTS will be based on this mass balance.

Expected Range – The total weight of a canister prior to cleaning will be in the range of 350 to 400 kg.

Requirements - The scale will need to be available and procedures that include the weighing step will need to be prepared.

4.2 Fuel Cleaning

4.2.1 Measure Radiation of Effluent During Cleaning and Decapping

Sequence – These measurements will be taken during the PSI. The measurement during cleaning will be used to establish an understanding of the cleaning cycle and provide a tool for optimizing the cleaning cycle time should fuel damage during cleaning become an issue. The measurement during decapping will be used to confirm assumptions made in IWTS development.

Method – A monitor will be placed on the effluent line with a continuous reading during cleaning and decapping.

Criteria/Data Use – Optimization of cleaning time could be done if fuel damage during cleaning becomes an issue. The IWTS assumed a maximum cesium concentration based on flushing in the decapper being spread over 3 minutes.

Expected Range – Intact fuel in the K West basin is not expected to have significant material removed and therefore no significant radiation from the effluent. For this technique to have value there must be a measurable drop in radiation from the effluent when particulate has been removed from the fuel. The actual value of the readings will depend on the placement of the monitor and the amount of material being removed by the process.

Requirements – A radiation monitor attached to a strip chart or equivalent recording device will be needed. The operating procedure will need to include obtaining the reading.

4.2.2 Weigh Canister After Cleaning

Sequence - During the PSI, each canister of fuel will be weighed after cleaning.

Method – A scale accurate to within less than 1% will be used to weigh each canister. Canister weighing requires an extra step. The canister will have to be moved to the process table to be weighed with the scale.

Criteria/Data Use – The weight of the canister will be used to produce a mass balance for each of the canisters during the PSI. Estimates of particulate collected in the IWTS will be based on this mass balance.

Expected Range – The total weight of a canister after cleaning will be in the range of 350 to 400 kg. The amount of material removed by the cleaning machine will vary significantly by canister, depending on fuel condition. K West canisters with intact fuel are not expected to have measurable material removed by the cleaning process.

Requirements - The scale will need to be available and procedures that include the weighing step will need to be prepared.

4.2.3 Visual Examination of Fuel After Cleaning

Sequence – The top of the fuel will be video taped for all canisters in the PSI and canisters that are expected to be loaded into monitored MCOs. Fuel and scrap will be video taped after being dumped on the table for all canisters in the PSI and canisters that are expected to be loaded into monitored MCOs. Complete visual examination of disassembled fuel will be done only for those assemblies in the PSI. Real time observation of the examination of disassembled fuel by the Data Evaluation Team is planned.

Method - A hard copy, taken from a video camera, will be made for observations of tops of baskets and dumped fuel, so that the information will be available to the Data Evaluation Team. Video records will be made of disassembled fuel. The purpose of disassembly is to inspect for the quantity of canister particulate. This validation step supports the safety basis and is considered outside the scope of this document.

Criteria/Data Use – Estimates of fuel damage and particulate will be made from all the observations. Correlations will be made between pre and post cleaning observations of the top of the canister to assess the impact of the cleaning process on the fuel.

Expected Range – The bounding value for reactive fuel surface area for a fuel basket is 7,900 cm². This equates to 146 cm² per fuel assembly. The geometric surface area of an intact full length, Mark IV, fuel assembly is 3156 cm². The bounding value for oxide film and adhering particulate mass in a fuel basket is 1.16 kg or 21 g per assembly. Visual observations of fuel can be correlated to fuel that was previously examined for particulate mass. Since the bounding particulate was based on the worst element observed, and a majority of elements are intact, actual fuel is expected to average significantly less particulate than the bounding value.

Requirements - Equipment will need to be in place to take the videos. There are no new requirements associated with this step.

4.2.4 Visually Inspect Canister After Dumping

Sequence – During the PSI a visual examination of the inside of each canister will be made, after the fuel is dumped.

Method – A hard copy, taken from a video camera will be made.

Criteria/Data Use – This step is to determine whether any debris, canister particulate, or fuel is left in the canister after dumping. This observation will support the mass balance to be done on canisters.

Expected Range – After dumping, the canister is expected to be empty, free of fuel, sludge, and debris, and is expected to be undamaged by the cleaning process.

Requirements - Equipment will need to be in place to take the videos. There are no new requirements associated with this step.

4.2.5 Weigh Canister After Dumping

Sequence - During the PSI, each canister will be weighed after the fuel is dumped.

