POLLUTION PREVENTION
OPPORTUNITY NEEDS ASSESSMENT
FOR JOHN F. KENNEDY SPACE CENTER, FLORIDA

(Final Report)

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NASA ACQUISITION POLLUTION PREVENTION OFFICE

JOHN F. KENNEDY SPACE CENTER, FLORIDA 32899

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Acronyms and Abbreviations

AL	Alabama
ARF	Solid Rocket Booster Assembly and Refurbishment Facility
AP2	Acquisition Pollution Prevention
CA	California
CCAS	Cape Canaveral Air Station
CFC	Chlorofluorocarbon
cm	Centimeter
CNS	Canaveral National Seashore
CPPOT	Common Pollution Prevention Opportunities Table
CR/CA	Component Refurbishment/Chemical Analysis
DI	Deionized
DLA	Defense Logistics Agency
DoD	Department of Defense
DM	Demineralized
ELV	Expendable Launch Vehicle
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right to Know Act
ESTCP	Environmental Security Technology Certification Program
ET	External Tank
F	Fahrenheit
FC	Fluorocarbon
FL	Florida
FP	Flashpoint
FSM	Fuel Service Module
FSS	Fixed Service Structure
GN_2	Gaseous Nitrogen
GSA	Government Service Agency
GSE	Ground Support Equipment
HAP	Hazardous Air Pollutant
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFE	Hydrofluoroether
HID	High Intensity Discharge
HSDB	Hazardous Substance Data Bank
HVAC	Heating, Ventilation and Air Conditioning
HVLP	High Volume, Low Pressure
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System
ISS	International Space Station
JASPPA	Joint Acquisition Sustainment Pollution Prevention Activity
JBOSC	Joint Base Operations and Support Contract
JG-APP	Joint Group on Acquisition Pollution Prevention
JG-PP	Joint Group on Pollution Prevention
JLC	Joint Logistics Commanders
JTP	Joint Test Protocol
JTR	Joint Test Report
kg	Kilogram
KSC	Kennedy Space Center
LA	Louisiana
LE	Launch Equipment
MAF	Michoud Assembly Facility
MBMR	Mechanical Bench Machine Repair
MCC	Marshall Conversion Coating
MD	Maryland
MDI	4,4'-Methylenediphenyl Isocyanate

MEK	Methyl Ethyl Ketone
MINWR	Merritt Island National Wildlife Refuge
MLP	Mobile Launch Platform
MMH	Monomethylhydrazine
MO	Missouri
MSDS	Material Safety Data Sheet
NACE	National Association of Corrosi on Engineers
NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Evaluation
NFPA	National Fire Protection Association
NLM	National Library of Medicine
NSLD	NASA Shuttle Logistics Depot
NVR	Non-Volatile Residues
O&C	Operations and Checkout Building
ODS	Ozone Depleting Substance
OK	Oklahoma
OPF	Orbiter Processing Facility
OSHA	Occupational Safety and Health Administration
PAR	Potential Alternatives Report
P2	Pollution Prevention
PCB	Polychlorinated Biphenyl
PEL	Permissible Exposure Limit
PGOC	Payload Ground Operations Contract
POL	Petroleum, Oils, Lubricants
PPE	Personal Protective Equipment
PPONA	Pollution Prevention Opportunity Needs Assessment
PPOPT	Pollution Prevention Opportunity Prioritization Table
PRF	Parachute Refurbishment Facility
Psi	Pounds per Square Inch
RCRA	Resource Conservation and Recovery Act
RPSF	Rotation, Processing and Surge Facility
RSS	Rotating Service Structure
RTV	Room Temperature Vulcanization
SE	Support Equipment
SGS	Space Gateway Support
SRB	Solid Rocket Booster
SRM	Solid Rocket Motor
SSPC	Steel Structures Painting Council
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TOXNET	Toxicology Data Network
TPS	Thermal Protection System
TRI	Toxic Release Inventory
TVC	Thrust Vector Control
TVCD	Thrust Vector Control Deservicing
TWA	Time-Weighted Average
UPS	Uninterruptable Power Supply
USA	United Space Alliance
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USN	United States Navy
VAB	Vehicle Assembly Building
VOC	Volatile Organic Compond
WAD	Work Authorization Document

1.0 Introduction

1.1 Background

Pollution Prevention (P2) is the environmental policy of the United States as declared in the Pollution Prevention Act of 1990. As this strategy will suggest, P2 is a vehicle for reinventing traditional environmental programs and devising innovative alternative strategies to:

- Protect human health and the environment
- Reduce the federal government's risk of criminal and civil liability
- Yield savings by reducing raw material purchases and waste treatment and disposal costs
- Improve federal government's credibility and image regarding the environment

The United States Environmental Protection Agency (USEPA) equates P2 with source reduction and other practices that reduce or eliminate the creation of pollutants. Significant pollution prevention opportunities exist within the federal government.

In October 1998, the Joint Group on Pollution Prevention (JG-PP) was co-chartered by the Joint Logistics Commanders (JLC), the United States Armed Services, Defense Logistics Agency (DLA) and the National Aeronautics and Space Administration (NASA) to replace the former Joint Group on Acquisition Pollution Prevention (JG-APP). This endeavor was established to assist in validating, implementing and qualifying less hazardous materials and processes and to avoid duplication of efforts in reducing hazardous material procurements. In addition, JG-PP created the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA); a working group of working-level managers to direct program goals and execute pollution prevention (P2) projects. To successfully support JG-PP commitments, NASA established an Acquisition Pollution Prevention (AP2) Office. To achieve P2 goals of mutual interest and benefit to all NASA centers, the NASA AP2 Office will identify common P2 needs that affect manufacturing, maintenance and institutional processes. This approach shall encourage partnering, leverage limited resources, avoid duplication of effort and reduce total cost of process ownership.

The mechanism through which manufacturing and maintenance processes are described and analyzed to identify and integrate potential P2 opportunities is the *"Pollution Prevention Opportunity Needs Assessment (PPONA)".* The PPONA prepared for the John F. Kennedy Space Center (KSC) provides detailed process descriptions of pre and post launch operations, institutional procedures (e.g., metal finishing, painting, refurbishing, etc.), space vehicle maintenance and range/tracking facility activities. To assist KSC and other NASA Centers in achieving NASA P2 goals, the NASA AP2 Office has identified potential P2 opportunities and detailed previously implemented initiatives. The completion of this PPONA shall enable the NASA AP2 Office to identify and prioritize the implementation of potential P2 projects. This shall allow for more efficient planning and use of resources. After the identification of common P2 needs by NASA and joint DoD, the NASA AP2 Office and/or JG-PP shall present P2 projects to stakeholders. The initiation of P2 projects is based on the following six-phase JG-PP methodology:

- ***Phase I- Identification***- Participants and candidate hazardous materials and processes are identified and scoped for potential projects.
- ***Phase II-Technical***- Engineering performance requirements, test validation procedures and requirements, potential alternative materials or processes and candidate alternative testing is identified.
- ***Phase III- Business-*** Funding sources, alternative testing costs, testing contract vehicles and implementation agreements are identified.
- ***Phase IV-Alternative Demonstration/Validation***- Performance and documentation of required tests and analysis of results is conducted.

- ***Phase V-Single Process Initiative-*** A concept paper gaining approval for implementing acceptable alternative changes is submitted for contractual changes. The sharing of validated alternatives with acquisition and sustainment communities is also completed.
- ***Phase VI- Implementation-*** Implementation plan is submitted. The NASA AP2 Office shall be responsible for supporting the sharing of P2 concepts and procedures through technology transfer.

NASA AP2 and JG-PP participants can expect the following benefits to validating P2 alternatives:

- Increased focus on P2 dollars
- Reduced demonstration/validation costs
- Increased technical confidence
- Source reduction of hazardous materials or wastes by fostering partnerships
- Reduced hazardous material procurements by avoiding duplicative efforts
- Improved sharing of P2 solutions
- Accelerated implementation of qualified alternatives
- Consistent application of Agency policies

1.2 Summary of PPONA Findings

NASA and other federal agencies have emphasized the importance of implementing cost-effective waste reduction strategies. To assist KSC in implementing these strategies, the NASA AP2 Office has identified potential pollution prevention opportunities relating to resident processes. Implementation of identified opportunities will reduce hazardous waste generation, improve resource allocation, reduce environmental, safety and health costs and improve worker safety.

These pollution prevention opportunities were determined with the aid of a P2 questionnaire, subsequent process identification and facility assessments. Data analysis (of P2 questionnaires) and facility assessment findings revealed the following:

- One hundred-eighteen (118) processes at KSC use hazardous materials or generate hazardous waste
- Seventy percent (70%) of the identified processes required further investigation. Processes that required further investigation are described in Section 3.3.
- Sixty-six percent (66%) of the processes requiring further investigation were evaluated during facility assessments.
- Forty-eight pollution (48) prevention opportunities relating to resident processes were identified. A detailed description of each pollution prevention opportunity is provided in Section 3.1. Twenty-one of the forty-eight opportunities are duplicates. As a result, a sum total of twenty-seven different pollution prevention opportunities were identified at KSC.

The total percentage of waste generated from processes with identified pollution prevention opportunities was determined. Currently, six processes (with identified opportunities) generate approximately **73.27** percent of the sum total waste at KSC. Waste volumes reported below were obtained from the "*KSC Hazardous Waste Report*". Volumes reported are for the time period of October 1, 1998 through September 30, 1999. Waste volumes from processes with identified pollution prevention opportunities are provided in Table 7 found within Section 5.1. The following six processes generate approximately **73.27** percent of the waste:

1) ***Metal Finishing: Spray application of Alodine® (30.4 percent)-*** To ensure the adhesion of coatings, USA-SRB treats aluminum components (SRB sections and smaller SRB parts) with Alodine®. Approximately 105,622 pounds of Alodine® wastewater and other chromium solutions were generated. This is the largest waste stream (by volume) generated at KSC. A process description is provided on page 63.

2) ***Surface Preparation: Coating removal with blasting media (27.55 percent)-*** Prior to coating application, SGS Corrosion Control, USA Ground Operations, and USA-NSLD conduct surface preparation with pneumatic blasting media. Approximately 95,718 pounds of spent blast media was generated. This is the second largest waste stream (by volume) generated at KSC. Process descriptions are provided on pages 56, 75 and 84.
3) ***General Cleaning: Methyl Ethyl Ketone (6.14 percent)-*** USA Ground Operations, USA-SRB and Boeing Payload Ground Operations Contract (PGOC) use Methyl Ethyl Ketone (MEK) and/or other solvents to clean flight components and painting equipment. Approximately 21,331 pounds of spent solvents and contaminated debris were generated. Process descriptions are provided on pages 57, 65, 67, 75, 78, 80 and 85.
4) ***Fueling or Fuel De-servicing: Monomethylhydrazine (5.01 percent)-*** USA Ground Operations, USA-SRB and Boeing PGOC use monomethylhydrazine (MMH) as a fuel. Approximately 17,404 pounds of hydrazine-related wastes were generated from fueling and fuel de-servicing activities. Process descriptions are provided on pages 62, 67 and 77.
5) ***Testing: Monomethylhydrazine (4.17 percent*)**-** USA Ground Operations and USA-SRB and generated approximately 14,496 pounds of hydrazine-related waste from the testing activities. Process descriptions are provided on page 62.

Twenty-seven common pollution prevention opportunities were identified at KSC. To quantify common opportunities and improve the likelihood of project implementation, a *"Common Pollution Prevention Opportunities Table"* (CPPOT) was developed. The CPPOT is provided in Section 4.2. The completion of the CPPOT should aid in executing successful P2 programs at KSC. In addition, it is necessary to prioritize the implementation of potential P2 projects. To accomplish this goal, a *"Pollution Prevention Opportunity Prioritization Table"* (PPOPT) was developed. The PPOPT uses an objective scoring system to assign numerical values to process specific chemical constituents. When this scoring system is used, the material substitution of monomethylhydrazine is ranked as the number one priority at KSC. Other identified pollution prevention opportunities receiving high prioritization include the material substitution of Alodine® used in spray application and the implementation of a supplemental coating removal process to eliminate the generation of spent blast media. The PPOPT for all identified pollution prevention opportunities is provided in Section 5.2. Pollution prevention prioritization should allow for more efficient planning and use of resources.

Three processes with identified pollution prevention opportunities were found to generate no or negligible amounts of hazardous waste. However, they use ODSs and other hazardous constituents of significant importance. Hazardous constituents used in these processes include CFC-113, TCE and HCFC-141b. Due to a lack of waste generation, these processes were not included in the final prioritization table. Since CFC-113, TCE and HCFC-141b negatively impact the environmental, they should be considered for elimination and/or substitution.

With the identification of common P2 pollution prevention opportunities, resident process owners shall determine the feasibility of specific project implementation. It is projected that final project decisions shall be made approximately thirty days from the distribution of this report.

1.3 KSC Physical Description

KSC is the primary site for launching NASA space systems. Its location allows initial launch trajectories to be over the Atlantic Ocean away from populated areas. KSC, located approximately forty miles due east of Orlando, is on the north end of Merritt Island adjacent to Cape Canaveral. The geographic coordinates of the area are latitude 28^o 38' North and longitude 80^o 42' West. KSC is classified as a marine environment.

In early 1962, NASA began acquiring property to support the Manned Lunar Landing Program. Approximately 84,000 acres were purchased on Merritt Island in the northern Brevard County and the southernmost tip of Volusia County. In addition, approximately 56,000 acres of state-owned submerged land were negotiated with the State of Florida for exclusive rights dedicated to the United States.

Merritt Island contains prime habitat for unique and endangered wildlife. As a result, NASA entered into an agreement with the United States Fish and Wildlife Service (USFWS) to establish the Merritt Island National Wildlife Refuge (MINWR) within the boundaries of KSC. In addition, the majority of the Canaveral National Seashore (CNS) is part of the KSC. A very small part of KSC has been developed or designated for NASA operational and industrial use.

1.4 Climatic Conditions at KSC

KSC is located in a subtropical climate with hot, humid summers and short, mild winters. Summer weather begins in April and ends the beginning of January. Winter weather conditions occur January to March with no other recognizable seasons. Typical summer temperatures range from 70 ° F (at dawn) to the upper 80's and low 90's by late afternoon. Heavy localized afternoon thunderstorms with lightning are frequent through out the summer months. In addition, humidity is high year round with seasonal fluctuations less than the diurnal fluctuation of 30 percent. On a diurnal basis, humidy values range fro 50 to 65 percent during night and early morning hours to 80 to 95 percent during afternoon hours. Insolation values at KSC are high. Mean daily direct sunshine ranges from a maximum of 9.5 hours in April and May to a minimum of six hours in December.

1.5 Environmental Conditions and Corrosion

Since launch platforms, launch vehicles, Ground Support Equipment (GSE) and other structures are subject to high salt, high humidity and intense ultraviolet sunlight, environmental deterioration (corrosion) of materials is accelerated. Corrosion test results indicate that KSC has the highest corrosivity of any test site in the continental United States. Launch vehicle exhaust plumes, which are highly acidic, accelerate GSE and materials corrosion.

1.6 Mission Support Programs and Operations

KSC is the major NASA center for launch operations and programs relating to manned space missions. Comprehensive technological programs are required to support missions. The following activities has been developed to ensure proper support:

- Assembly, integration, inspection and preflight preparation of space vehicles and their payloads
- Design, development, validation, activation, operation and maintenance of GSE and supporting hardware
- Tracking and data acquisition
- Launch operations for reusable manned space shuttle vehicles
- Recovery and refurbishment of the Space Shuttle SRBs.
- Landing operations and refurbishment of the Space Shuttle Orbiter
- Logistics support for flight operations
- Design, construction, operation and maintenance of launch and industrial facilities

2.0 Assessment Methodology

2.1 Team Composition

The completion of a PPONA requires a team effort involving key personnel. The core P2 assessment team consisted of an Environmental Engineer and two Engineering Analysts from the NASA AP2 Office. Support personnel from the NASA AP2 Office included a Project Manager, Engineer, Pollution Prevention Specialist, Project Coordinator and Information Technologist. The core P2 Assessment Team was responsible for identifying processes and completing the PPONA.

