

## Cleaning Processes across NASA Centers

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### Cleaning:

All significant surfaces of the hardware must be pre-cleaned to remove dirt, grit, scale, corrosion, grease, oil and other foreign matter prior to any final precision cleaning process. Metallic parts shall be surface treated (cleaned, passivated, pickled and/or coated) as necessary to prevent latent corrosion and contamination. (“Process Specification for Cleaning of Hardware”/PRC-5001, Rev. E [JSC], page 7)

### Stages of Cleaning Processes:

1. Pre-cleaning/surface cleaning
2. Inspection
3. Precision cleaning
4. Verification
5. Handling
6. Drying
7. Final Packaging

### Chemicals for Cleaning

- Detergent/Degreaser \*
- Caustic Acid (Oakite HD 126) \*
- Rinse Water (RO Water) \*
- Mild Alkaline (Oakite 31) \*
- Oakite Liquid Rustripper \*
- Oakite Rustripper \*

### Equipment for Cleaning Processes

- Personal Protective Equipment
- “Bunny suits” to protect clean rooms from outside contaminants
- Vats/Tanks
- Sandblaster machines \*
- Jet spray washers \*
- Heated pressure washers \*

### Locations for Cleaning

- Clean flow benches \*
- Clean rooms
- High bay areas \*
- Onsite

### Types of Items Cleaned

- Components
- Tank Lines
- Pressure Vessels
- Tools
- Personal Protective Equipment

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\* Primary Source: WSTF

Clean Rooms/Clean Areas/Location Cleaning

	WSTF	MSFC	SSC
Clean Rooms	<p><u>Class 10,000 clean room (180 sq ft)</u></p> <ul style="list-style-type: none"> <li>Function tests of components up to 11,000 psi: valves, regulators, and intensifiers</li> <li>Precision clean cryogenic pumps</li> <li>Precision clean relief valves, high pressure compressors, and other components</li> </ul> <p><u>Class 10,000 clean room (140 sq ft)</u></p> <ul style="list-style-type: none"> <li>Precision clean of all clean room garments used at WSTF</li> </ul> <p><u>Class 100 clean room (600 sq ft)</u></p> <ul style="list-style-type: none"> <li>Final verification and cleanliness of components up to 50 A</li> <li>Capable of handling flight hardware</li> </ul> <p><u>Class 100 Flight Hardware clean room (400 sq ft)</u></p> <ul style="list-style-type: none"> <li>Pilot Operating Valves (POV), Veneer Direct Acting Valves (DAV), Oxygen Regenerating Compressor Assembly (ORCA), Hydrogen Flow Control Valve (HFCV)</li> </ul> <p><u>Class 100 reassembly room (300 sq ft)</u></p> <ul style="list-style-type: none"> <li>Function test of components up to 20,000 psi</li> </ul>	<p><u>Class 100,000 clean room (4,000 sq ft)</u></p> <ul style="list-style-type: none"> <li>Precision Cleaning facility cleans valves components, tubing, piping and misc hardware.</li> <li>Precision cleaning of Project hardware for ECLSS, MSRR, G-LIMIT and others.</li> </ul> <p><u>Class 10,000 clean room (4500 sq ft)</u></p> <ul style="list-style-type: none"> <li>Precision Cleaning facility cleans valves components, tubing, piping and misc hardware.</li> </ul> <p><u>Class 30,000 clean room (432 sq ft)</u></p> <ul style="list-style-type: none"> <li>Packaging and inspection for Precision Cleaning</li> <li>Black and white light inspection</li> </ul> <p><u>Class 100,000 clean room Precision Assembly (2000 sq ft)</u></p> <ul style="list-style-type: none"> <li><u>Precision Assembly of Project hardware.</u> <ul style="list-style-type: none"> <li>ECLSS : Rack, OGA, ORU, UPA, DA, Pump</li> <li>MSRR</li> <li>G-LIMIT</li> </ul> </li> </ul> <p><u>Class 100 Flow bench</u></p> <ul style="list-style-type: none"> <li>NVR and Particulate analysis</li> <li>Small item assembly</li> </ul>	<p><u>Class 10,000 clean room (1500 sq ft)</u></p> <ul style="list-style-type: none"> <li>Function tests of components up to 6,500 psi.</li> <li>Precision clean components, tubing, and fittings</li> </ul>
Clean Areas	<ul style="list-style-type: none"> <li>Several Class 100 Flow benches</li> <li>Bubble Point Tester for filters</li> <li>Heise gauge-cleaning station up to 50,000 psi</li> </ul>	<p><u>Class 300,000 Clean Areas</u></p> <ul style="list-style-type: none"> <li>Dry Film Lube, Precision Cleaning, MLI Blanket Fabrication</li> </ul>	<ul style="list-style-type: none"> <li>Anteroom (450 sq ft) with Class 100 Flow bench</li> <li>Test Cell – functional testing of precision cleaned components to 15,000 psi</li> </ul>
Location Cleaning	<p>High Bay Area</p> <ul style="list-style-type: none"> <li>6,000 gallon tanker trucks</li> <li>Large vessels</li> <li>4-inch convoluted hoses</li> <li>Long pipes</li> <li>Pressure vessels</li> <li>Chambers</li> </ul>	<p>Location Cleaning outsourced</p>	<p>High Bay Area</p> <ul style="list-style-type: none"> <li>Convoluted hoses</li> <li>Long pipes</li> <li>Pressure vessels</li> </ul>
Other	<p>Vats (for Component Cleaning)</p> <ul style="list-style-type: none"> <li>Detergent/Degreaser (Simple Green) – Vat size 2.5' L x 2.5' W x 2 'D</li> <li>Caustic Acid (Oakite HD 126) – Vat size 2.5' L x 2.5' W x 2 'D</li> <li>Rinse Water – (RO water) – Vat size 2.5' L x 2.5' W x 2 'D</li> <li>Mild Alkaline (Oakite 31) – Vat size 2.5' L x 2.5' W x 2 'D</li> <li>Oakite Liquid Rustripper – Vat size 2.5' L x 2.5' W x 2 'D</li> <li>Oakite Rustripper – Vat size 2.5' L x 2.5' W x 2 'D</li> </ul>	<p><u>Grit Blast</u></p> <ul style="list-style-type: none"> <li>Grit blasting using, Black Beauty, Garnet, Sand, Steel Shot, Walnut hulls, corn cobs and soda.</li> <li>Pressure Washing</li> </ul>	<p>Vats (for Component Cleaning)</p> <ul style="list-style-type: none"> <li>Caustic Cleaner (Cee-Bee J-84AL Liquid)– Vat size 10' L x 3.8' W x 4.5 'D</li> <li>Mild Alkaline (Cee-Bee Super Bee 300LF) – Vat size 8' L x 3.8' W x 4.5 'D</li> <li>Protective Coating (Cee-Bee MX-15U) - Vat size 8' L x 3.8' W x 4.5 'D</li> <li>Deoxidizer (Cee-Bee C-623) - Vat size 8' L x 3.8' W x 4.5 'D</li> <li>Passivation Solution (HNO3) – Vat Size 8' L x 3.8' W x 4.5 'D</li> </ul>