Method – A scale accurate to within less than 1% will be used to weigh each canister.

Criteria/Data Use – The weight of the canister will be used to produce a mass balance for each of the canisters during the PSI. Estimates of particulate collected in the IWTS will be based on this mass balance.

Expected Range – Canister weight will vary depending on canister type, but will be 10% or less of the full canister weight.

Requirements - The scale will need to be available and procedures that include the weighing step will need to be prepared.

4.2.6 Visually Quantify Sludge Released by Disassembly After Cleaning

This activity supports the project safety basis and is considered outside the scope of this document. The procedure is described in Stegen, 2000.

4.2.7 Visually Inspect Coarse Scrap

Sequence - During the PSI, some coarse scrap will be loaded back into canisters. Coarse scrap will be observed while on the table and as it is being loaded into the canisters.

Method – The sorting and loading of coarse scrap will be video taped. The video image will be evaluated to estimate fuel surface area on the scrap.

Criteria/Data Use – An estimate of the surface area on coarse scrap will be compared to estimates used in modeling, and the operation will be evaluated to assure that smaller pieces of scrap are not being loaded into the coarse section of the scrap basket.

Expected Range – Coarse scrap is expected to range from 1” pieces to complete elements that are damaged and will not fit into a fuel basket. Scrap throughout this range is acceptable. The bounding surface area for a scrap basket is 45,000 cm². Actual scrap baskets are expected to contain significantly less than this amount.

Requirements – Video equipment to estimate surface area will need to be in place.

4.2.8 Weigh and Measure Volume of Coarse Scrap

Sequence – During the PSI, some coarse some scrap will be loaded back into canisters. Scrap will be kept separate by key. Each canister will need to be weighed empty and then weighed after the addition of coarse scrap. The volume of scrap in the canister will also be measured.

Method – A scale accurate to within less than 1% will be used to weigh each canister after scrap addition. The distance to the top of the scrap will be measured with a ruler with a plate on the end of it.

Criteria/Data Use – The ratio of scrap to fuel will be determined during the PSI to project the number of scrap baskets needed per MCO. The process has been designed assuming an average of one scrap basket per MCO, but the MCO can accept 0, 1, or 2 scrap baskets. If the ratio of scrap to fuel is unacceptably high, adjustments to the process will be considered where practical.

Expected Range – The amount of coarse scrap to be generated is unknown at this time, but for the SNF process to be successful, coarse scrap will need to be less than 20% of the initial fuel mass.

Requirements – The scale will need to be available and procedures that include weighing canisters before and after scrap addition will need to be prepared.

4.2.9 Visually Inspect Fine Scrap

Sequence - During the PSI, fine scrap will be loaded back into canisters. Fine scrap will be observed while on the table and as it is being loaded into the canisters.

Method – The collection and loading of fine scrap will be video taped. The video image will be evaluated to estimate fuel surface area on the scrap.

Criteria/Data Use – An estimate of the surface area on fine scrap will be compared to estimates used in modeling, and the operation will be evaluated to assure that an excessive number of pieces smaller than ¼” are not being loaded into the fine section of the scrap basket.

Expected Range – Fine scrap is expected to range from ¼” to 1” with a negligible quantity of finer material. Scrap throughout this range is acceptable. Larger pieces are also acceptable in the fine section of the scrap basket.

Requirements – Video equipment to estimate surface area will need to be in place.

4.2.10 Weigh and Measure Volume of Fine Scrap

Sequence - During the PSI, fine scrap will be loaded back into the same canisters as the coarse scrap, but kept separate by key. Each canister will need to be weighed before and after the addition of fine scrap.

Method - A scale accurate to within less than 1% will be used to weigh each canister before and after fine scrap addition. The distance to the top of the scrap will be measured with a ruler with a plate on the end of it.

Criteria/Data Use – The ratio of fine scrap to coarse scrap will be used to project the volume of fine scrap to be created by the process. The process has been designed allowing for up to 10% of the volume of the scrap basket to be occupied by fine scrap. It is acceptable to place coarse scrap in the fines portion of the scrap basket, but unacceptable to place fines in the coarse section of the scrap basket. If the ratio of fine scrap to coarse scrap is too high, adjustments to the process will be considered where practical.

Expected Range – The amount of fine scrap to be generated is unknown at this time, but for the SNF process to be successful, fine scrap needs to be limited to about 2% of the initial fuel mass.