2.2 Baseline Survey of Processes

On August 6, 1999, the NASA AP2 Office distributed a P2 Questionnaire to process owners partcipating in the KSC Environmental Working Group. The intent of the P2 Questionnaire was to identify processes that assist in completing a PPONA. The following tasks were completed during the baseline survey:

A. *Analysis of Questionnaire Responses*

1) Reviewed submittals to determine if questions were answered
2) If submittals were incomplete, contacted or met with process owners to discuss questionnaire
3) Developed an inventory of processes with potential environmental implications

The following organizations submitted P2 questionnaires:

- Allied Signal Tech Services Corporation
- The Boeing Company (PGOC)
- Canaveral National Seashore
- Dynacs Engineering
- Dynamac Corporation
- GSA Fleet Management Center
- Johnson Control, Inc.
- Merritt Island National Wildlife Refuge Maintenance Facility
- NASA (KSC Environmental Program Office)
- SGS Corrosion Control
- United Space Alliance (Ground Operations, NASA Shuttle Logistics Depot and Wiltech Corporation)
- United Space Alliance (SRB)

B. *Process Determination*

1) Conducted preliminary analysis of specific process data
2) Identified processes that use hazardous and non-hazardous materials/substances
3) Linked material usage and hazardous waste generation to a specific process
4) Contacted or met with process owners to clarify or obtain additional process information
5) Identified process owners with similar processes

C. *Development of Microsoft Access â Database*

1) Designed database to capture specific processes
2) Populated database with information obtained from questionnaires

2.3 Process Identification

In early September 1999, the NASA AP2 Office began analyzing data received from the questionnaire submittals. The purpose of the analysis was to identify processes that use hazardous chemicals with potential environmental implications. All industrial processes that used EPA's 17 high-risk "priority" chemicals and ODSs were given top priority for future evaluation and investigation. In addition, processes that used large volumes of TRI-reportable chemicals, generated hazardous waste or had the potential to be JG-PP projects were selected for assessment. After selecting processes that required further investigation, facility assessments were scheduled with the process owners:

- The Boeing Company (PGOC)
- SGS Corrosion Control
- United Space Alliance (Ground Operations)
- United Space Alliance (NASA Shuttle Logistics Depot)
- United Space Alliance (SRB)
- Wiltech Corporation

Note: The Pollution Prevention Opportunity Needs Assessment prepared for the John F. Kennedy Space Center only details manufacturing and maintenance processes that required further investigation.

2.4 Meetings and Facility Assessments

In late September 1999, the NASA AP2 Office initiated meetings with resident process owners to clarify and determine if identified processes required further investigation for pollution prevention opportunities. Following clarification and identification of selected candidate processes, the NASA AP2 Office scheduled real-time facility assessments. Facility assessments were conducted to evaluate selected processes and identify pollution prevention opportunities. Prior to conducting facility assessments at USA Ground Operations and Wiltech Corporation, facility orientations were provided to assessment team members on September 30 and October 1, 1999. The following meetings and facility assessments were conducted:

<u>Meetings</u>

1) September 21, 1999 - USA Ground Operations
2) September 21, 1999 - SGS Corrosion Control
3) November 19, 1999 - USA Ground Operations
4) December 20, 1999 - Wiltech Corporation

<u>Facility Assessments</u>

1) October 12 and 14, 1999 - USA-SRB
2) October 20 and 21, 1999 - Boeing PGOC
3) October 26, 1999 - SGS Corrosion Control
4) November 23, 1999 - NASA Supply Logistics Depot
5) December 2, 1999 - USA Ground Operations
6) December 2, 1999 - Wiltech Corporation

The following tasks were completed during each facility assessment:

A. Initial Orientation

1) Prior to a visual assessment of selected processes, met with process owners to discuss candidate processes

2) Discussed processes that use hazardous and non-hazardous materials/substances
3) Eliminated certain processes from visual assessment based on responses and candidate process criteria
4) Selected processes that required visual assessment
5) Discussed pollution prevention initiatives already implemented

B. Visual Assessment

1) Observed selected maintenance and manufacturing processes
2) Determined types of hazardous waste generated
3) Identified potential pollution prevention opportunities

C. Data Collection and Out-brief Meeting

1) Met with process owners to obtain the following data sources: MSDSs, hazardous waste disposal inventories, TRI reports, corporate hazardous waste procedures, hazardous waste reduction reports, manufacturing product specifications, NASA standards, pollution prevention plans, material usage data and other pertinent process information. Databases maintained by individual corporations were also obtained.
2) Discussed potential pollution prevention initiatives
3) Conducted out-brief meeting to discuss initial findings

Note: To ensure accurate data sets and factual reporting, the NASA AP2 Office contacted certain process owners to obtain additional information when clarification was required.

2.5 Principal Process Flow Diagrams

Principal process flow diagrams were developed to depict selected candidate processes in an orderly and logically systematic manner. They present a graphical representation of the dynamic and interrelated steps necessary to complete a physical process. Process flow diagrams provide a schematic illustration of candidate processes from origin to termination.

Each principal process flow diagram begins with a specific component, material or activity. This description represents the starting point of the process. Process diagrams flow logically from left to right. The starting point of each process is connected (with lines) to other intermediate steps of the process. Intermediate steps provide a specific process description and are depicted with diamond, rectangle or square-shaped figures. The ending point of each process provides the final product or activity. It is depicted with an oval-shaped figure. In addition, information regarding waste generation and PPE requirements is provided to supplement the process descriptions. Process flow diagrams are provided as Figures in Section 6.1 of the Appendix.

2.6 KSC Organization Elements

The John F. Kennedy Space Center is organized by a system of directorates. Each directorate is responsible for a particular operation at KSC. NASA contractors have departments that support one or more directorates. Process owners pertinent to this report belongs to one of the following directorates:

- PH (Shuttle Processing)
- LO (Logistics Operations)
- NN (Space Station and Shuttle Payloads)
- JP (Joint Performance Management Office)

Each directorate is responsible for the following activities:

Shuttle Processing (PH)

Shuttle Processing is responsible for the overall management, planning, technical direction and support (preflight, launch, landing and recovery activities) of Space Shuttle vehicles. USA Ground Operations, USA-SRB and Wiltech Corporation support this directorate.

Logistics Operations (LO)

Logistics Operations (LO) ensure that flight hardware, GSE, materials, commodities and associated planning are provided to support customer milestones. In addition, LO provides specialized laboratory facilities and develop expertise and methodologies to support hardware failure analysis, chemical and material analysis, precision cleaning and calibration. Other activities conducted by LO include the maintenance and enhancement of logistic processes and systems. The NASA Shuttle Logistics Depot supports this directorate.

Space Station and Shuttle Payloads (NN)

The Space Station and Shuttle Payloads directorate (NN) is responsible for the direction and management of preflight assembly, testing, checkout, documentation and integration of Shuttle payload elements, payload carriers and experiments. Other responsibilities include the management and preflight checkout of delegated expendable vehicles located at KSC and Vandenberg Air Force Base, CA. Boeing PGOC supports this directorate.

Joint Performance Management Office (JP)

Joint Performance Management Office (JP) provides contract management and administration for the Joint Base Operations and Support Contract (JBOSC). The JBOSC is a joint initiative between KSC and the 45th Space Wing located at Vandenberg Air Force Base. JP provides base operations, maintenance, development, engineering, construction activation, and support services. Space Gateway Support (SGS) supports this directorate through the JBOSC.

3.0 Processes

3.1 Pollution Prevention Opportunities

Executive Orders require NASA and other federal agencies to comply with environmental management, hazardous waste minimization and P2 requirements and programs. To assist process owners in achieving their P2 goals, the NASA AP2 Office has developed potential pollution prevention opportunities. These opportunities should reduce waste generation and hazardous material usage. The following pollution prevention opportunities have been identified:

Note: Pollution prevention opportunities or options may include:

- *Process Elimination*
- *Process Substitution*
- *Input Material Substitution*
- *Waste Reduction*
- *In-process Recycling/Reuse*
- *Out-process Recycling/Reuse*
- *Waste Segregation*
- *Equipment Layout and Automation*
- *Improved Maintenance and Housekeeping*
- *Improved Operational Procedures or Schedules*

3.1.1 Shuttle Processing (PH)

A. USA Ground Operations

i. Metal Finishing

USA Ground Operations generates Alodine® wastewater and unused Alodine®1200 from the dip application of small aluminum parts (flight hardware, camera mounts, camera cases, pipe brackets, equipment housings, casings, fittings and GSE). In addition, wipes and cotton swabs contaminated with Alodine® 1200 and pasa-jell are generated from touch-up procedures.

Pollution Prevention Opportunity

Input Material Substitution

Further investigation of a non-chromate conversion coating used in hand and dip applications is required. This substitution would eliminate the generation of chromium-bearing wastes generated from anodizing.

ii. Foam Application

To repair damage caused by transportation and subsequent handling, insulation foam containing HCFC-141b is applied to the External Tank. HCFC-141b, a class II ODS is used as a blowing agent.

Pollution Prevention Opportunity

Input Material Substitution

Since HCFC-141b cannot be manufactured or imported beyond 2003, material substitution of HCFC-141b with EPA-approved alternatives should be considered. This substitution requires a specification change. Michoud Assembly Facility requires the use of foam containing HCFC-141b. If appropriate, USA Ground Operations should consider submittting a specification change request.

iii. Sealing/ Adhesives

To prevent the over burning of fuel and flame blowout between solid rocket motors, a J-seal (asbestos donut) has been installed between the two cleaves plates of each solid rocket motor. To bond the J-seal to the cleaves plates, an adhesive containing 1,1,1 trichloroethane is used.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of 1,1,1 trichloroethane should be considered. This substitution would eliminate the generation of hazardous solids (contaminated with 1,1,1 trichloroethane). Material substitution may require a specification change. If a specification change is required, USA Ground Operations should consider submitting a specification change request.

iv. Coating Application

During stacking, SRBs (Forward Skirt, Aft Skirt and Solid Rocket Motors) are touched-up (by hand) with Hypalon® (contains tetracholorethylene). Approximately 40 pounds of Hypalon® are used a year. Solids contaminated with Hypalon® are considered hazardous waste.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of Hypalon® with a non-hazardous seal-coat should be considered. This substitution would eliminate the generation of hazardous solids (contaminated with Hypalon®) and excess Hypalon® paint. Material substitution may require a specification change. If a specification change is required, USA Ground Operations should consider submitting a specification change request.

v. Surface Preparation

Prior to flight, 1,1,1 trichloroethane is used to clean and dry the J-seal. Approximately one gallon of 1,1,1 trichloroethane is used a year.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of 1,1,1 trichloroethane should be considered. This substitution would eliminate the generation of hazardous solids (contaminated with 1,1,1 trichloroethane) and lead to an improved working environment for employees. Material substitution may require a specification change. If a specification change is required, USA Ground Operations should consider submitting a specification change request.

vi. Machining

Machining procedures use a limited amount of cutting fluids and oil lubricants. Hazardous chemicals used in machining include trichloroethylene (TCE), dichloromethane, tetrachloroethylene and HCFC-141b.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of hazardous chemicals used in machining would lead to an improved working environment for employees. If a specification change is required, USA Ground Operations should consider submitting a specification change request. In addition, the material substitution of HCFC-141b with ODS-free lubricants will assist USA Ground Operations in meeting corporate and KSC ODS reduction goals.

B. USA-SRB

i. Testing

Prior to flight, the TVC system is tested with hydrazine. USA-SRB generates hydrazine rinsates (generated from flushing fuel lines after hydrazine transfer) and contaminated hydrazine. In the first nine months of 1999, approximately 230 pounds of hydrazine rinsates and contaminated hydrazine were generated.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of hydrazine would eliminate the generation of hydrazine rinsates and contaminated hydrazine. In addition, eliminating hydrazine would reduce environmental, safety and health costs associated with its storage, handling and disposal. Material substitution would require a specification change and significant testing.

ii. Metal Finishing

USA-SRB generates Alodine® wastewater from the spray and dip application of SRB sections and smaller SRB components. In the first nine months of 1999, approximately 62,550 gallons of Alodine® wastewater and other chromium solutions were generated. In addition, USA-SRB generates hazardous wipes from the hand application of Alodine® or pasa-jell. Approximately 400 pounds of hazardous Alodine® wipes are generated a year.

Pollution Prevention Opportunity

Input Material Substitution

Further investigation of a non-chromate conversion coating used in spray, dip and hand applications is required. This substitution would eliminate the generation of chromium-bearing wastes generated from anodizing.

a. ***JG-PP Involvement***

- **Non-Chromate Conversion and Cadmium Alternatives**

On August 17, 1999, Robert Hill, JASSPA Chairman, presented projects (which benefit NASA and DoD) to members of the ESTCP Board. The purpose of the presentation was to obtain funding by demonstrating the benefits of each proposed project. The meeting was held in Patuxent River, MD. In November 1999, ESCTP decided to fund projects involving the non-chromate pretreatment, cadmium alternatives and the hand-held laser. On January 25 through 27, 2000, an "early customer interface" meeting was held at Kennedy Space Center, FL to discuss non-chromate conversion and cadmium alternatives.

iii. Coating Removal

After flight, the TPS and seal coat of the SRB is removed by hydralasing. In the first nine months of 1999, approximately 16,100 pounds of TPS debris were generated. TPS debris has been determined to be characteristically hazardous for tetrachloroethylene.

After flight, the protective coating (which contains cadmium, chromium or lead) on certain fasteners (spherical nuts, spherical bearings, parachute spools, rings, bolts and other critical fasteners) and shoes is removed by bead blasting. In the first nine months of 1999, approximately 6,330 pounds of spent bead blast was generated.

Pollution Prevention Opportunities

<u>*Input Material Substitution*</u>

To ensure that moisture does not compromise the TPS coat, USA-SRB uses Gacoflex Hypalon® HFR-2100 (Hypalon®) to seal the TPS coat. Hypalon® contains 74 % tetrachloroethylene by volume. Since TPS debris has been determined to be hazardous for tetrachloroethylene, the investigation of a non-hazardous seal coat should be considered. Material substitution may eliminate the generation of hazardous TPS debris.

Material substitution of metal-based protective coatings should be considered. This substitution would eliminate the generation of hazardous bead blast. If a specification change is required, USA-SRB should consider submitting a specification change request.

iv. Coating Application

After a TPS coat of Marshall Conversion Coating (MCC) is applied, a seal coat of Hypalon® is roll-applied to the TPS coat. Since Hypalon® contains 74 % tetrachloroethylene by volume, USA-SRB has determined (by process knowledge) that waste masking material, spent rollers, spent paint filters, other solid debris (contaminated with Hypalon®) and excess Hypalon® paint is hazardous waste. In the first nine months of 1999, approximately 2290 pounds of hazardous paint solids and 1550 pounds of Hypalon® paint waste were generated.

After Alodine® pretreatment, SRB sections and smaller SRB parts are painted (spray and touch-up) with Deft IS-248 primer. USA-SRB generates approximately 0.75 to 1.0 gallons of waste primer per kit (one kit is equal to three gallons) of mixed primer. Deft IS-248 is wasted due to a short pot life.