## Onsite Cleaning

	WSTF	MSFC	SSC
Tank Lines		<p><u>Mid-Strength 300 Series (Non-Magnetic) Stainless Steel</u> (24'Lx5'Wx10'D</p> <ol style="list-style-type: none"> <li>1. Aqueous Degrease</li> <li>2. Rinse</li> <li>3. Pickle (micro etch) – Nitric/Hydrofluoric Acid</li> <li>4. Rinse</li> <li>5. Passivation – Nitric Acid</li> <li>6. Rinse</li> <li>7. Hot Water Rinse</li> <li>8. Precision Cleaning</li> </ol> <p><u>Aluminum Cleaning Process</u> (24'Lx5'Wx10'D</p> <ol style="list-style-type: none"> <li>1. Aqueous Degrease</li> <li>2. Rinse</li> <li>3. [Steps a, b, c, and d at least once, but repeated as necessary, or to specification] <ol style="list-style-type: none"> <li>a. Tri-Acid Deoxidizer</li> <li>b. Rinse</li> <li>c. Caustic Etch</li> <li>d. Rinse</li> </ol> </li> <li>4. Chromate Conversion Coating</li> <li>5. Rinse</li> <li>6. Hot Water Rinse</li> <li>7. Precision Cleaning</li> </ol> <p><u>Carbon Steel (Magnetic) Cleaning Process (16'Lx5'Wx8'D</u></p> <ol style="list-style-type: none"> <li>1. Aqueous Degrease</li> <li>2. Rinse</li> <li>3. Mild Steel Pickle – Sulfuric Acid</li> <li>4. Rinse</li> <li>5. Iron Phosphate</li> <li>6. Rinse</li> <li>7. Hot Water Rinse</li> <li>8. Precision Cleaning</li> </ol>	<p><u>Mid-Strength 300 Series (Non-Magnetic) Stainless Steel</u></p> <ol style="list-style-type: none"> <li>1. Degrease</li> <li>2. DI Water Rinse</li> <li>3. Caustic cleaner</li> <li>4. DI Water Rinse</li> <li>5. Deoxidizer – if required</li> <li>6. DI Water Rinse</li> <li>7. Mild Alkaline</li> <li>8. DI Water Rinse</li> <li>9. Passivation -Nitric Acid</li> <li>10. Mild Alkaline</li> <li>11. DI Water Rinse</li> </ol> <p><u>Aluminum Cleaning Process</u></p> <ol style="list-style-type: none"> <li>1. Degrease</li> <li>2. DI Water Rinse</li> <li>3. Deoxidizer – if required</li> <li>4. DI Water Rinse</li> <li>5. Protective Coating-if required</li> <li>6. DI Water Rinse</li> </ol> <p><u>Carbon Steel (Magnetic) Cleaning Process</u></p> <ol style="list-style-type: none"> <li>1. Degrease</li> <li>2. DI Water Rinse</li> <li>3. Caustic cleaner</li> <li>4. DI Water Rinse</li> <li>5. Deoxidizer – if required</li> <li>6. DI Water Rinse</li> <li>7. Mild Alkaline</li> <li>8. DI Water Rinse</li> <li>7. Protective Coating</li> </ol>
Other	<ul style="list-style-type: none"> <li>• Very long lines</li> <li>• Large pressure vessels</li> </ul>	<p>DI water facility Large Hardware</p>	<ul style="list-style-type: none"> <li>• DI Water Plant</li> </ul>