Requirements - The scale will need to be available and procedures that include weighing canisters before and after scrap addition will need to be prepared.

4.2.11 Visually Inspect Fine Scrap in Cleaning Machine Screen

Sequence – During the PSI, the Primary Cleaning Machine will be cleaned out after processing each canister. The fine scrap collected on the cleaning machine wash basket and strainer will be dumped on a grid on the process table and photographed and will be used to obtain a size estimate of the material.

Method – A hard copy, taken from a video camera will be made.

Criteria/Data Use – The data will be used to assess the tendency to blinding of the strainer and accumulation of material smaller than ¼”. Periodic cleaning of the Primary Cleaning Machine is necessary to assure that the small material is not routinely loaded into the fines portion of the scrap basket.

Expected Range – The quantity and distribution of material collected on the cleaning machine wash basket and strainer is unknown at this time.

Requirements - Equipment will need to be in place to take the videos. There are no new requirements associated with this step.

4.2.12 Weigh Fine Scrap in Cleaning Machine Screen

Sequence – During the PSI, the fine material in the Primary Cleaning Machine strainer will be weighed each time the machine is cleaned.

Method – The cleaning machine strainer will be weighed before use and after removal for each cleanout. This scale is accurate to within less than 1%.

Criteria/Data Use – The fine scrap accumulated in the cleaning machine will be considered part of the total quantity of fine scrap that needs to be estimated as explained above.

Expected Range – The weight of material collected on the cleaning machine wash basket and strainer is unknown at this time. However, this is one of two sources of fine scrap which should not exceed 2% of the initial fuel mass.

Requirements – A location needs to be identified to place the strainer for weighing. A procedure will be need to be developed for this weighing.

4.3 Loading of Baskets

4.3.1 Weigh Scrap

Sequence – The weight of loaded scrap baskets will be taken for all scrap baskets loaded for the first 3 MCOs containing a scrap basket.

Method – Each basket will be weighed using a load cell on a stiffback. The load cell is accurate to within 1%. Ordinarily, baskets can be weighed when they are being moved. However, scrap baskets will initially need to be weighed more frequently than they are moved.

Criteria/Data Use – The data will be used to project the number of scrap baskets needed to complete the project. This information is needed to project the number of MCOs and the appropriateness of the process design, which assumes an average of 1 scrap basket per MCO.

Expected Range – The weight of uranium is limited to 980 kg in a Mark IV scrap basket and 1265 kg in a Mark IV fuel basket. Fuel baskets will be corrected for buoyancy and for cladding and end caps. Scrap basket weighing will be corrected for buoyancy by assuming everything in the basket is uranium, as described in Duncan and Sexton, 1998.

Requirements – The load cell will need to be available for this procedure.

4.3.2 Weigh Coarse and Fine Scrap

Sequence - For the first 3 MCOs, the scrap basket will be weighed before and after each addition of fine scrap and after all scrap is loaded. A video record of the scrap addition will be taken for use in interpreting the results.

Method - The scrap basket will be weighed in the same manner as full baskets. This procedure will require more weighings of the first three scrap baskets.

Criteria/Data Use – The data will be used to confirm the appropriateness of the scrap basket design, which allows 10% of the volume for fine scrap, and to estimate the exposed fuel surface area in the scrap basket.

Expected Range – The ratio of fine scrap to coarse scrap is not known, but a ratio of less than 10% by volume is the basis of the design and is expected.

Requirements – The load cell to weigh baskets and a video camera covering the scrap loading will be required.

4.3.3 Visual Examination of Loaded Fuel and Scrap Baskets

Sequence – Visual examination of baskets after they are fully loaded will be done for the first three MCOs. They will also be done for all baskets in each MCO selected for monitoring in the CSB.

Method – A hard copy, taken from a video camera will be made.

Criteria/Data Use – The condition of the fuel in a loaded basket will be used to correlate with other assessments of fuel surface area and particulate. The objective will be to obtain a basis for estimating fuel surface area and particulate only by looking at the top of a loaded basket.

Expected Range – The bounding value for reactive fuel surface area for a fuel basket is 7,900 cm². This equates to 146 cm² per fuel assembly. The surface area of a full length, Mark IV, fuel assembly is 3156 cm². The expected result of visual examinations is that at least 50% of outer elements and 85% of inner elements will be intact after loading. For fuel basket observations to be useful there must be good correlation between damage observable from the top of the basket to total damage observable from detailed visual examinations. Scrap basket observations will be harder to quantify, but the general distribution of whole elements that would not fit in fuel basket, small pieces in the coarse section of the basket, and fine scrap will be observable from the top of the basket.