After the protective coating on certain fasteners and shoes is removed by bead blasting, Lube-lock (which contains lead and cadmium) is applied by spraying. In the first nine months of 1999, approximately 250 pounds of hazardous solids contaminated with lead and cadmium (spent paint filters and masking material) were generated. In June 1999, USA-SRB switched from using Lube-lock to lead-free Booster-lube. On October 13, 1999, USA-SRB ceased using Booster-lube due to it separating prior to application. Currently, Lube-lock is being used.

Pollution Prevention Opportunities

Input Material Substitution

Material substitution of Hypalon® with a non-hazardous seal-coat should be considered. This substitution would eliminate the generation of hazardous solids (contaminated with Hypalon®) and excess Hypalon® paint. Material substitution may require a specification change. If a specification change is required, USA-SRB should consider submitting a specification change request.

If practicable, material substitution of Deft IS-248 with a primer with a longer pot life could eliminate the generation of unusable primer. Material substitution may require a specification change. If a specification change is required, USA-SRB should consider submitting a specification change request.

Material substitution of Lube-lock should be considered. This substitution would eliminate the generation of hazardous solids contaminated with lead and cadmium. USA-SRB is currently investigating why Booster-lube separates prior to application. USA-SRB hopes to revert back to using Booster-Lube once the problem has been solved.

v. Precision Cleaning

Prior to installation in the Aft Skirt, pipes and hoses must undergo precision cleaning. USA-SRB generates spent trisodium phosphate, spent Turco 3878 LF and waste isopropanol from precision cleaning procedues. Spent trisodium phosphate and spent Turco 3878 LF are non-hazardous. Waste isopropanol is managed as hazardous waste. In the first nine months of 1999, approximately 3,750 pounds of isopropanol was generated from flushing fuel lines (Thrust Vector Control De-servicing) and precision cleaning procedures.

Pollution Prevention Opportunities

In-Process Recycling/Reuse

Isopropanol is a relatively benign solvent when compared to other solvents. However, waste isopropanol is classified as a hazardous waste due to its low flash point. To reduce the volume of hazardous waste generated, solvent reclamation should be considered.

******USA Ground Operations recently purchased a molecular sieve to regenerate isopropanol. In the future, waste isopropanol generated by USA-SRB will be regenerated with the molecular sieve. Regenerated isopropanol has a purity of 99.9 percent.

vi. Sealing/ Adhesives

Certain SRB fasteners are sealed for corrosion protection with chromium-based PR-1422. USA-SRB has switched to chromium-free PR-870 for sealing applications that do not require PR-1422. In the first nine months of 1999, approximately 1,100 pounds of PR-1422 waste (spatulas, gloves and wipes) was generated.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of PR-1422 would eliminate the generation of hazardous solids contaminated with chromium. Material substitution of PR-1422 may require a specification change. If a specification change is required, USA-SRB should consider submitting a specification change request.

vii. General Cleaning

USA-SRB generates hazardous rags (contaminated with MEK) from wipedowns of SRB hardware. In the first nine months of 1999, approximately 215 pounds of hazardous rags were generated.

Pollution Prevention Opportunities

Input Material Substitution

Material substitution of MEK would eliminate the generation of hazardous rags contaminated with MEK. USA-SRB is in the process of substituting MEK with DS-104, a non-hazardous solvent.

Out-Process Recycling/Reuse

If practicable, require the use of reusable rags. The laundering of rags contaminated with MEK would reduce waste disposal costs.

C. Wiltech Corporation

i. Component Refurbishment

Wiltech performs high purity cleaning of ground support and flight hardware. The vast majority of flight and certain ground support hardware require solvent cleaning and verification with CFC-113.

Prior to installation, ground support and flight equipment requires precision cleaning. Wiltech generates approximately 1000 gallons of waste isopropanol a year from precision cleaning procedures. Currently, waste isopropanol is shipped off-site for disposal.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of CFC-113 with Vertrel® and HFE-7100 would eliminate or reduce ODS usage. Currently, Wiltech is working to implement the use of Vertrel® and HFE-7100. A specification change has been submitted. Wiltech is awaiting final approval to implement the material substitution of CFC-113.

In-Process Recycling/Reuse

Isopropanol is a relatively benign solvent when compared to other solvents. However, waste isopropanol is classified as a hazardous waste due to its low flash point. To reduce the volume of hazardous waste generated, solvent reclamation should be considered.

******USA Ground Operations recently purchased a molecular sieve to regenerate isopropanol. In the future, waste isopropanol generated by Wiltech will be regenerated with the molecular sieve. Regenerated isopropanol has a purity of 99.9 percent.

3.1.2 Logistics Operations (LO)

A. <u>USA-NASA Shuttle Logistics Depot</u>

i. Metal Finishing

USA-NSLD generates waste Alodine®1200S from the dip application of small aluminum parts (flight hardware). In addition, wipes and cotton swabs contaminated with Alodine® 1200S and pasa-jell are generated from touch-up procedures.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Further investigation of a non-chromate conversion coating used in dip and hand applications is required. This substitution would eliminate the generation of chromium-bearing wastes generated from anodizing.

ii. Foam Application

To ensure adequate thermal and shock protection, a pre-mixed insulation foam containing HCFC-141b is applied to valve assemblies and engines. HCFC-141b, a class II ODS is used as a blowing agent.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Since HCFC-141b cannot be manufactured or imported beyond 2003, material substitution of HCFC-141b with EPA-approved alternatives should be considered. This substitution requires a specification change. If appropriate, USA-NSLD should consider submittting a specification change request.

iii. Precision Cleaning

USA-NSLD performs high purity cleaning of oxygen lines, fuel lines, reservoirs and equipment. These components require solvent cleaning and verification with CFC-113.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Material substitution of CFC-113 with Vertrel® and HFE-7100 would eliminate or reduce ODS usage. Currently, USA-NSLD is working to implement the use of Vertrel® and HFE-7100. A specification change has been submitted. USA-NSLD is awaiting final approval to implement the material substitution of CFC-113.

iv. Coating Application

USA-NSLD generates excess paint, spent paint filters contaminated with chromium, waste masking material, spent rollers and brushes, contaminated rags and other hazardous solid debris from the application of coatings. These wastes are characteristically hazardous for chromium. Government or customer specifications may require the use of certain coatings.

Pollution Prevention Opportunities

Input Material Substitution

Material substitutions of coatings that contain chromium would eliminate the generation of hazardous solid debris. A coating system free of chromium may require a specification change. If a specification change is required, USA-NSLD should consider submitting a specification change request.

Out-Process Recycling/Reuse

If practicable, the laundering of hazardous rags contaminated with solvents would reduce hazardous waste generation.

v. Surface Preparation

Prior to coating application, certain spots of flight hardware (aluminum, stainless steel and plastic) are stripped with Miller Stevenson-171 (contains dichloromethane) or McGean-Rocoh CEEBE 228-D epoxy stripper. To complete coating removal, the substrate is wiped down with rags. Currently, USA-NSLD use five gallons of Miller Stevenson-171 and two quarts of McGean-Rocoh CEEBE 228-D epoxy stripper a year.

Surface preparation is also conducted within a blast cabinet using an abrasive blast media. USA-NSLD generates spent media blast contaminated with lead and chromium.

Pollution Prevention Opportunities

Process Substitution

USA-NSLD should investigate a new coating removal technology. This substitution will eliminate the use of dichloromethane and could reduce the generation of hazardous waste.

Input Material Substitution

Material substitution of metal-based coatings would eliminate the generation of hazardous media blast and reduce hazardous waste disposal costs. A coating system free of chromium and lead may require a specification change. If a specification change is required, USA-NSLD should consider submitting a specification change request.

Material substitution of dichloromethane would eliminate the generation of hazardous rags contaminated with dichloromethane. If a specification change is required, USA-NSLD should consider submitting a specification change request.

vi. Cable Fabrication

USA-NSLD fabricates electrical cables used in flight hardware. Cable fabrication involves the use of Tetra-etch® to ensure the bonding of Teflon®-coated cables. Small volumes of waste Tetra-etch® are generated from cable fabrication.

Pollution Prevention Opportunities

Input Material Substitution

If practicable, material substitution of Teflon®-coated cables with non-Teflon® coated cables could eliminate the use of Tetra-etch®. In addition, the material substitution of certain hazardous chemicals used in cable fabrication and repair could eliminate the generation of contaminated rags.

Material substitution of Tetra-etch® with a potting material that adheres to Teflon® would eliminate the use of Tetra-etch®. This substitution may require a specification change. If a specification change is required, USA-NSLD should consider submitting a specification change request.

vii. General Cleaning

USA-NSLD generates ripple cloths (contaminated with MEK) from the physical wipedown of Orbiter components. In addition, waste MEK and hazardous solid debris (contaminated with MEK) is generated from equipment cleaning. Government or customer specifications may require the use of MEK.

Pollution Prevention Opportunities

Input Material Substitution

Material substitution of MEK would eliminate the generation of hazardous ripple cloths contaminated with MEK. If a specification change is required, USA-NSLD should consider submitting a specification change request.

Material substitution of MEK would eliminate the generation of hazardous solid debris. If a specification change is required, USA-NSLD should consider submitting a specification change request.

Out-Process Recycling/Reuse

If practicable, the laundering of ripple cloths contaminated with MEK would reduce hazardous waste generation.

viii. Printed Circuit Board Repair

USA-NSLD occasionally repairs printed circuit boards. Contaminated rags are generated from repair procedures.

Pollution Prevention Opportunity

Out-Process Recycling/Reuse

If practicable, the laundering of hazardous rags contaminated with solvents would reduce hazardous waste generation.

3.1.3 Space Station and Shuttle Payloads (NN)

A. <u>BOEING PGOC</u>

i. Fueling

Hypergolic fueling of payloads generates rinsates (hydrazine, alcohol and oxidizer), hydrazine solids (contaminated absorbent materials and Tyvek® suits) and oxidizer solids. Approximately 550 gallons of rinsates were generated in 1998.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Material substitution of hydrazine would eliminate the generation of hydrazine rinsates and solids. In addition, eliminating hydrazine would reduce environmental, safety and health costs associated with its storage, handling and disposal. Material substitution of hydrazine requires a specification change and qualification. If appropriate, Boeing PGOC should consider submitting a specification change request.

a. *<u>JG-PP Involvement</u>*

- **Hypergolic Fuel Alternatives**

On February 2, 2000, an "early customer interface" meeting was held at Redstone Arsenal, AL to discuss hypergolic fuel alternatives (hypergolic azides). JG-PP is interested in replacing hydrazine and monomethylhydrazine (MMH) used in liquid gas generators and propellant systems. The estimated cost of using hydrazine is over $1 million annually.

ii. Metal Finishing

Boeing PGOC generates hazardous Alodine® wipes from the hand application of Alodine®. Approximately 220 gallons of hazardous wipes were generated in 1998.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Further investigation of a non-chromate conversion coating used in hand application is required. This substitution would eliminate the generation of hazardous Alodine® wipes generated from Alodine® anodizing.

iii. Precision Cleaning

Boeing PGOC performs high purity cleaning of gauges used in facility, GSE and payload operations. Currently, gauges are flushed with trichloroethylene (TCE). Small volumes of waste TCE are generated.

Pollution Prevention Opportunity

<u>Input Material Substitution</u>

Material substitution of TCE with HFE-7100 has been implemented. Boeing PGOC will permanently replace TCE if HFE-7100 is determined to be an acceptable substitute.

a. *JG-PP Involvement*

- **CFC-113 Replacement**

Aircraft oxygen lines, reservoirs, and equipment require frequent cleaning due to contamination from organic compounds. Current procedures for cleaning contaminated oxygen lines involve removing every line and component and cleaning each individual part. In many cases, oxygen lines are cleaned with alcohol, water-soluble solutions and CFC-113. To eliminate or reduce CFC-113 usage and the man-hours associated with oxygen line cleaning, NASA, USAF and USN are interested in a developing an ODS, HAP and VOC-free oxygen line cleaning system. This system will be used to clean onboard systems and in-shop components.

Currently, a Joint Test Protocol (JTP) is being developed. On April 18, 2000, a demonstration of the software/hardware (that operates the upgraded oxygen line cleaning system) will be held at Tinker Air Force Base, OK. The demonstration will occur on a full-scale mock-up of a B-1B oxygen line system. Preliminary estimates indicate that an entire B-1B oxygen system can be cleaned for approximately $2500. This includes materials, labor and travel. Other benefits and impacts of this project are the following:

- Eliminates CFC-113 use for oxygen line cleaning
- Reduces man-hours associated with oxygen line cleaning
- Documents NASA/joint service oxygen cleanliness standards
- Cleaning system is fully transportable and self-contained
- HFE 7100, HFE 301 and FC-72 appear to be likely alternatives

A final review of the JTP will also occur on April 18, 2000.

iv. Surface Preparation
Coating Application

Boeing PGOC facilities and GSE maintenance painting generates solid debris contaminated with TCLP metals (barium, cadmium, chromium and lead). Approximately 530 gallons of solid debris contaminated with TCLP metals were generated in 1998. Government or customer specifications require the use of certain hazardous materials.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of metal-based coatings would eliminate the generation of hazardous solid debris contaminated with TCLP metals and reduce hazardous waste disposal costs. A coating system free of TCLP metals may require a specification change. If a specification change is required, Boeing PGOC should consider submitting a specification change request.

v. Surface Preparation
General Cleaning

Boeing PGOC facilities and GSE maintenance painting generates hazardous rags (contaminated with MEK), paint stripper and debris, waste paint and MEK/paint rinsate. Approximately 134 gallons of hazardous rags contaminated with MEK were generated in 1998. Government or customer specifications require the use of certain hazardous materials.

Boeing PGOC generates hazardous rags (contaminated with MEK) from wipedowns of payload hardware, GSE and assigned clean room areas. Approximately 104 gallons of hazardous rags (contaminated with MEK) were generated in 1998. The use of MEK on payloads is a customer driven specification.

Pollution Prevention Opportunities

Input Material Substitution

Material substitution of MEK would eliminate the generation of hazardous rags contaminated with MEK. If a specification change is required, Boeing PGOC should consider submitting a specification change request.

a. *JG-PP Involvement*

- Hazardous rags

Other parties interested in eliminating the generation of rags contaminated with MEK include:

- NASA/Michoud Assembly Facility, New Orleans, LA
- NASA/Jet Propulsion Laboratories, Pasadena, CA
- NASA/Rocketdyne Propulsion and Power, Conoga Park, CA
- NASA/Boeing, Palmdale, CA
- United States Navy
- United States Air Force

A proposal and cost estimate to study the tri-service magnitude of any compliance problems with MEK hand wiping (JASPPA.Q.99.10.14) will be submitted to JASPPA. The proposal and cost estimate will include the status of alternative technologies and existing studies. After the study is completed, JASPPA will make a decision on whether to pursue the project.

Out-Process Recycling/Reuse

If practicable, the laundering of hazardous rags contaminated with MEK would reduce hazardous waste generation.

vi. Cable Fabrication

Boeing PGOC generates rags (contaminated with oil and solvents) from cable fabrication and repair procedures. Approximately 60 gallons of rags (contaminated with oil and solvents) were generated in 1998. Hazardous Tetra-etch® is used to improve the bonding of Teflon®-coated cables.

Pollution Prevention Opportunities

Input Material Substitution

If practicable, material substitution of Teflon®-coated cables with non-Teflon® coated cables could eliminate the use of Tetra-etch®. In addition, the material substitution of certain hazardous chemicals used in cable fabrication and repair could eliminate the generation of contaminated rags.