## Documentation

	WSTF	MSFC	SSC
Surface Cleanliness	<p><b>SN-C-0005</b>, “Contamination Control Requirements for the Space Shuttle Program”</p> <p>JPR 5322.1, “Contamination Control Requirements Manual”</p>	<p><b>SN-C-0005</b>, “Contamination Control Requirements for the Space Shuttle Program”</p> <p><b>IEST-STD-CC1246</b>, “Product Cleanliness Levels and Contamination Control Program”</p>	<p><b>SSTD-8070-0089-FLUIDS</b>, “John C. Stennis Space Center Surface Cleanliness Requirements For SSC Fluid Systems”</p>
Center Procedures	<p><b>WJI-SVC-CSS-0092</b>, “General Component Precision Cleaning and Cleanliness Verification”</p> <p><b>WJI-SVC-CSS-0030</b>, “Precogning of Hardware, Components, and Assemblies to a Visibly Clean Level”</p> <p><b>WJI-SVC-CSS-0032</b>, “Final Cleaning and Cleanliness Verification of Hardware in the Class 100 Clean Room”</p>	<p><b>MSFC-SPEC-164</b>, “Cleanliness of components for use in Oxygen, Fuel, and Pneumatic Systems”</p> <p><b>MSFC-PROC-166</b>, “Hydraulic System Detailed Parts, Components, Assemblies, and Hydraulic Fluids for Space Vehicles, Cleaning, Testing, and Hauling”</p>	<p><b>STP-8810-0005</b>, “John C. Stennis Space Center Technical Procedure For Clean Line Cleaning”</p> <p><b>STP-8810-0019</b>, “John C. Stennis Space Center Technical Procedure For Cleaning Verification”</p>

**Table I. Classification of Cleanliness Levels Requirements**

A. Particulate Matter Contamination Levels			B. NVR Contamination Levels		C. Visible Contamination Levels	
Level	Particle Size Range (micrometer)	Maximum Number of Particles per 0.1 m <sup>2</sup> *	Level	Maximum Quantity of NVR (mg per 0.1m <sup>2</sup> )	Level	Definition
25	<5	Unlimited	A	1	<b>GC</b>	<b>Generally Clean.</b> Freedom from manufacturing residue, dirt, oil, grease, etc. The GC level should therefore be specified for hardware that is not sensitive to contamination and is easily cleaned or recleaned.
	5 to 15	19				
	>15 to 25	14				
	>25	0				
50	<15	Unlimited	B	2		
	15 to 25	17				
	>25 to 50	8				
	>50	0				
100	<25	Unlimited	C	3		
	25 to 50	68				
	>50 to 100	11				
	>100	0				
150	<50	Unlimited	D	4	<b>VC</b>	<b>Visibly Clean.</b> Free all particulate and nonparticulate matter visible to the normal unaided eye or corrected vision eye. This level is for hardware that requires removal of surface particulate and nonparticulate for operation; or hardware for which recleaning would be difficult and/or time-consuming.
	50 to 100	47				
	>100 to 150	5				
	>150	0				
200	<50	Unlimited	E	5		
	50 to 100	154				
	>100 to 200	16				
	>200	0				
250	<100	Unlimited	F	7		
	100 to 200	39				
	>200 to 250	3				
	>250	0				
300	<100	Unlimited	G	10		
	100 to 250	93				
	>250 to 300	3				
	>300	0				
500	<100	Unlimited	H	15	<b>VC+UV</b>	<b>Visibly Clean + Ultraviolet.</b> Visually clean and inspected with ultraviolet light. This level is usually specified for hardware that cannot tolerate buildup of hydrocarbons between uses or operations.
	100 to 250	1073				
	>250 to 500	27				
	>500	0				
750	<250	Unlimited	J	25		
	250 to 500	205				
	>500 to 750	9				
	>750	0				
1000	<500	Unlimited				
	500 to 750	34				
	>750 to 1000	5				
	>1000	0				

**\*No silting permitted**

("Process Specification for Cleaning of Hardware"/PRC-5001, Rev. E [JSC], page 20)

**Table 1: CLASSIFICATION OF CLEANLINESS**

CLASS	PARTICULATE LEVELS		NVR LEVELS	
	PARTICLE SIZE IN MICRONS	MAX. NUMBER PER 0.1 m <sup>2</sup>	LEVEL	MAXIMUM mg/0.1 m <sup>2</sup>
I	>2500	0	A	I
	700<X<2500	1		
	175<X<700	5		
II	NO SILTING		B	5
	>1000	0		
III	NO SILTING			
	>800	0		
IV	NO SILTING			
	>400	0		
V	VISUALLY CLEAN/NO SILTING			

**NOTE: For the purpose of this specification 0.1 square meter = 1 square foot.**

(Cleaning Specification MSFC-164-B)