Requirements – A video camera will need to be available for this observation. There are no new requirements.

4.3.4 Observe Gas Bubbles From Loaded Baskets

Sequence – Selected loaded fuel baskets from the first three MCOs will be observed for bubbling after loading. No delays in loading of MCOs will be imposed by this requirement.

Method – Video records of loaded baskets, prior to loading into the MCO will be made and evaluated for bubbling.

Criteria/Data Use – Correlations will be made of the presence and rate of bubbling with the estimated surface area. Also calculations of the reaction rate will be made, based on the observed rate of bubbling. The objective will be to determine if observed bubbling is a reliable indicator of reaction rate and if reaction rates observed are within expected ranges.

Expected Range – The expected fuel surface area in a scrap basket is 17,000 cm². This equates to an estimated gas generation rate of 2.1 mg/hr or 24 ml/hour at STP. A fuel basket has an expected surface area of only 425 cm², but a bounding value of 7,900 cm². These values would produce expected gas generation rates of 0.05 mg/hr and 0.99 mg/hr respectively.

Requirements – A video camera to estimate the gas generation rate will be required for this purpose.

4.4 Loading of MCO

4.4.1 Measure Centerline Temperature of Loaded MCO

Sequence – The second available fully loaded MCO will have a centerline temperature measurement.

Method – A thermocouple will be placed down the center of the baskets to about 2 feet above the bottom of the MCO. This measurement will be taken just prior to placement of the MCO shield plug.

Criteria/Data Use – The temperature differential between the MCO centerline and the basin water temperature will be compared to a predicted value and used in calculations of temperature rise and gas generation during transport to CVD.

Expected Range – Thermal calculations of wet transport were based on the assumption that the entire MCO is at uniform temperature prior to shipping. This measurement is expected to confirm a negligible temperature differential within the MCO prior to closure.

Requirements – A thermocouple which can be lowered into the MCO and an appropriate procedure will be required.

4.4.2 Measure Radiation Levels of Loaded MCO

Sequence – Radiation levels will be measured for the first three fully loaded MCOs.

Method – A neutron and gamma survey will be made while the baskets are being loaded into the MCO. A neutron and gamma survey will be made while the cask/pail/MCO assembly is about 3 feet from the surface of the water and continuing until the pail is in the resting position.

Criteria/Data Use – The data will be used to confirm dose rate modeling by comparing actual values to calculated values.

Expected Range – Dose rate expectations are described in Lorenz, 1999.

Requirements – A procedure for these measurements will need to be developed by Health Physics and gamma and neutron monitors will be required.

4.5 Cask Transfer

4.5.1 Radiation Level Survey Prior to Transfer to CVD

Sequence – Radiation levels prior to transfer to CVD will be measured for the first three fully loaded MCOs.

Method – A neutron and gamma shipping survey above and around the cask/transporter as well as in the truck cab will be made and a comprehensive smear survey of the cask exterior will be performed. Smear samples of all MCOs will be taken as a matter of normal operations. The first three will be considered Process Validation and will be more comprehensive.

Criteria/Data Use - The data will be used to confirm dose rate modeling by comparing actual values to calculated values.

Expected Range – Dose rate expectations are described in Lorenz, 1999.

Requirements – No new requirements.

4.5.2 Measure Temperature Rise After Cask Transfer to CVD

Sequence – The cask and MCO surface temperatures will be measured for the first three casks transferred to CVD. The gas temperature will also be recorded.

Method – Surface temperatures of the cask and MCO will be recorded on receipt at CVDF. The temperature of the gas being sampled will be recorded, based on the thermocouple in the transfer line. Some gas cooling is expected between the MCO and thermocouple, so all three temperatures will be evaluated. Transfer conditions, including time, temperature, and weather conditions will need to be recorded.

Criteria/Data Use – The temperature measurements will be compared to values predicted from modeling. In addition to the first three casks, recommendation may be made to take additional temperature data from a high decay heat MCO transferred during hot weather.

Expected Range – The cask temperature is expected to rise approximately 10°C during an 8-hour transfer on a hot day.

Requirements – An optical thermometer for measuring surface temperatures will be needed.

4.5.3 Measure Pressure Rise After Cask Transfer to CVD

Sequence – The cask pressure will be measured at CVD receipt for the first three casks transferred to CVD.