Material substitution of Tetra-etch® with a potting material that adheres to Teflon® would eliminate the use of Tetra-etch®. This substitution may require a specification change. If a specification change is required, Boeing PGOC should consider submitting a specification change request.

Out-Process Recycling/Reuse

If practicable, the laundering of hazardous rags contaminated with oil and solvents would reduce waste disposal costs.

vii. Machining

Boeing PGOC generates oily rags and used industrial oil from GSE and payload operations. Approximately 179 gallons of oily rags were generated in 1998. Hazardous chemicals that contain 1,1,1 trichloroethane and tetrachloroethylene are used in machining.

Pollution Prevention Opportunities

Input Material Substitution

Material substitution of hazardous chemicals used in machining would lead to an improved working environment for employees. If a specification change is required, Boeing PCOG should consider submitting a specification change request.

Out-Process Recycling/Reuse

If practicable, the laundering of oily rags would reduce waste disposal costs.

viii. Inventory Control

Boeing PGOC generates various volumes of off-specification and/or out-of-shelf life materials from payload, facility, GSE and maintenance operations. Approximately 215 gallons of hazardous lab-packed materials, 111 gallons of flammable adhesives and 160 gallons of other off-specification and/or out-of-shelf life materials were generated in 1998.

Pollution Prevention Opportunity

Waste Reduction

The creation of a hazardous materials pharmacy for Boeing PGOC activities could reduce the generation and disposal of off-specification or out-of-shelf life materials. In addition, a hazardous materials pharmacy would eliminate chemical storage (on the floor), reduce safety issues relating to hazardous material storage and eliminate TRI reporting requirements.

ix. Payload Assembly Sealing/Adhesives

Boeing PGOC generates waste epoxies and adhesives from payload assembly, facility and GSE repair activities. Epoxies and sealants used for payload assembly are specification driven and supplied by the payload customer. Approximately 60 gallons of flammable adhesives were generated in 1998.

Pollution Prevention Opportunity

Input Material Substitution

Material substitution of current adhesives with non-hazardous adhesives would reduce or eliminate the generation of hazardous waste. If appropriate, Boeing PCOG should consider submitting a specification change request. In addition, the creation of a list with approved non-hazardous adhesive substitutes should be considered.

x. Vehicle and Equipment Maintenance

Boeing PGOC generates oily rags from vehicle and equipment maintenance activities. Approximately 506 gallons of oily rags were generated in 1998.

Pollution Prevention Opportunity

Out-Process Recycling/Reuse

If practicable, the laundering of oily rags would reduce waste disposal costs

xi. Printed Circuit Board Manufacturing

Boeing PGOC occasionally fabricates and repairs printed circuit boards. Small amounts of acids and bases are generated.

Pollution Prevention Opportunity

Process Elimination

Boeing PGOC has decided to cease manufacturing printed circuit boards. Printed circuit boards used in future payloads, GSE and facility operations will be manufactured by outside vendors. As a result, wastes generated from manufacturing will be eliminated. Boeing PGOC will continue to repair printed circuit boards.

3.1.4 Joint Performance Management Office (JP)

A. <u>SGS Corrosion Control</u>

i. Coating Application

SGS Corrosion Control generates waste masking material, spent rollers, contaminated PPE, hazardous rags, Kraft paper (used to capture overspray) and other hazardous solid debris from the application of coatings. These wastes are characteristically hazardous for arsenic, barium, cadmium, chromium, lead, selenium, 1,2-dichloroethane, 1-1-dichloroethylene, MEK, tetrachloroethylene and TCE. In the first nine months of 1999, twenty-six 55-gallon drums of hazardous solid debris were generated. Materials used in corrosion control procedures are specification or customer driven.

SGS Corrosion Control generates waste solvents (xylene, toluene, MEK or mineral spirits) from cleaning spray guns used in spray application. In the first nine months of 1999, eight 55-gallon drums of waste solvents were generated.

Pollution Prevention Opportunities

<u>Input Material Substitution</u>

Material substitutions of coatings that contain TCLP constituents would eliminate the generation of hazardous solid debris. A coating system free of TCLP constituents may require a specification change. If a specification change is required, the customer requiring the hazardous chemical should consider submitting a specification change request.

a. ***<u>JG-PP Involvement</u>***

- **Non-Chromate Primers**

The Boeing Company Aircraft and Missiles pilot site in Saint Louis, MO expressed an interest in reducing or eliminating chromium-based primer coatings. Chromium-based primers are applied (by spraying) to aircraft exterior mold line skins. A JTP and Joint Test Report (JTR) have been delivered. Flight-testing on the F-15 will be completed by February 2000. Flight testing on the C-17 will occur in early 2000. The benefits and impacts of this project are the following:

- Reduces volatile organic compound (VOC) emissions by 60 percent
- Allows a manufacturing cost avoidance of greater than $250,000
- Eliminates worker exposure to chromium
- Reduces the generation of hazardous waste
- Affects six weapon systems (all services)
- Allows a depot cost avoidance of approximately $31.3 million over twenty years

In addition, Eric Eichinger of Boeing Reusable Space Systems, Huntington Beach, CA was interested in replacing their current chromium-based primer. During his research, he learned about the JG-PP B-A&M Non-chromate Primers Project and became interested in the feasibility of using the non-chrome alternative for demonstration on the Orbiter Columbia. After performing four extended tests required for Orbiter space flight, the technical confidence in migrating JG-PP's laboratory and field tests was sufficient to convince the Engineering Review Board of the demonstration.

Fifteen of the thirty Elevon Cove Seals were chosen for field testing of the non-chrome primer. These seals, also known as flipper doors, will be installed on the Orbiter Columbia by April 2000. The Orbiter Columbia will be launched after September 2000. The flipper doors will be inspected after each launch to compare the corrosion resistance of the candidate primer to the current primer. The immediate benefit to NASA is a $750,000 cost avoidance from migrating already accomplished engineering and laboratory testing.

Another area in which a non-chromate alternative may be used is on the propulsion module of the International Space Station (ISS). Marshall Space Flight Center is currently conducting out-gas testing of the non-chromate alternative. If the alternative passes, it will be used on the propulsion modules currently being designed.

- **Low/No VOC and Non-chromate Coating System for Support Equipment (SE)**

NASA and DoD use powered and non-powered SE in broad mission profiles. Powered SE includes, but is not limited to, portable/mobile generators, air compressors, hydraulic service units, air conditioners, ground heaters, light carts, gas turbine service equipment, universal maintenance stands, and self-propelled bomb lifts. Non-powered SE includes, but is not limited to, maintenance stands, tow bars, oxygen or nitrogen servicing carts and jacks. Primers and topcoats that contain chromium, lead and Hazardous Air Pollutants (HAPs) are applied (by spraying) to SE. A JTP was completed in November 1999. Laboratory testing will occur in April 2000. The benefits and impacts of this project are the following:

- Reduces VOC and HAPs emissions
- Eliminates worker exposure to chromium
- Reduces the generation of hazardous waste
- Affects all services
- Allows a single primer and topcoat system for NASA and DoD
- Compliance relief for depot and field activities

- **Low-VOC Identification Marking**

The Lockheed Martin Electronics and Missiles Company and Information Systems Company (Lockheed Martin) pilot site in Orlando, FL expressed an interest in reducing or eliminating MEK and toluene found in epoxy resin-based inks. These inks are used to stencil or stamp mechanical hardware and electronic components. A JTP and Potential Alternatives Report (PAR) has been completed. Testing started in February 1999. The project involves shifting from conventional epoxy stencil inks and paints to automated self-adhesives labels or low VOC inks. Raytheon Systems is also ready to test and implement. The benefits and impacts of this project are the following:

- Reduces VOC emissions (1,300 pounds per year)
- Reduces the generation of hazardous waste (9,800 pounds per year)
- Affects four depots and two Lockheed Martin facilities
- Allows a cost avoidance of approximately $1 million per year at all six facilities

Equipment Layout and Automation

To improve the transfer efficiency of coatings being sprayed, SGS Corrosion Control expressed an interest in purchasing additional High Volume, Low Pressure (HVLP) spray guns. Improved transfer efficiency reduces the amount of paint overspray coming in contact with solids.

******Zinc-rich coatings have been determined to be too viscous for use in HVLP spray guns.

In-Process Recycling/Reuse

To reduce virgin solvent usage and hazardous waste disposal costs, SGS Corrosion Control has expressed an interest in purchasing solvent reclamation units. Spent solvents generated from equipment cleaning are disposed of as hazardous waste. Solvent reclamation and reuse will reduce the generation of hazardous waste.

Waste Reduction

To reduce the volume of solvents used in equipment cleaning, SGS Corrosion Control has expressed an interest in purchasing paint gun washers. Currently, SGS Corrosion Control uses virgin solvent for each cleaning application. The use of paint gun washers will reduce virgin solvent usage and hazardous waste disposal costs.

SGS Corrosion Control has expressed an interest in purchasing a computerized paint mixing and dispensing system. This system will precisely mix and dispense color specific paints. As a result, excess and unused paints will not be generated. In addition, computerized paint mixing will eliminate the ordering of color specific paints.

ii. Surface Preparation

SGS Corrosion Control generates spent media blast (plastic, star blast and steel grit) from coating removal procedures. In the first nine months of 1999, two hundred and one 55-gallon drums of spent media blast were generated. In September 1999, SGS Corrosion Control decided to begin recycling spent plastic blast media. SGS Corrosion control will continue generating spent star blast and steel grit contaminated with TCLP metals.

Pollution Prevention Opportunity

Process Substitution

SGS Corrosion Control should continue investigating a new coating removal technology. SGS is considering a supplemental coating removal process that uses a stripping gel. This substitution will eliminate the generation of spent blast media (plastic and steel).

a. *JG-PP Involvement*

- **Supplemental Coating Removal-Hand Held Laser**

Aircraft and missiles systems components require coating removal and repainting. Currently, coating removal is accomplished with hazardous chemical strippers or blast media. To eliminate and reduce waste chemical strippers (MEK and dichloromethane) and dry blast media (plastic and wheat starch) used in current coating removal processes, NASA and DoD are interested in a Class I hand-held laser system.

Currently, a JTP and PAR are under development. The project will evaluate the performance of the candidate portable laser coating removal system for qualification as a supplemental coating removal process. A meeting to discuss the JTP and PAR will be held in March 2000. The JTP will be completed in April 2000 with laboratory testing beginning in May 2000. The laser system will focus on small, irregular-shaped and hard to reach surfaces. The benefits and impacts of this project are the following:

- Eliminates or reduces hazardous material usage
- Reduces the generation of hazardous waste
- Eliminates VOC emissions
- Laser system is portable and hand-held
- Laser system strips substrates that currently cannot be done with conventional methods
- Improves worker safety and reduces labor costs
- Paint residue is sole waste product

Other Technologies

- **Pulse Optical Energy Coating Removal- FLASHJET** â

Another technology capable of eliminating and reducing hazardous chemical stripping and blast media is The Boeing Company FLASHJET® coatings removal process. This process uses a pulsed optical energy system to selectively remove topcoats without damaging underlying primers. The FLASHJET® coatings removal process is beginning to gain acceptance within DoD. In November 1998, Naval Air Station-Kingsville installed a FLASHJET® system for the Navy's T-45 program. There are intentions to install the FLASHJET® system at Army, Air Force and Naval installations.

Other parties interested in The Boeing Company FLASHJET® coatings removal process:

- USA-SRB, Kennedy Space Center, FL
- NASA Shuttle Logistics Depot, Cape Canaveral, FL

3.2 Pollution Prevention Opportunity Benefits

The NASA AP2 Office has developed a list of realized benefits relating to identified pollution prevention opportunities. Implementation of identified pollution prevention opportunities may contribute to:

- *Reduced environmental, safety and health costs*
- *Reduced or elimination of hazardous waste disposal costs*
- *Cost avoidance of purchasing materials*
- *Regulatory relief from applicable regulations*
- *Reduced manufacturing and maintenance costs*
- *Improved working environment for employees*
- *Reduced air emissions*
- *Assists in meeting hazardous material reduction goals*

The forementioned benefits may assist process owners in the decision to implement identified pollution prevention opportunities. The list of benefits provided is not comprehensive. Other benefits exist and should be investigated.

3.2.1 Shuttle Processing (PH)

A. <u>USA Ground Operations</u>

i. Metal Finishing

<u>Pollution Prevention Opportunities</u>

Input Material Substitution

- Material substitution of Alodine® 1200 used in the dip application of small aluminum parts (flight hardware, camera mounts, camera cases, pipe brackets, equipment housings, casings, fittings and GSE) with a non-chromate conversion coating

- Material substitution of pasa-jell used in touch-up procedures with a non-chromate conversion coating

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Reduces environmental, safety and health costs associated with the storage, handling and disposal of unused Alodine® 1200, Alodine® 1200 waste waters and contaminated wipes/cotton swaps
4) Cost avoidance of purchasing Alodine® 1200 and pasa-jell
5) Reduces manufacturing and maintenance costs
6) Improves working environment for employees
7) Reduces chromium emissions

ii. Foam Application

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of insulation foam that contain HCFC-141b with EPA-approved alternatives

<u>Opportunity Benefits</u>

1) Eliminates ODS emissions
2) Regulatory relief from OSHA and EPCRA
3) Improves working environment for employees
4) Reduces manufacturing and maintenance costs
5) Assists USA Ground Operations in meeting corporate ODS reduction goals

iii. Sealing/ Adhesives Surface Preparation

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of 1,1,1 trichloroethane used in J-seal bonding, cleaning and drying with non-regulated materials

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of 1,1,1 trichloroethane
3) Eliminates generation of hazardous solids contaminated with 1,1,1 trichloroethane
4) Regulatory relief from RCRA, OSHA and EPCRA
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs
7) Reduces VOC emissions

iv. Coating Application

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of Hypalon® (contains tetrachloroethylene) with a non-regulated seal-coat

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of Hypalon®
3) Eliminates generation of excess Hypalon® and hazardous solids contaminated with Hypalon®
4) Regulatory relief from RCRA, OSHA and EPCRA
5) Reduces VOC emissions
6) Improves working environment for employees
7) Reduces manufacturing and maintenance costs

v. Machining

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of hazardous chemicals used in machining with non-regulated materials

Opportunity Benefits

1) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous cutting fluids and oil lubricants
2) Eliminates generation of hazardous rags contaminated with TCE, dichloromethane and tetrachloroethylene
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Improves working environment for employees
5) Assists USA Ground Operations in meeting corporate ODS reduction goals

B. USA-SRB

i. Testing

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of hydrazine used in TVC system testing with hypergolic azides

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of hydrazine rinsates and contaminated hydrazine
4) Reduces air emissions from hydrazine-based systems
5) Cost avoidance of purchasing hydrazine
6) Improves working environment for employees

ii. Metal Finishing

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of Alodine® 1200 used in spray, dip and hand applications of SRB sections and smaller SRB components with a non-chromate conversion coating
- Material substitution of pasa-jell used in hand application with a non-chromate conversion coating

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA

3) Reduces environmental, safety and health costs associated with the storage of Alodine® 1200 and the handling and disposal of Alodine® 1200 waste waters and contaminated wipes
4) Cost avoidance of purchasing Alodine® 1200 and pasa-jell
5) Reduces manufacturing and maintenance costs
6) Improves working environment for employees
7) Reduces chromium emissions

iii. Coating Removal

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of Gacoflex Hypalon® HFR-2100 (contains tetrachloroethylene) with non-regulated materials
- Material substitution of TCLP metal-based coatings used on fasteners and shoes with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of TPS debris (contaminated with tetrachloroethylene) and hazardous solid debris contaminated with TCLP metals
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC and other air emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

iv. Coating Application

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of Gacoflex Hypalon® HFR-2100 (contains tetrachloroethylene) with a non-regulated seal coat
- Material substitution of TCLP metal-based coatings used on SRB fasteners and shoes with non-regulated materials
- Material substitution of Deft IS-248 primer with materials with a longer pot life