Method – A cask lid connection will be made to purge the cask. There is a pressure indicator in this line that will be read prior to purging the cask.

Criteria/Data Use – The pressure measurements will be compared to values predicted from modeling. In addition to the first three casks, recommendation may be made to take additional pressure data from a high decay heat MCO transferred during hot weather. Since this pressure data is taken from connections made to purge the cask, no additional operational steps are required to take these temperature readings.

Expected Range – The cask pressure is expected to rise approximately 5 psi during an 8-hour transfer on a hot day.

Requirements – The current design includes a pressure indicator on the line from the cask lid connection.

4.5.4 Gas Sample After Transfer to CVD

Sequence – A gas sample from the cask annulus will be taken from each of the first three casks transferred to CVD, prior to purging of the cask at CVD receipt.

Method – An evacuated sample cartridge of approximately 0.5 liters volume will be placed in the purge line at the connection provided for that purpose. The sample will be considered radioactive and sent to the laboratory and analyzed for hydrogen, xenon, and nitrogen.

Criteria/Data Use - The gas sample data will be used to evaluate the extent of uranium oxidation reaction that has taken place during transport of the cask/MCO to CVD. This will be compared to predictions based on modeling.

Expected Range – The total hydrogen present after an 8-hour transfer is expected to be less than half the initial helium backfill quantity. Xenon is expected to be approximately 4 orders of magnitude less than hydrogen (the exact ratio varies by fuel burnup) and is an indicator that the hydrogen is from fuel oxidation. Nitrogen is not expected and would be an indicator of air inleakage.

Requirements – The capability to sample gas is included in the existing design. A procedure will need to be in place for the sampling and handing of the sample.

4.6 Bulk Water Removal

4.6.1 Neutron and Gamma Survey of Cask Before and After MCO Drain and Cask Drain

Sequence – The first three MCOs will have readings taken.

Method - Neutron and gamma surveys of the cask will be taken before and after draining the MCO and before and after draining the cask.

Criteria/Data Use – The data will be used to confirm that neutron dosimetry will not be permanently needed by facility staff.

Expected Range – Dose rate expectations are described in Lorenz, 1999.

Requirements – No new requirements

4.6.2 Neutron and Gamma Survey of PWC Tank Before and After MCO Bulk Water Drain

Sequence – Readings will be taken for the first three MCOs drained.

Method - Neutron and gamma surveys of the PWC tank will be taken before and after draining the MCO.

Criteria/Data Use - The data will be used in conjunction with surveys of the cask to assess the accumulation of particulates and to confirm that neutron dosimetry will not be permanently needed by facility staff.

Expected Range – Dose rates will depend on the accumulation of particulates.

Requirements – No new requirements

4.7 Drying

4.7.1 Gas Generation Rate During CVD

Sequence – These readings will be taken on all MCOs that are also selected for monitoring. Because this test does not significantly impact the operating time, the gas generation rate for additional MCOs of interest may be taken.

Method – The flowrate for the first eight hour helium purge will be recorded and the concentration of hydrogen, xenon, and nitrogen, will be measured in the helium purge using the Residual Gas Analyzer (RGA) Unit.

Criteria/Data Use – This data will be used to determine the total MCO reaction under low pressure water vapor conditions. These results can be compared to predictions based on modeling.

Expected Range – Nominal values for expected corrosion are as follows:

Surface Area, m ² /MCO (with 1 scrap basket)	1.9
Hydrogen Release Rate at 45°C (mol/sec)	4.6 x 10 ⁻⁶
Hydrogen Concentration (ppm, with 1.1 scfm He flowrate)	146
Xenon concentration (ppb, 12% Pu fuel has 1.3 gmol Xe/MTU)	23

Nitrogen is not expected and would be an indicator of air inleakage.

Requirements – A procedure for this test will need to be prepared. The RGA will be valved in to the process system to allow on line sampling.

4.7.2 Neutron and Gamma Survey Before Shipment From CVD

Sequence – The first three MCOs will require this survey.

Method - A neutron and gamma shipping survey above and around the cask/transporter as well as in the truck cab will be made and a comprehensive smear survey of the cask exterior. Smear samples of all MCOs will be taken as a matter of normal operations. The first three will be considered Process Validation and will be more comprehensive.

Criteria/Data Use - The data will be used to confirm dose rate modeling by comparing actual values to calculated values.

Expected Range – Dose rate expectations are described in Lorenz, 1999.

Requirements – No new requirements

4.8 CSB Receipt

4.8.1 Neutron and Gamma Survey at CSB Receipt

Sequence - The first three MCOs will require this survey.

Method - A neutron and gamma shipping survey above and around the cask/transporter as well as in the truck cab will be made and a comprehensive smear survey of the cask exterior. Smear samples of all MCOs will be taken as a matter of normal operations. The first three will be considered Process Validation and will be more comprehensive.

Criteria/Data Use – The data will be used to confirm dose rate modeling by comparing actual values to calculated values.

Expected Range – Dose rate expectations are described in Lorenz, 1999.

Requirements – No new requirements

4.9 Integrated Water Treatment System

4.9.1 Weigh Knockout Pot

Sequence – The knockout pot will be weighed after each fuel wash batch during PSI until the frequency of weighing can be modified based on experience.

Method – A lifting fixture and load cell will be used to weigh the knockout pot without removing the connecting piping. Cold testing will verify the ability to weigh the knockout pot with this method.

Criteria/Data Use – The rate of uranium metal accumulation in the knockout pot will be assessed relative to the knockout pot weight limit for lifting purposes and relative to a lower limit that could be imposed to assure thermal stability.

Expected Range – The knockout pot will weigh approximately 250 kg empty. The approximate volume of the knockout pot is 120 l. Assuming no more than 60 l of material could accumulate in the pot before blinding occurs, weights of material that could accumulate in the pot are as follows.

Material	Assumed Density	Weight of 60 l	Weight of 60 l in water
Uranium Oxide	2.5	150 kg	90 kg
Uranium	19	1140 kg	1080 kg

Note that there will be a very significant difference in the weight of accumulated oxide and uranium. The maximum weight that the current load cell can handle is 900 kg, so accumulating 60 l of uranium would not be acceptable. Further, limiting the collected mass to 200 kg has been imposed as a means of assuring thermal stability in knockout

pots that are not equipped with copper dividers. This limit would have no impact if the collected mass is primarily oxide.

Requirements – A procedure, lifting fixture, and load cell will be required for this weighing.

4.9.2 Sample IXM Inlet and Outlet

Sequence – Sampling will be done once per shift while the cleaning machine is running during the PSI. The frequency of additional sampling will be determined based on results during the PSI. Samples will also be taken at the CVDF inlet and outlet during bulk water draining of the MCOs selected for monitoring.

Method – Connections for sampling on both the inlet and outlet of the IXMs are included in the design. Samples will be removed and sent to the laboratory for analysis of filtered and unfiltered total alpha.

Criteria/Data Use – The data will be used to assess the rate of IXM usage and the potential for allowing disposal of IXMs as non-TRU waste.

Expected Range – Ranges are unknown at this time.

Requirements – A procedure for the sampling will be required.

4.9.3 IWTS Effluent Water Clarity Evaluation

Sequence – Samples of the IWTS effluent will be evaluated during the PSI.

Method – A sample will be sent to the laboratory and measured for turbidity.

Criteria/Data Use – Readings will provide an indication of the effectiveness of the IWTS filtration. These will be used in conjunction with observations of the clarity of the water in the working area.

Expected Range – The IWTS is expected to provide effluent no greater than 1 NTU.

Requirements – There are no new requirements.

4.9.4 Radiation Levels in IWTS

Sequence – Radiation levels in the IWTS will be measured at the conclusion of the PSI.

Method - Gamma radiation levels will be measured at the IWTS piping, sand filter, knockout pot, and settlers at the conclusion of the PSI.

Criteria/Data Use – These readings will provide early indication of the accumulation of deposits that could lead to unacceptable levels during processing. The measurements will also provide inputs for sludge removal project design.

Expected Range – Radiation levels in the IWTS are unknown at this time.

Requirements – No new requirements

5.0 INTERFACES

Process Validation activities will be planned to minimize data interpretation and process feedback decisions by operators. Operators will provide data to the Data Evaluation Team (discussed in Section 6) and samples to the laboratory. The laboratory will provide results to the Data Evaluation Team. The interpretation of the data and related process feedback will be the responsibility of that team. The following table describes operations interfaces associated with each Process Validation step.