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste Gacoflex Hypalon® HFR-2100, waste Deft IS-248 and hazardous solids contaminated with lead and cadmium
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC, lead and cadmium emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

v. Precision Cleaning

Pollution Prevention Opportunity

In-Process Recycling/Reuse

- Solvent reclamation of waste isopropanol

** Waste isopropanol will be regenerated with a molecular sieve

Opportunity Benefits

1) Reduces hazardous waste disposal costs
2) Cost avoidance of purchasing isopropanol
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste isopropanol
4) Molecular sieve regenerates isopropanol to a purity of 99.9 percent
5) Regulatory relief from RCRA, OSHA and EPCRA
6) Reduces EPCRA reporting and RCRA regulatory requirements
7) Reduces manufacturing and maintenance costs

vi. Sealing/Adhesives

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of chromium-based PR-1422 with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage and handling of PR-1422 and disposal of PR-1422 waste (spatulas, gloves and wipes)
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces chromium and other air emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

vii. General Cleaning

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of MEK (used to wipedown SRB hardware) with non-regulated chemicals

Out Process Recycling/ Reuse

- Laundering of hazardous rags

Opportunity Benefits

1) Eliminates hazardous or solid waste disposal costs

2) Cost avoidance of purchasing new rags
3) Reduces environmental, safety and health costs associated with storage and handling of MEK and disposal of rags contaminated with MEK
4) Regulatory relief from RCRA, OSHA and EPCRA
5) Improves working environment for employees

C. Wiltech Corporation

i. Component Refurbishment

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of CFC-113 with Vertrel® or HFE-7100

Opportunity Benefits

1) Eliminates use and future solvent reclamation of CFC-113
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Eliminates ODS emissions
4) Improves working environment for employees
5) Reduces manufacturing and maintenance costs
6) Assists Wiltech in meeting corporate ODS reduction goals

Pollution Prevention Opportunity

In-Process Recycling/Reuse

- Solvent reclamation of waste isopropanol

** Waste isopropanol will be regenerated with a molecular sieve

Opportunity Benefits

1) Reduces hazardous waste disposal costs
2) Cost avoidance of purchasing isopropanol
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste isopropanol
4) Molecular sieve regenerates isopropanol to a purity of 99.9 percent
5) Regulatory relief from RCRA, OSHA and EPCRA
6) Reduces EPCRA reporting and RCRA regulatory requirements
7) Reduces manufacturing and maintenance costs

3.2.2 Logistics Operations (LO)

A. <u>USA-NASA Shuttle Logistics Depot</u>

i. Metal Finishing

<u>Pollution Prevention Opportunities</u>

Input Material Substitution

- Material substitution of Alodine® 1200S used in the dip application of small aluminum parts (flight hardware) with a non-chromate conversion coating

- Material substitution of Alodine® 1200S and pasa-jell used in touch-up procedures with a non-chromate conversion coating

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Reduces environmental, safety and health costs associated with the storage, handling and disposal of Alodine® 1200S and contaminated wipes/cotton swabs
4) Cost avoidance of purchasing Alodine® 1200S and pasa-gell
5) Reduces manufacturing and maintenance costs
6) Improves working environment for employees
7) Reduces chromium emissions

ii. Foam Application

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of insulation foam that contain HCFC-141b with EPA-approved alternatives

<u>Opportunity Benefits</u>

1) Eliminates ODS emissions
2) Regulatory relief from OSHA and EPCRA
3) Improves working environment for employees
4) Reduces manufacturing and maintenance costs
5) Assists USA-NSLD in meeting corporate ODS reduction goals

iii. Precision Cleaning

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of CFC-113 with Vertrel® or HFE-7100

<u>Opportunity Benefits</u>

1) Eliminates use and future solvent reclamation of CFC-113

2) Regulatory relief from RCRA, OSHA and EPCRA
3) Eliminates ODS emissions
4) Improves working environment for employees
5) Reduces manufacturing and maintenance costs
6) Assists USA-NSLD in meeting corporate ODS reduction goals

iv. Coating Application

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of chromium-based coatings used on flight hardware with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous debris contaminated with chromium
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces chromium emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

v. Surface Preparation

Pollution Prevention Opportunities

Process Substitution

- Implementation of a new coating removal technology with a process that reduces or eliminates hazardous waste generation

Input Material Substitution

- Material substitution of TCLP metal-based coatings used on flight hardware with non-regulated materials
- Material substitution of dichloromethane used in coating removal with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous debris (contaminated with dichloromethane, lead and chromium)
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC, lead and chromium emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

vi. Cable Fabrication

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of Teflon®-coated cables with non-Teflon®-coated cables
- Material substitution of Tetra-etch® with a potting material that adheres to Teflon®

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste Tetra-etch®
3) Reduces manufacturing and maintenance costs
4) Cost avoidance of purchasing Teflon®-coated cables and Tetra-etch®
5) Regulatory relief from OSHA and EPCRA
6) Improves working environment for employees
7) Eliminates VOC emissions

vii. General Cleaning

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of MEK (used in physical wipedowns and equipment cleaning) with non-regulated chemicals

Out Process Recycling/ Reuse

- Laundering of hazardous rags

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Cost avoidance of purchasing new rags
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste MEK and hazardous solid debris (contaminated with MEK)
4) Regulatory relief from RCRA, OSHA and EPCRA
5) Improves working environment for employees
6) Reduces VOC emissions
7) Reduces manufacturing and maintenance costs

viii. Coating Application
Cable Fabrication
Printed Circuit Board Repair

Pollution Prevention Opportunity

Out-Process Recycling/Reuse

- Laundering of hazardous rags

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Cost avoidance of purchasing new rags
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of contaminated rags

3.2.3 Space Station and Shuttle Payloads (NN)

A. <u>Boeing PGOC</u>

i. Fueling

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of hydrazine with hypergolic azides

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of rinsates, hydrazine solids and oxidizer solids
4) Reduces air emissions from hydrazine-based systems
5) Cost avoidance of purchasing hydrazine
6) Improves working environment for employees

ii. Metal Finishing

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of Alodine®1200 used in hand application with a non-chromate conversion coating

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Reduces environmental, safety and health costs associated with the storage of Alodine® 1200 and handling and disposal of hazardous Alodine® wipes
4) Cost avoidance of purchasing Alodine® 1200
5) Improves working environment for employees

iii. Precision Cleaning

<u>Pollution Prevention Opportunity</u>

Input Material Substitution

- Material substitution of TCE used in high purity gauge cleaning with HFE-7100

<u>Opportunity Benefits</u>

1) Reduces environmental, safety and health costs associated with storage and handling of TCE
2) Regulatory relief from RCRA, OSHA and EPCRA
3) Eliminates TCE emissions

4) Improves working environment for employees

iv. Surface Preparation Coating Application

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of TCLP metal-based coatings used in facility and GSE maintenance painting with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous solid debris contaminated with TCLP metals (barium, cadmium, chromium and lead)
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC and metals emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

v. Surface Preparation General Cleaning Machining

Pollution Prevention Opportunities

Input Material Substitution

- Material substitution of MEK used in facility and GSE maintenance painting with non-regulated materials
- Material substitution of hazardous chemicals used in machining with non-regulated materials

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of MEK and hazardous chemicals
3) Eliminates generation of hazardous rags contaminated with MEK and other hazardous chemicals
4) Regulatory relief from RCRA, OSHA and EPCRA
5) Improves working environment for employees

vi. Cable Fabrication

Pollution Prevention Opportunity

Input Material Substitution

- Material substitution of Teflon®-coated cables with non-Teflon®-coated cables
- Material substitution of Tetra-etch® with a potting material that adheres to Teflon®

Opportunity Benefits

1) Eliminates hazardous waste disposal costs

2) Reduces environmental, safety and health costs associated with storage, handling and disposal of waste Tetra-etch®
3) Reduces manufacturing and maintenance costs
4) Cost avoidance of purchasing Teflon®-coated cables and Tetra-etch®
5) Regulatory relief from OSHA and EPCRA
6) Improves working environment for employees
7) Eliminates VOC emissions

vii. Inventory Control

Pollution Prevention Opportunity

Waste Reduction

- Creation of a hazardous materials pharmacy

Opportunity Benefits

1) Reduces the generation of off-specification or out-of-shelf life materials
2) Regulatory relief from RCRA and OSHA
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous materials
4) Reduces EPCRA reporting requirements
5) Improves working environment for employees

viii. Surface Preparation
General Cleaning
Coating Application
Cable Fabrication
Machining
Vehicle/Equipment Maintenance

Pollution Prevention Opportunity

Out Process Recycling/ Reuse

- Laundering of hazardous or oily rags

Opportunity Benefits

1) Eliminates hazardous or solid waste disposal costs
2) Cost avoidance of purchasing new rags
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of contaminated rags

Opportunity benefits relating to printed circuit board manufacturing, payload assembly and sealing/adhesives can not be determined. Pollution prevention opportunity benefits were identified to assist Boeing PGOC with meeting their pollution prevention goals.

3.2.4 Joint Performance Management Office (JP)

A. <u>SGS Corrosion Control</u>

i. Coating Application

<u>Pollution Prevention Opportunities</u>

Input Material Substitution

- Material substitution of coatings that contain TCLP constituents with non-regulated materials

<u>Opportunity Benefits</u>

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous solid debris contaminated with TCLP constituents
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC and metals emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

Equipment Layout and Automation

- Installation of HVLP paint guns

<u>Opportunity Benefits</u>

1) Reduces hazardous waste generation and disposal costs
2) Improves working environment for employees
3) Improves transfer efficiency during coating application
4) Reduces manufacturing and maintenance costs
5) Reduces VOC emissions
6) Reduces RCRA regulatory requirements

In-Process Recycling/Reuse

- Solvent reclamation

<u>Opportunity Benefits</u>

1) Reduces hazardous waste disposal costs
2) Cost avoidance of purchasing virgin solvents
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of spent solvents
4) Reduces RCRA regulatory requirements
5) Reduces manufacturing costs
6) Assists SGS Corrosion Control in meeting corporate waste reduction goals

Waste Reduction

- Installation of paint gun washers
- Installation of computerized paint mixing and dispensing system

Opportunity Benefits

1) Reduces hazardous waste disposal costs
2) Cost avoidance of purchasing virgin solvents and paints
3) Reduces environmental, safety and health costs associated with storage, handling and disposal of spent solvents
4) Eliminates generation of excess and unused paints
5) Reduces RCRA regulatory requirements
6) Eliminates the ordering of color specific paints
7) Reduces manufacturing and maintenance costs
8) Assists SGS Corrosion Control in meeting corporate waste reduction goals

ii. Surface Preparation

Pollution Prevention Opportunities

Process Substitution

- Implementation of a new coating removal technology with a process that reduces or eliminates hazardous waste generation

Opportunity Benefits

1) Eliminates hazardous waste disposal costs
2) Reduces environmental, safety and health costs associated with storage, handling and disposal of hazardous debris contaminated with TCLP constituents
3) Regulatory relief from RCRA, OSHA and EPCRA
4) Reduces VOC, lead and chromium emissions
5) Improves working environment for employees
6) Reduces manufacturing and maintenance costs

3.3 Process Descriptions

Process descriptions detail processes or operations conducted at the John F. Kennedy Space Center. Each process is provided in sequential order and describes the steps involved, materials used and waste or products produced. In some cases, process locations and current pollution prevention initiatives are provided. Process descriptions are intended to assist resident KSC process owners with identifying potential P2 opportunities. The following processes or operations are conducted at KSC:

3.3.1 Shuttle Processing (PH)

A. USA Ground Operations

United Space Alliance (USA) is contracted to manage the operation and maintenance of multi-purpose space and ground systems. Work performed by USA includes the implementation of NASA's Space Shuttle and Space Station programs. Areas of responsibility relating to these programs include mission design and planning, ground and flight operations, payload integration, integrated logistics, launch and recovery, astronaut and flight controller training and vehicle processing. USA Ground Operations performs the following processes:

i. Corrosion Prevention

Target Product or Constituent: ***Zinc-Rich Epoxy Primer***

Structures that require corrosion prevention include the Rotating Service Structure (RSS), Fixed Service Structure (FSS), liquid oxygen tanks, liquid hydrogen tanks, sound suppression system, Mobile Launch Platforms (MLPs), water towers and the Demate/Mate facility. Corrosion prevention is conducted every five to seven years for structures located in close proximity of the ocean and every seven to ten years for structures not located in close proximity of the ocean. Zinc-rich epoxy primer is the primary coating utilized.

Surface Preparation

Target Product or Constituent: ***TCLP metals and Spent Blast Media***

To ensure the success of a particular coating, surface preparation is essential. Surface preparation of steel structures and tanks may involve wet or abrasive blasting. Blast procedures are driven by SSPC SP 5-89 (White Metal Blast Cleaning) and SSPC SP 10-89 (Near-White Blast Cleaning). Surface preparation is dependent on the age and condition of the coating. Ninety-five percent of all blast procedures are accomplished with Black Beauty (abrasive blast media). However, MLPs and other structures at KSC have been or may be wet-blasted. To prevent fugitive emissions from abrasive blasting procedures, tarpaulins are placed around the structure being blasted. In addition, tarpaulins are placed on the ground to ensure easy collection of spent blast media. Prior to disposal, spent blast media and paint solids are analyzed for TCLP metals. Contaminated debris determined to be non-hazardous is placed in twenty-yard roll-off boxes and disposed of on-site. Black Beauty is non-recyclable since it shatters upon impact with steel. Older structures coated with TCLP-based coatings have been determined to be characteristically hazardous. Spent blast media and paint solids determined to be non-hazardous are collected and disposed of on-site. Abrasive blasting procedures are routinely conducted at KSC.

ii. Coating Application

Spray Painting

Target Product or Constituent: ***Zinc-Rich Epoxy Primer and Waste Solvents***

After surface preparation is completed, a coating system is applied by spraying. In early December 1999, SDB Engineering and Construction, Inc. completed corrosion prevention at the Mate/Demate facility. It is believed that this facility has never undergone corrosion prevention. This job required the use of approximately 150 to 200 gallons of zinc-rich epoxy primer. Approximately 5,000 gallons of zinc-rich epoxy primer and polyurethane are spray-applied annually.

Small aluminum parts undergo coating application (by spraying) within the Launch Equipment (LE) Paint Shop (Building K-6 1397). Spent paint filters were reported to be non-hazardous and are disposed of to the dumpster.

Waste solvents (xylene, toluene and MEK) generated from cleaning spray guns (used in spray application) are sent to USA Ground Operations' Mod Management for solvent reclamation. Since the implementation of solvent reclamation, approximately 200 gallons of waste solvents are generated annually. Prior to solvent reclamation, USA Ground Operations generated approximately 4000 gallons of waste solvents a year. In addition, the use of two-part polyurethanes has reduced the generation of waste solvents. Rags contaminated with solvents are collected and laundered.

Coating Application (Brush/Roll Painting)

Target Product or Constituent: ***Zinc-Rich Epoxy Primer, Toluene, MEK, Xylene, TCLP metals, 1,1,1 Trichloroethane and Tetrachloroethylene***

Since some corrosion prevention procedures can not be completed by spray application, MLPs and other structures undergo brush or roll painting. Coatings used include zinc-rich epoxy primers (1,100 gallons a year), polyurethane topcoats or coatings that contain MEK, xylene, toluene, barium, chromium and 1,1,1 trichloroethane. Toluene, xylene and MEK are used to thin coatings, adhesives and sealants. The majority of brush or roll painting procedures involve the maintenance or repair of MLPs.