Table 2, Process Validation Interfaces

Process Validation Step	Deliverable	To	Number
4.1.1 Visual examination prior to cleaning	Video Image	DET	35
4.1.2 Weigh fuel prior to cleaning	Weight	DET	35
4.2.1 Measure radiation of effluent during cleaning and decapping	Strip chart	DET	35 or less
4.2.2 Weigh canister after cleaning	Weight	DET	35
4.2.3 Visual examination of fuel after cleaning	Video Image	DET	Canisters 35 Assem. 490
4.2.4 Visually inspect canister after dumping	Video Image	DET	35
4.2.5 Weigh canister after dumping	Weight	DET	35
4.2.7 Visually inspect coarse scrap	Video Image	DET	3 or more
4.2.8 Weigh coarse scrap	Weight	DET	35
4.2.9 Visually inspect fine scrap	Video Image	DET	3 or more
4.2.10 Weigh fine scrap	Weight	DET	70
4.2.11 Visually inspect fine scrap in cleaning machine screen	Video Image	DET	12
4.2.12 Weigh fine scrap in cleaning machine screen	Weight	DET	12
4.3.1 Weigh scrap	Weight	DET	90
4.3.2 Weigh coarse and fine scrap	Weight	DET	12
4.3.3 Visual examination of loaded fuel and scrap baskets	Video Image	DET	119
4.3.4 Observe gas bubbles from loaded baskets	Video record	DET	10
4.4.1 Measure centerline temperature of loaded MCO	Temperature	DET	1
4.4.2 Measure radiation levels of loaded MCO	Radiation survey	DET	3
4.5.1 Radiation level survey prior to transfer to CVD	Radiation survey	DET	3
4.5.2 Measure temperature rise after cask transfer to CVD	Temperature	DET	3
4.5.3 Measure pressure rise after cask transfer to CVD	Pressure	DET	3
4.5.4 Gas sample after transfer to CVD	Gas sample	Lab	3
4.6.1 Neut./gamma cask before/after MCO drain & cask drain	Radiation survey	DET	3
4.6.2 Neut./gamma lines/equip before/during/after MCO drain	Radiation survey	DET	3
4.7.1 Gas generation during CVD	Helium flow Hydrogen conc. Xenon conc. Nitrogen conc.	DET	7 to 24
4.7.2 Neutron and gamma survey before shipment from CVD	Radiation survey	DET	4
4.8.1 Neutron and gamma survey at CSB receipt	Radiation survey	DET	4
4.9.1 Weigh knockout pot	Weight	DET	TBD
4.9.2 Sample inlet and outlet of IXM	Water sample	Lab	TBD
4.9.3 IWTS effluent water clarity evaluation	Water Sample	Lab	3
4.9.4 Radiation levels in IWTS	Radiation survey	DET	9

6.0 DATA EVALUATION TEAM

Interpretations of data and comparisons of data to predictions based on modeling will be done by a Data Evaluation Team.

A team of approximately five individuals representing operations and engineering will be identified as a Data Evaluation Team. They will assess fuel cleaning effectiveness, fuel damage, and particulate estimates to establish visual standards for operations, interpret results to confirm or adjust equipment performance, and confirm acceptable MCO behavior. These assessments will be used to perform trending analysis to estimate the total number of MCOs required and determine changes or additions to Process Validation activities. The team must possess familiarity with the SNF safety basis, characterization data, basin operations, and process engineering.

7.0 IMPLEMENTATION OF PROCESS VALIDATION

Some of the steps in Process Validation occur during the PSI, prior to Operational Readiness Review (ORR). Others occur after startup. After startup, validation activities occur in parallel with other operational activities. In those cases, special procedures and MCO travelers will be required for those MCOs requiring validation steps. Some validation steps are done on initial MCOs and other steps are done on MCOs selected for specific characteristics. The Process Engineer will be responsible to identify what validation steps apply to selected MCOs. Figure 1 is intended to show the relationship of Process Validation to other activities.

7.1 Validation Procedures

Process Validation requires additional steps during operations for selected MCOs. The number of additional steps is not the same for all MCOs addressed by Process Validation. The Operational Procedures will need to be supplemented with procedures that address the additional steps. In addition, methods need to be in place to clearly identify which MCOs require which additional steps.

7.2 Validation Traveler

Additional data will be recorded for those MCOs subject to Process Validation. The traveler will need to be supplemented to include the information required for Process Validation.

7.3 Validation Report(s)

Process Engineering will prepare reports that provide data and conclusions from all Process Validation steps.

Figure 1, Process Validation Tasks

8.0 REFERENCES

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