During stacking, SRBs (Forward Skirt, Aft Skirt and SRMs) are touched-up with Hypalon® (contains tetrachloroethylene). Approximately 40 pounds of Hypalon® are used annually.

Miscellaneous

Target Product or Constituent: ***TCLP metals and Spent Blast Media***

Prior to corrosion prevention of small metal parts, USA Ground Operations conducts surface preparation. Surface preparation is conducted within a blast cabinet using an abrasive blast media. Approximately 20 gallons of spent blast media is generated annually from blasting cabinets located at the NASA Shuttle Logistics Depot (NSLD), LE paint shop, crawler shop and heavy equipment shops.

iii. Metal Finishing

Target Product or Constituent: ***Chromic Acid***

Behind LE Paint Shop (Building K-6 1397)

To improve corrosion prevention and to ensure coating adhesion, small aluminum parts (flight hardware, camera mounts, camera cases, pipe brackets, equipment housings, casings, fittings and GSE) are treated with Alodine® 1200. Alodine® anodizing is accomplished within four 250-gallon tanks. Prior to the application of Alodine® 1200, newly fabricated parts are cleaned in a nitric/phosphoric acid solution and rinsed with deionized water. After the deionized water rinse, parts are treated with Alodine® 1200. A deionized water rinse completes the dip application process. To minimize worker exposure, stainless steel baskets are used to remove parts from the dip tanks. All four tanks are disposed of once a year as a characteristic hazardous waste. Prior to use, Alodine® 1200 is analyzed to determine its specification. If it meets the desired specification, it is used to pretreat aluminum.

Mod Management Field Operations

Within the field, various flight items, structural GSE and aluminum field welding operations are anodized. Anodizing is conducted by hand applying/touching up (with wipes) aluminum with pasa-jell. Wipes contaminated with pasa-jell are neutralized and kept in aqueous solution to prevent spontaneous combustion.

Orbiter Processing Facility (OPF)

Alodine® 1200 and pasa-jell is used to touch-up aluminum components during orbiter processing. Anodizing is conducted by hand applying Alodine® 1200 or pasa-jell with wipes or cotton swabs. Contaminated wipes and cotton swabs are managed as a hazardous waste.

Miscellaneous

Prior to launch, pasa-jell is used to touch-up certain SRB components. Pasa-jell is hand applied (with wipes) on the launch pad.

iv. Foam Application

Vechicle Assembly Building (VAB) and Launch Pads

Target Product or Constituent: ***HCFC-141b and 4,4'-Methylenediphenyl Isocyanate***

To ensure that the liquid fuel system is maintained within mandated temperature ranges, the External Tank (ET) is insulated with foam. All major ET foam applications are conducted at the Michoud Assembly Facility (MAF) in New Orleans, LA. Due to damage caused by transportation and subsequent handling, ET foam is applied (by spraying) prior to flight. Foam application is accomplished within the VAB (Baker Tower and enclosed highbays) and the launch pads. Depending on flight schedule, approximately eight ETs are repaired a year.

Insulation foam (Isofoam SS-1171) consists of a two-part product (Part A and B). Part A contains 4,4'-Methylenediphenyl Isocyanate (MDI), resins and 1,1-dichloro-1-fluroethane (HCFC-141b). Part B contains HCFC-141b. Parts A and B are mixed within a spray gun prior to application. Approximately three to five gallons of foam are used per application. In addition, USA Ground Operations occasionally uses another type of insulation foam to repair smaller areas where spray application is not feasible. This foam contains HFC-134a and does not require mixing. Specifications regarding foam application were established by MAF.

Prior to flight, USA Ground Operations applies insulation foam around the actuator arms, trailing edges of the external rings and motor segments of the Aft Skirt. Foam application occurs on the launch pad.

Rotation, Processing and Surge Facility (Building K6-494)

Target Product or Constituent: ***HFC-134a and Silicone Rubber***

The Rotation, Processing and Surge Facility (RPSF) is responsible for SRB processing. Prior to flight, insulation foam is applied (by spraying) to the following Aft Skirt components: Aft motor stiffener rings, external trailing edge and internal attach ring. Insulation foam is used to reinforce pre-treated areas and to protect components during splashdown.

Insulation foam (Instafoam® 802) consists of a two-part product (Part A and B). Part B contains HFC-134a. Parts A and B are mixed within a spray gun prior to application. In addition, a silicon black rubber foam (used as vapor barrier) is applied to the internal ring of the Aft Skirt.

Facilities Maintenance

Target Product or Constituent: ***MDI***

To secure wiring and seal spaces, an aerosol sealant (Instafoam®) is applied by spraying. USA Ground Operations uses approximately 20 gallons (two-hundred cans) of Instafoam® a year. Insulation foam contains thirty percent MDI by volume.

v. Sealing/Adhesives

Target Product or Constituent: ***1,1,1 Trichloroethane***

To prevent the over burning of fuel and flame blowout between solid rocket motors, a j-seal (asbestos donut) has been installed between the two cleaves plates of each solid rocket motor. To bond the j-seal to the cleaves plates, an adhesive containing 1,1,1 trichloroethane is used. Approximately 40 quarts of adhesive are used a year.

To eliminate the use of 1,1,1 trichloroethane, USA Ground Operations used a water-based adhesive for one flight. This substitution was not successful due to the adhesive burning the j-Seal. USA Ground Operations reverted back to using the original adhesive.

vi. Surface Preparation

Target Product or Constituent: ***1,1,1 Trichloroethane***

Prior to flight, 1,1,1 trichloroethane is used to brush-clean and dry the j-seal. Approximately one gallon of 1,1,1 trichloroethane is used a year.

vii. General Cleaning

Target Product or Constituent: ***Terpenes, Citrus Cleaner and Vertrel*** *â*

The Mechanical Bench Machine Repair Shop (MBMR) within the VAB cleans and maintains orbiter tire rims. Prior to flight, tire rims are cleaned by removing carbon-carbon dust. Cleaning procedures consist of hand wiping tire rims with soap and hot water. After the initial soap and hot water wipedown, a terpene-based solution or citrus cleaner is applied by spraying. To complete the cleaning process, isopropanol is applied to remove terpene/citrus and adhesive residues. Terpene and citrus cleaners have replaced the use of MEK and dichloromethane. Rags contaminated with isopropanol and oily residues are collected and laundered. To eliminate wastes generated from wheel bearing maintenance, new bearings are purchased.

To ensure cleanliness, Orbiter, SRB and other components are physically wiped down. Physical wipedowns consist of hand wiping or scrubbing components with mops or brushes. Due to F-listed solvent usage and contamination with lead-based greases, wiping procedures generated large volumes of hazardous waste. To eliminate hazardous waste generation, USA Ground Operations began using terpenes and Vertrel®. Approximately 100,000 gallons of terpenes are used annually to clean SRB sections. The largest wiping operation occurs within Hangar AF on the CCAS. Vertrel® is primarily used at USA Ground Operations' Main Engine Shop. 1,1,1 trichloroethane and tetrachloroethylene were previously used for wiping procedures.

viii. Refrigeration

Direct Support Refrigeration-VAB

Target Product or Constituent: ***HCFC-124 and CFC-22***

USA Ground Operations is responsible for the direct support refrigeration of the Orbiter's purge air and coolant systems. Direct support refrigeration processing includes the recovery, consolidation and reuse of ODSs and the de-servicing of ODS cylinders. The VAB handles refrigeration activities for the OPF and Pads 1 and 2. ODSs used at the VAB include HCFC-124 and CFC-22. USA Ground Operations recently substituted CFC-114 with CFC-124. Malfunctions, leaking gaskets, bad valves and other equipment failures result in a loss of approximately 1,000 pounds of ODSs a year. USA Ground Operations has implemented an ODS tracking system for auditing purposes.

ix. Machining

Target Product or Constituent: ***TCE, 1,1,1 Trichloroethane, Dichloromethane, Tetrachloroethylene and HCFC-141b***

Machining procedures use a limited amount of cutting fluids and oil lubricants. USA Ground Operations uses the following cutting fluids and oil lubricants:

Product	Contents	Annual Usage
Slide Cutting Fluid	10 % TCE	Forty quarts
Rapid Tap	80 % 1,1,1 trichloroethane	Stock depleted
Coating TFE	50 % dichloromethane and 20 % tetrachloroethylene	One can
Lubribond 220	75 % dichloromethane	Six cans
Lubricant	95 % HCFC-141b	Unknown

Cutting fluids that contain 1,1,1 trichloroethane will be eliminated by attrition and replaced with vegetable oil. Currently, USA Ground Operations has two hundred cans of slide cutting oil, ninety-five 16 ounce cans of HCFC-141b lubricant and fifteen cans of Lubribond 220 in stock. USA Ground Operations is currently phasing out all cutting fluids and oil lubricants that have hazardous constituents.

x. Acid Electrolyte

Crawler, Generator and Heavy Equipment Shops

Target Product or Constituent: ***Sulfuric Acid***

Spent lead-acid batteries of all sizes are rejuvenated with sulfuric acid. Approximately 150 gallons of sulfuric acid is used a year. Once a battery can no longer be rejuvenated, it is shipped off-site for recycling.

xi. Printed Circuit Board Repair

Target Product or Constituent: ***Lead Solder***

USA Ground Operations occasionally repairs printed circuit boards. Repair procedures consist of surface preparation, etching, soldering and layering of boards. All lead solder is recycled. Due to the small scale of this operation, etching solutions are never changed out. USA Ground Operations has outsourced printed circuit board fabrication to outside vendors since 1992.

xii. Resins

Target Product or Constituent: ***Potting Compound and Resins***

Two-part polymers and/or resins are used for potting or molding electronic components. USA Ground Operations uses approximately 110 gallons of potting compound (for insulation) and less than one gallon of Scotch Cast 4407 molding compound (for cosmetic purposes) a year. Wastes generated from potting and molding include contaminated rags and excess resins. Solvents are not used.

Non-destructive evaluation requires resins for mold impression work. Resins are purchased in dental kits. Approximately three to twenty kits are used a year.

B. USA-SRB

USA-SRB is contracted to integrate the Space Shuttle SRBs and to assemble, test, refurbish, re-certify and evaluate the non-motor segments of the SRB. Processes performed by USA-SRB involve precision robotic application, removal and reapplication of multi-layered protective coatings and insulation. USA-SRB also evaluates, services and installs electrical, mechanical and hydraulic systems. USA-SRB performs the following processes:

i. Testing

Target Product or Constituent: ***Monomethylhydrazine and Rinsates***

TVC Testing-Aft Skirt Test Facility

Prior to flight, the TVC system is tested with hydrazine to ensure that there is no loss of hydraulic pressure. TVC testing is accomplished at the Aft Skirt Test Facility (Building L7-251). After testing, approximately two gallons of unused hydrazine is generated. Unused hydrazine is stored within two 200-gallon tanks or two 100-gallon tanks located on-site. Hydrazine used in TVC testing is analyzed for moisture content and reused for future testing (if it meets specification). Hydrazine rinsate (generated from flushing lines after hydrazine transfer) and contaminated hydrazine is disposed of as a characteristic hazardous waste. Approximately 230 pounds of hydrazine rinsate and contaminated hydrazine were generated in the first nine months of 1999.

Flushing Fuel Lines of TVC System- Aft Skirt Test Facility

Target Product or Constituent: ***Monomethylhydrazine and Isopropanol***

After the TVC system has been tested with hydrazine, unused hydrazine is removed and the lines are flushed with water and isopropanol. Isopropanol is used to remove moisture and decontaminate the fuel lines. In the first nine months of 1999, approximately 750 pounds of waste isopropanol and hydrazine were generated from flushing fuel lines of the TVC System.

Non-Destructive Evaluation (NDE) of SRB Hardware

Target Product or Constituent: ***Nitric Acid and Sodium Hydroxide***

USA-SRB performs routine non-destructive evaluation of SRB hardware. Prior to testing and evaluation, SRB hardware is etched with a nitric acid or sodium hydroxide solution. After etching, SRB hardware is visually examined for defects. In the first nine months of 1999, USA-SRB generated approximately 87 pounds of waste sodium hydroxide solution. Waste nitric acid is also generated. NDE activities are accomplished within Hangar N of the CCAS.

ii. Fuel De-servicing

Flushing Fuel Lines of SRB Hardware-Thrust Vector Control De-servicing

Target Product or Constituent: ***Monomethylhydrazine and Isopropanol***

After flight, the TVC system of the Aft Skirt is taken out of service. De-servicing of the TVC involves removing approximately two gallons of unused hydrazine and flushing the lines with water and isopropanol. Isopropanol is used to remove moisture and decontaminate the fuel lines. In the first nine months of 1999, approximately 3,750 pounds of waste isopropanol was generated from flushing fuel lines (TVCD) and precision cleaning procedures. Unused hydrazine is analyzed for moisture content and reused if it meets specification. TVCD is accomplished within CCAS Building 66249.

iii. Metal Finishing

Target Product or Constituent: ***Chromic Acid***

To ensure the success of a particular coating, proper surface preparation is essential. Surface preparation may involve the application of a conversion coating to improve adhesion, corrosion resistance and thermal compatibility. To ensure the adhesion of coatings, USA-SRB treats aluminum components (SRB sections and smaller SRB parts) with Alodine®. Alodine® is applied by spray, dip or hand application.

Metal finishing is accomplished within two separate buildings on the CCAS. SRB sections (Aft, Forward and Cone sections) and larger components are sprayed within CCAS Building 66310. On average, spraying procedures are conducted one or twice per calendar month. Twenty to thirty SRB sections are sprayed a year. Smaller SRB components are dipped within Building 66250. Thousands of smaller components are dipped a year.

Spray Application

Prior to the spray application of Alodine®, SRB sections and larger aluminum components are hydralased with a detergent (Turco 4215 NC-LT). Detergent wash water is directed to a drain (designated for the detergent wash water) and collected with a 3000-gallon tank. Prior to disposal to the sewer system, wastewater from detergent washing is analyzed. If the wastewater is determined to be within discharge limits, it is discharged to the sewer system as an industrial wastewater. After the detergent wash, Alodine® 1200 is applied (via spraying) to SRB sections and larger aluminum components. To prevent over conversion of the aluminum substrate, Alodine® is thoroughly rinsed off with water from a garden hose. Each individual operator determines the amount of wastewater generated from rinsing procedures. Currently, wastewater from rinsing is directed to a drain (designated for Alodine® wastewater) and collected within a 4500-gallon mobile tanker truck stored within the building. Once the tanker truck reaches the 90-day storage limit or contains 1800 gallons of Alodine® wastewater, it is shipped off-site as a characteristic hazardous waste. USA-SRB formerly used a 1000-gallon tank to collect wastewater generated from the Alodine® process. This tank is currently not being used. USA-SRB is currently modifying the collection sump (with secondary containment) associated with the 1000-gallon tank. They anticipate that the tank and associated equipment will soon be ready for future use. In the first nine months of 1999, approximately 62,550 pounds of Alodine® wastewater and other chromium solutions were generated. Spray application procedures generate approximately 80 % of the Alodine® wastewater.

USA-SRB has implemented waste minimization procedures to reduce waste generation from spray application procedures. To reduce the generation of wastewater from rinsing procedures, industrial nozzles have been installed on the Alodine® rinse water hoses. Industrial nozzles encourage water conservation through improved water dispersion efficiency. Nozzle performance also relates to each individual operator. Another waste minimization procedure includes not pretreating the inside of the Forward Skirt after every flight. Typically, the Forward Skirt is treated every five flights.

The floor of the area used for the spray application of Alodine® was last coated with excess GacoFlex Hypalon® HFR-2100 White. When this product is removed from the floor by scrapping or chipping, USA-SRB intends to perform a hazardous waste determination on pealing and chipping paint prior to disposal.

Dip Application

Smaller SRB components undergo chemical conversion by dipping. Smaller SRB components are first cleaned with a heated solution of Turco 4215 NC-LT. After component cleaning, Turco 4215 NC-LT is rinsed with deionized water. Smaller SRB components are then treated with a heated solution of Alodine® 1200. A deionized water rinse completes the dip application process. Dip application procedures generate 20 % of the Alodine® waste. The majority of Alodine® wastewater generated from rinsing procedures is directed to a 2500-gallon wastewater tank located outside CCAS Building 66250 and disposed of as a characteristic hazardous waste.

USA-SRB has implemented several waste minimization procedures to reduce Alodine® wastewater generation from dip application. Since Alodine® 1200 is lost to evaporation, wastewater is now reused to replenish the Alodine® 1200 tank. Approximately 15 gallons of Alodine® wastewater is placed in the Alodine® 1200 tank a week. Other waste minimization procedures relating to the dip application process include using a rinse spray gun (for rinsing procedures), performing weekly testing of the Alodine® 1200 bath and replumbing the Alodine® process line to prevent contamination. The implementation of a rinse spray gun has reduced the total volume of water used in rinsing procedures. In the past, the Alodine® 1200 bath was disposed once a year as a characteristic hazardous waste. Currently, Alodine® 1200 is analyzed weekly to determine its specification. If it meets the desired specification, it is used to pretreat aluminum. In addition, approximately 200 pounds of out-of-shelf life Alodine® (pH<2) is generated a year.

Hand Application

Prior to coating application, Alodine® 1200 or pasa-jell is also used to touch-up SRB components. Anodizing is conducted by hand applying Alodine® 1200 or pasa-jell with wipes. Approximately 400 pounds of hazardous Alodine® wipes are generated a year. Contaminated wipes are kept in aqueous solution to prevent spontaneous combustion.

iv. Coating Removal

Thermal Protection System (TPS)/Seal Coat Hydralase of SRB Hardware

Target Product or Constituent: ***Tetrachloroethylene***

After flight, the TPS and seal coat of the SRB is removed by hydralasing. Hydralase procedures are accomplished manually or with a robot at the CCAS. Manual and robotic hydralasing occurs within CCAS Building 66240 and Building CCAS 66320, respectively. Wastewater generated from hydralasing is directed and captured in a 75,000-gallon storage tank and reused in future hydralase procedures. USA-SRB has determined that solid TPS debris generated from hydralasing is characteristically hazardous for tetrachloroethylene. The primer and topcoat of the SRB is removed by Space Gateway Support (SGS). Primer and topcoat removal is accomplished by blasting SRB hardware with plastic beads or steel shot.

Bead Blasting of SRB Hardware (Fasteners and Shoes)

Target Product or Constituent: ***Barium, Cadmium, Chromium or Lead***

After flight, the protective coating (which contains cadmium, chromium or lead) on certain fasteners (spherical nuts, spherical bearings, parachute spools, rings, bolts and other critical fasteners) and shoes is removed via bead blasting. Fasteners that are not blasted (and reused) are scrapped out. Bead blasting procedures are accomplished with a blast cabinet within Hangar N at the CCAS.

Aluminum oxide is used to bead blast certain fasteners and shoes. Spent bead blast media has been determined to be characteristically hazardous for barium, cadmium, chromium and/or lead. In the first nine months of 1999, approximately 5,100 pounds of spent bead blast media was generated.

v. Coating Application

Primer Coat of SRB Hardware

Target Product or Constituent: ***Xylene, Toluene, MEK and Deft IS-248***

After Alodine® treatment is completed, SRB sections and smaller SRB parts are painted (spray and touch-up) with Deft IS-248, a barium chromate based primer. Spray and touch-up painting of primer coat is accomplished within CCAS Building 66310 and Hangar AF.

HVLP and standard spray guns are used to apply the primer coat. Prior to spray painting a Forward or Aft Skirt, USA-SRB mixes two (6 gallons) or three kits (9 gallons) of Deft IS-248 primer. Deft IS-248 has a short pot life and may experience gelling and clumping prior to application. As a result, approximately 0.75 to one gallon of primer is wasted per kit of mixed primer. Organic solvent waste (xylene, toluene and MEK) is generated from a Herkules Paint gun washer used to clean spray guns. Approximately five gallons of organic solvent waste is generated every ten paint jobs. Spent paint filters generated from primer coat application were determined to be non-hazardous. Spent filters are bagged and disposed to the dumpster as a solid waste two to four times a year.

Top Coat of SRB Hardware

Target Product or Constituent: ***Xylene, Toluene, MEK and Deft IS-213***

After SRB sections and smaller SRB parts are pretreated with Alodine® and coated with Deft IS-248 Primer, they are painted (spray and/or touch-up) with Deft IS-213 topcoat. Spray and touch-up painting of topcoat is accomplished within CCAS Building 66310 and Hangar A.

HVLP and standard spray guns are used to apply Deft IS-213. Organic solvent waste (xylene, toluene and MEK) is generated from a Herkules Paint gun washer used to clean spray guns. Approximately five gallons of organic solvent waste is generated every ten paint jobs. Spent paint filters generated from topcoat application were determined to be non-hazardous. Spent filters are bagged and disposed to the dumpster as a solid waste. No pot life issues exist with Deft IS-213.

TPS Coat of SRB Hardware

Target Product or Constituent: ***Dichloromethane***

After a topcoat of Deft IS-213 is applied, MCC is spray-applied (by a robot) to provide thermal protection. MCC consists of ground cork, glass echospheres and a two-part adhesive of Scotchweld EC2216 A and B. Since MCC is mixed at the tip of the spray gun (i.e., point of dispersion), no pot life issues exist. Approximately 15 gallons of waste dichloromethane is generated per year from cleaning lines used in MCC application. In November 1999, USA-SRB switched from using dichloromethane to hot water for equipment line flushing. In addition, an industrial wastewater is generated from cleaning the nozzle of the spray applicator. Solid TPS debris generated from TPS Coat application is disposed of as a non-hazardous waste. TPS Coat application is accomplished within the Solid Rocket Booster Assembly and Refurbishment Facility (ARF).

Seal Coat of SRB Hardware

Target Product or Constituent: ***Tetrachloroethylene***

After a TPS Coat of MCC is applied, a seal coat of Gacoflex Hypalon® HFR-2100 (Hypalon®) is roll-applied to the TPS Coat. Hypalon® ensures that moisture does not compromise the TPS Coat. Two coats of Hypalon® are roll-applied to the TPS Coat. Hypalon® application is accomplished within CCAS Building 66310 and Hangar AF.

Waste masking material, spent rollers, spent paint filters and other solid debris is generated from the application of Hypalon®. Since Hypalon® contains 74 % tetrachloroethylene by volume, it is suspected that wastes contaminated with Hypalon® are hazardous. In the first nine months of 1999, approximately 2290 pounds of paint solids contaminated with Hypalon® were generated. Excess Hypalon® paint is also generated. In the first nine months of 1999, approximately 1550 pounds of excess Hypalon® paint was generated.

Lube Coating of SRB Hardware (Shoes)

Target Product or Constituent: ***Cadmium and Lead***

After the protective coating has been removed from the shoes by bead blasting, a dry film lubricant is applied by spraying. Depending on the type of dry film lubricant utilized, shoes are oven cured at 500° to 1000 °F. Lube coating of shoes is accomplished within Hangar N at the Cape Canaveral Air Station. A dry film lubricant is also applied to new or blasted fasteners (bolts and bearings) which require lubricity.

In June 1999, USA-SRB switched from using lead-based Lube-lock to lead-free Booster-lube. By replacing Lube-lock, USA-SRB anticipated eliminating 240 pounds of hazardous air emissions and 1500 pounds of hazardous waste a year. On October 13, 1999, USA-SRB ceased using Booster-lube since it separates prior to spray application. Currently, USA-SRB has reverted back to using Lube-lock until the problems with Booster-lube have been solved. In the first nine months of 1999, USA-SRB generated approximately 250 pounds of hazardous solids contaminated with lead and cadmium (spent paint filters and masking material).

vi. Precision Cleaning

TVC System

Target Product or Constituent: ***Isopropanol and Aqueous Solutions***

USA-SRB is responsible for manufacturing certain components of the TVC System (pipes and hoses). Prior to installation in the Aft Skirt, pipes and hoses must undergo precision cleaning. Precision cleaning is accomplished within the ARF.

The level of cleaning required for each component of the TVC System varies. Trisodium phosphate, Turco 3878 LF-NC and isopropanol are used in precision cleaning. Some components only require cleaning with trisodium phosphate, while other components require cleaning with both trisodium phosphate and Turco 3878 LF-NC. Other components (reservoir parts) do not require cleaning with trisodium phosphate or Turco 3878 LF-NC. All components are cleaned with isopropanol.

Prior to chemical cleaning, an air gun is used to remove or loosen any foreign objects on the component. After air cleaning, certain components are submerged in a trisodium phosphate degreaser. To remove excess trisodium phosphate, components are cleaned with an air gun. Components are then cleaned with Turco 3878 LF-NC. To remove excess Turco 3878 LF-NC, components are rinsed with Grade A water. Components then undergo ultrasonic cleaning in Grade

A water. After ultrasonic cleaning, components are placed in a drying area and cleaned with isopropanol.

The precision cleaning process generates spent trisodium phosphate, spent Turco 3878 LF-NC and waste isopropanol. Spent trisodium phosphate is disposed as a non-hazardous waste every nine months. Turco 3878 LF-NC is analyzed and disposed of approximately every six months. If spent Turco 3878 LF-NC does not exceed RCRA regulatory and discharge levels, it is disposed to the sewer system. In the first nine months of 1999, approximately 3,750 pounds of waste isopropanol was generated from fuel line flushing (TVCD) and precision cleaning procedures.

vii. Sealing/Adhesives

Sealing Fasteners

Target Product or Constituent: ***Chromium***

After the primer and topcoat have been applied to SRB hardware, certain SRB fasteners are sealed for corrosion protection with chromium-based PR-1422. For sealing applications that do not require PR-1422, USA-SRB has switched to PR-870, a chromium-free sealant. In the first nine months of 1999, approximately 1,100 pounds of PR-1422 waste (spatulas, gloves and wipes) were generated. Sealing of fasteners is accomplished within CCAS Building 66310 and Hangar AF.

viii. General Cleaning

Fuel Service Module (FSM) Cleaning

Target Product or Constituent: ***Monomethylhydrazine and Phosphoric Acid***

Prior to flight, the Fuel Service Module (FSM) of the Aft Skirt undergoes precision cleaning with phosphoric acid solution. FSM cleaning is accomplished within the ARF.

FSM cleaning involves removing unused hydrazine and rinsing the interior of the FSM with a phosphoric acid solution. Excess phosphoric acid generated from precision cleaning is shipped out as characteristic hazardous waste. In the first nine months of 1999, approximately 30 pounds of waste phosphoric acid was generated.

Surface Cleaning of SRB Hardware

Target Product or Constituent: ***MEK***

Prior to coating, SRB hardware is wiped down to remove contaminants and hydrocarbons. Physical wipedowns consist of hand wiping hardware with MEK. Rags contaminated with MEK are containerized and disposed of as a hazardous waste. In the first nine months of 1999, USA-SRB generated approximately 215 pounds of MEK contaminated rags. USA-SRB is in the process of substituting MEK with a non-hazardous solvent (DS-104). Surface cleaning is accomplished within the ARF.

Facilities, Equipment and GSE Hardware Painting

Target Product or Constituent: ***Xylene, Toluene, MEK and Unused Paint***

USA-SRB facilities, equipment and assigned GSE require spray and touch-up painting. Painting procedures generate waste organic solvent (from equipment cleanup) and unused paint waste (residues from aerosol cans utilized during GSE painting). Painting is performed on an as-needed basis.

ix. Foam Application

Target Product or Constituent: ***HFC-134a and MDI***

After the Thrust Vector Control (TVC) system is installed within the Aft Skirt, insulation foam (FP-115-134A) is applied (by spraying) around the TVC system. Insulation foam serves to protect the internal elements of the Aft Skirt during splash down. Foam application is accomplished within the ARF. Approximately 12 to 14 Aft Skirts are completed a year. To ensure additional protection, certain components of the TVC system are sprayed prior to installation.

Insulation foam consists of a two-part product (Part A and B). Part A contains 4,4'-methylenediphenyl isocyanate (MDI) and 1,1,1,2 tetrafluoroethane (HFC-134a). Part B contains HFC-134a. Parts A and B are mixed within the spray gun prior to application. Approximately two sets (one set equals 17 gallons of Part A and 17 gallons of Part B) are used per Aft Skirt. Approximately one-eight of a set is used in TVC foaming applications.

x. Cable Fabrication

Target Product or Constituent: ***1,2-Dimethoxyethane and Teflonâ-coated Cables***

USA-SRB fabricates electrical cables used in SRB hardware. Cable fabrication involves the use of Tetra-etch® to ensure the bonding of Teflon®-coated cables. Small volumes of waste Tetra-etch® are generated from cable fabrication. Cable fabrication is accomplished within Hangar N of the CCAS.

xi. Photoprocessing

Target Product or Constituent: ***Silver***

To support NDE, USA-SRB performs small scale, infrequent in-house photographic development. Waste photographic fixer is shipped to SGS for silver reclamation.

C. Wiltech Corporation

Wiltech Corporation (Wiltech) is subcontracted to perform component refurbishment and chemical analysis (CR/CA) for various NASA, KSC contractor and Air Force customers. Services provided by Wiltech include:

- Precision cleaning of hardware with all required cleanliness certifications
- Functional component hardware refurbishment, testing and certification
- Hypergolic decontamination of fuel and oxidizer system hardware
- Depot level component refurbishment of selected flight hardware
- Chemical analysis of commodities and supplies to ensure manufacturing specifications

Wiltech performs approximately 19,000 component cleaning and refurbishment tasks a year. The majority of these tasks are processed in accordance with KSC cleanliness specification KSC-C-123 (September 25, 1995). In addition, Wiltech performs approximately 20,000 chemical analyses a year. CR/CA activities are accomplished within Building K6-1696. This section provides component refurbishment activities. Chemical analysis activities were not investigated.

i. Component Refurbishment

Target Product or Constituent: ***Aqueous solutions, CFC-113 and Isopropanol***

Wiltech performs precision cleaning of tubes, hoses, air ducts, valves, storage vessels, in-place lines, mobile lines and other equipment used in Shuttle, payload and Air Force operations. Currently, eighty percent of Wiltech's workload involves the cleaning of ground support hardware. Approximately twenty percent relates to the cleaning of flight hardware.

Precision cleaning involves the use of aqueous or non-aqueous cleaning solvents. The solvent used in precision cleaning relates to the component's application. Non-flight items (ground support hardware) and a very small percentage of flight hardware is cleaned and verified with aqueous solutions. Approximately seventy percent of all precision cleaning procedures are completed with aqueous solutions. The majority of flight items are cleaned and verified with non-aqueous solutions (CFC-113 and isopropanol). However, certain flight items are cleaned with aqueous solutions and verifed with non-aqueous solutions. Depending on customer specifications, certain ground support hardware is cleaned and verified with non-aqueous solutions. Wiltech performs the following precision cleaning procedures:

Non-Flight

Aqueous Cleaning- 300 Series Stainless Steel with Gross Contamination

Aqueous cleaning of 300 series stainless steel with gross contamination (weld slag or rust) begins by submerging components in Brulin 1990. To remove excess Brulin 1990, components are rinsed with hot deionized (DI) water (to a neutral pH). After initial degreasing, components undergo secondary degreasing with Brulin 815 G.D. for three to five minutes. To remove excess Brulin 815 G.D., components are rinsed with hot deionized water (to a neutral pH) using an ultrasonic time-delay system. After degreasing, components are placed in a nitric/hydrofluoric acid pickling solution, rinsed with hot deionized water (to a neutral pH), cleaned with an air gun and placed in a nitric acid solution for one hour. After nitric acid passivation, components are rinsed with hot deionized water (to a neutral pH) and cleaned with an air gun. To determine cleanliness, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification.

Aqueous Cleaning Verification and Certification

Aqueous cleaning verification is conducted to certify cleanliness specifications. Verification begins with an ultrasonic deionized water wash for five minutes. After rinsing, 200 microliters of deionized rinse water are collected and analyzed for non-volatile residues. A particulate matter determination with Zonyl® completes the component certification process. Components are cleaned to a specification of 25 to 1000A.

Aqueous Cleaning- 300 Series Stainless Steel with Minor Contamination

Aqueous cleaning of 300 series stainless steel with minor contamination begins by submerging components in Brulin 1990. To remove excess Brulin 1990, components are rinsed with hot deionized water (to a neutral pH). After initial degreasing, components undergo secondary degreasing with Brulin 815 G.D for three to five minutes. To remove excess Brulin 815 G.D., components are rinsed with hot deionized water (to a neutral pH) using an ultrasonic time-delay system. After degreasing, components are cleaned in a heated sodium hydroxide for 30 minutes, rinsed with hot deionized water (to a neutral pH), cleaned with an air gun and placed in a nitric acid solution for up to one hour. After nitric acid passivation, components are rinsed with hot deionized water (to a neutral pH) and cleaned with an air gun. To determine cleanliness, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

Aqueous Cleaning of Invar Metal, Carbon Steel and 400 Series Stainless Steel with Minor Contamination

Aqueous cleaning begins by submerging components in Brulin 1990. To remove excess Brulin 1990, components are rinsed with hot deionized water (to a neutral pH). After initial degreasing, components undergo secondary degreasing with Brulin 815 G.D. for three to five minutes. To remove excess Brulin 815 G.D., components are rinsed with hot deionized water (to a neutral pH) using an ultrasonic time-delay system. After degreasing, components are cleaned in a heated sodium hydroxide for fifteen to thirty minutes, rinsed with hot deionized water (to a neutral pH), cleaned with an air gun and placed in a phosphoric acid solution for ten to twenty minutes. After phosphoric acid treatment, components are rinsed with isopropanol and cleaned with an air gun. To determine cleanliness, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

Aqueous Cleaning of Aluminum

Aqueous cleaning of aluminum begins by submerging components in Brulin 815 G.D. To remove excess Brulin 815 G.D., components are rinsed with hot deionized water (to a neutral pH). After initial degreasing, components undergo secondary degreasing. The solution used in secondary degreasing is based on the extent of contamination or type of component being cleaned. The following solutions may be used:

1) Heated Turco 3878 LF-NC for 15-30 minutes
2) Heated Amway LOC for 15-30 minutes

After secondary degreasing, components are rinsed with hot deionized water (to a neutral pH). To remove general contaminants, components are placed in Oakite 34 for one to three minutes, rinsed with hot deionized water (to a neutral pH) and cleaned with an air gun. To determine cleanliness, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

Aqueous Cleaning of Copper, Brass and Bronze

Aqueous cleaning begins by submerging components in Brulin 815 G.D. To remove excess Brulin 815 G.D., components are rinsed with hot deionized water (to a neutral pH. After initial degreasing, components undergo secondary degreasing. The solution used in secondary degreasing is based on the extent of contamination or type of component being cleaned. The following solutions may be used:

1) Heated Turco 3878 LF-NC for 15-30 minutes
2) Heated Amway LOC for 15-30 minutes

After secondary degreasing, components are rinsed with hot deionized water (to a neutral pH). To remove general contaminants, components are placed in Oakite 34 for one to three minutes, rinsed with cold deionized water (to a neutral pH) and cleaned with an air gun. To determine cleanliness, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification. To ensure the removal of aqueous solutions from larger components, verification and certification is conducted with CFC-113. ***Note:*** See Solvent Cleaning and Verification. Since drying methods may stain brass components, verification and cleaning is conducted with CFC-113.

Precision Cleaning of Coated/Anodized, Polished or Monel Parts and Dissimilar Metallic Assemblies

Precision cleaning begins by submerging components in CFC-113 or heated Amway LOC and water. To remove excess CFC-113 or Amway LOC and water, components are rinsed with hot deionized water (to a neutral pH). After initial degreasing, components undergo secondary degreasing with heated Amway LOC for fifteen to thirty minutes. To remove excess Amway LOC, components are rinsed with hot deionized water (to a neutral pH). After rinsing, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

Aqueous Cleaning of Coated/Non-Coated Metallic, Non-metallic and Bi-metallic Assemblies and/or Parts

Aqueous cleaning begins by scrubbing components with heated Amway LOC and water. To remove excess Amway LOC and water, components are rinsed with hot deionized water (to a neutral pH). After rinsing, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification. If requested, solvent cleaning and verification is conducted.

Aqueous Cleaning of Rubber/Synthetic Rubber and Metallic/ Bi-metallic Assemblies and/or Parts

Aqueous cleaning begins by scrubbing components for fifteen to thirty minutes with Turco 3878 LF-NC or Amway LOC and water. To remove excess Turco 3878 LF-NC or Amway LOC and water, components are rinsed with hot deionized water (to a neutral pH). After rinsing, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

Aqueous Cleaning of Tygon Tubing and Tubing Kits

Aqueous cleaning begins by submerging or flushing the internal surfaces of tubing with Amway LOC and water for five to fifteen minutes. To remove excess Amway LOC and water, components are rinsed with hot deionized water (to a neutral pH). After rinsing, a visual inspection of water flow "break" is conducted. If the water flow breaks or beads up on the component, it must undergo further degreasing. If the water flows off the component without breaking, it is dried with compressed gaseous nitrogen (GN_2) and taken to the clean room for validation and certification. ***Note:*** See Aqueous Cleaning Verification and Certification.

CFC-113 and isopropanol melts and removes the elastomers from tygon tubing. When a NVR test is conducted with CFC-113 and isopropanol, contamination is revealed during analysis. To ensure cleanliness, validation and certification is completed with filtered DI water using the boil test method. CFC-113 or isopropanol may be used for components not requiring validation and certification.

Flight

Electropolishing of 300 Series Stainless Steel

If requested, Wiltech performs electropolishing of 300 series stainless steel. Electropolishing is accomplished by submerging components in Hydrite 4000 (sulfuric/ortho-phosphoric acid mixture) and rinsing them with deionized water. Electropolishing removes small surface particles and is conducted prior to solvent validation and certification.

Solvent Cleaning and Verification

The vast majority of flight and certain ground support hardware undergo solvent cleaning and verification with CFC-113. Solvent cleaning begins by hand-scrubbing visually contaminated components with CFC-113. After initial cleaning, components are placed in a sink and cleaned. During this process, the component is covered and agitated with filtered CFC-113. After cleaning, a sample is collected and analyzed for non-volatile residues using a solvent purity meter. Solvent cleaning and verification is completed when the component is cleaned to the appropriate cleanliness standard (25 to 1000A). Certain customers require gravimetric analysis to determine the level of cleanliness. Currently, Wiltech is working to implement the use of Vertrel® and HFE-7100. This substitution will eliminate or reduce CFC-113 usage.

Solvent Cleaning of Electrical Accessories and Coils

Electrical accessories and coils are cleaned by spraying or wiping the component with CFC-113 or isopropanol. CFC-113 is applied by spraying the solvent inside the connector and wires. Coils requiring validation are flushed with CFC-113 or isopropanol. Corrosion is removed by mechanical means.

Precision Cleaning of Convoluted Hoses using the Jet Mole

In order to clean the internal bellows and convex folds of a convoluted hose, Wiltech has developed the Jet Mole process. This process uses a pointed fitting (with two series of evenly spaced holes) attached to a stainless steel high-pressure flexible hose. The first series of holes allows the fitting to be propelled (under high-pressure) up the extended hose. The second series cleans between the convex folds of the convoluted hose.

Prior to cleaning, hoses are hung vertically. Vertical hanging allows the stainless steel mesh of the hose to become unconstricted. Once the hose is fully extended, a Jet Mole sends cleaning solutions (solvent and aqueous) and rinse water up the extended hose. The Jet Mole process begins by flushing hoses with Brulin 1990. To remove excess Brulin 1990, hoses are flushed with deionized water. After initial degreasing, hoses are cleaned with a chemical caustic for 30 minutes, rinsed with deionized water and flushed with a nitric acid solution for one hour. After nitric acid passivation, the entire surface of the hose is flushed with deionized water. To achieve cleanliness standards, deionized water used in flushing procedures is collected and filtered for particulate matter. In order for hoses to meet NVR test requirements, Wiltech must complete precision cleaning procedures with a flush of CFC-113. This flush must be conducted since Wiltech cannot prove that aqueous cleaning procedures achieve Non-Volatile Residues (NVR) specifications.

Waste Generation and Treatment

Aqueous cleaning and verification procedures generate waste Brulin and Turco solutions, spent acids (nitric, hydrofluoric and phosphoric), spent sodium hydroxide, spent Hydrite 4000 (hydrochloric/sulfuric acid) and rinsewaters (deionized water). Waste management varies with each chemical. Waste Brulin and waste Turco are discharged to the sewer system. General chemistry wastewaters (from chemical anayses) and rinsewaters are collected and processed with a LICON® treatment system located behind Building K6-1696. After LICON® treatment, waters are demineralized (within Building K6-1697) and used in future precision cleaning procedures. Industrial sludges generated from LICON® treatment have been determined to be non-hazardous and are shipped off-site for disposal. Spent acids, caustics and electropolishing solutions that cannot be treated are containerized and shipped off-site as a hazardous waste. These wastes are disposed of once or twice a year due to metal contamination. The following wastes (and quantities) are shipped off-site a year: nitric acid (2500 gallons), sodium hydroxide (1000 gallons), phosphoric acid (400 gallons), Hydrite 4000 (100 gallons) and hydrofluoric acid (20 gallons).

Solvent cleaning and verification procedures generate waste isopropanol, contaminated CFC-113 and CFC-113 still-bottoms. Approximately 1000 gallons of waste isopropanol and 100 gallons of CFC-113 still bottoms are shipped off-site a year. To reduce waste isopropanol generation, USA Ground Operations recently purchased a molecular sieve (to regenerate isopropanol) for Wiltech. Regenerated isopropanol has a purity of 99.9 percent. Isopropanol will also be used for non-critical applications. Wiltech has used the molecular sieve to regenerate small amounts of isopropanol. However, it does not have the capability to regenerate all waste isopropanol. Currently, Wiltech is awaiting technical support from USA Ground Operations.

To determine specification, Turco solutions, sodium hydroxide, Hydrite 4000 and phosphoric acid are analyzed weekly. If they meet the desired specification, they are used in aqueous precision cleaning procedures.

3.3.2 Logistics Operations (LO)

A. <u>USA-NASA Shuttle Logistics Depot</u>

United Space Alliance conducts space operations involving the operation and maintenance of multi-purpose space and ground systems. This work includes operation of the NASA Shuttle Logistics Depot (NSLD). USA-NSLD is responsible for manufacturing, overhauling, repairing and procuring more than 4,000 replaceable parts. USA-NSLD performs the following processes:

i. Metal Finishing

Alodine® Anodizing

Target Product or Constituent: ***Chromic Acid, Sodium Hydroxide and Turco Liquid Smutgo NC***

To ensure coating adhesion, aluminum components (flight hardware) are treated with Alodine® 1200S. Prior to Alodine® 1200S application, components are cleaned in silicated sodium hydroxide and rinsed with deionized water. After initial degreasing, components are deoxidized with Turco Liquid Smutgo NC. To remove Turco Liquid Smutgo NC, components are rinsed with deionized water. To complete the anodizing process, components are treated with Alodine® 1200S and rinsed with deionized water. Once a week, Alodine® 1200S is analyzed to determine its specification. If it meets the desired specification, it is used to pretreat aluminum. USA-NSLD generates approximately one 55-gallon drum of waste Alodine® 1200S every two years.

Small aluminum components of four in^2 or less and wire connectors are treated with Alodine® 1200S or pasa-jell. To prevent spontaneous combustion, wipes contaminated with Alodine® 1200S or pasa-jell are neutralized and kept in aqueous solution.

Aluminum Etching

Target Product or Constituent: ***Sodium Hydroxide and Oakite 160***

To remove imperfections, aluminum components (flight hardware) undergo etching. Aluminum etching begins by submerging components in non-silicated sodium hydroxide. To remove excess sodium hydroxide, components are rinsed with deionized water. After initial degreasing, components are treated with Oakite 160 and rinsed with deionized water. To complete the etching process, components are deoxidized with Turco Liquid Smutgo NC and rinsed with deionized water. USA-NSLD generates approximately one 55-gallon drum of waste sodium hydroxide every two years.

ii. Foam Application

Target Product or Constituent: ***HCFC-141 and Liquid Catalyst Rubber***

To ensure adequate thermal and shock protection, a pre-mixed insulation foam containing HCFC-141b is applied to valve assemblies and engines. Foam application occurs twice a year and relates to repair activites. In addition, a liquid catalyst rubber (RTV-560) is applied as a thermal coating.

iii. Precision Cleaning

Target Product or Constituent: ***MEK and Isopropanol***

Oxygen lines, fuel lines, reservoirs and equipment require solvent cleaning and verification with CFC-113. Prior to the precision cleaning, components are wiped down with MEK or isopropanol.

After physical wipedown, components are covered and agitated with filtered CFC-113. After cleaning, a sample is collected and analyzed for non-volatile residues. A particulate matter determination completes the component certification process. The component is recleaned if it does not meet the appropriate cleanliness standard. Currently, USA-NSLD is working to implement the use of Vertrel® and HFE-7100. A specification change request is being reviewed. This substitution will eliminate or reduce CFC-113 usage.

iv. Coating Application

Target Product or Constituent: ***Waste Solvents (MEK, Toluene and Xylene), Chromium and Off-Specification Paint***

After surface preparation is completed, a coating system is applied (by spraying) to flight hardware and GSE. Coating application involves the following procedures:

- Determine coating system
- Inspect for proper masking
- Apply primer (if required) and inspect
- Apply intermediate coat(s) (if required) and inspect
- Apply topcoat(s) (if required) and inspect

Waste MEK is generated from cleaning spray guns used in spray application. In addition, excess paints, spent paint filters contaminated with chromium, waste masking material, spent rollers and brushes, contaminated rags and other hazardous solid debris is generated from the application of coatings. All wastes are commingled and disposed of as a hazardous waste. In addition, USA-NSLD generates off-specification and unused paint. Approximately three 15-gallon drums of off-specification and unused paint are disposed a year.

USA-NSLD generates waste latex paint (non-regulated) and excess solvent-based paints from facility painting. Paint residues are generated from aerosol can puncturing.

v. Surface Preparation

Target Product or Constituent: ***Dichloromethane, TCLP metals and Hazardous Rags***

Prior to coating application, certain spots of flight hardware (aluminum, stainless steel and plastic) may require coating removal with chemical stripping agents. To accomplish chemical stripping, Miller Stevenson-171 (contains dichloromethane) or McGean-Rocoh CEEBE 228-D epoxy stripper is applied (by brushing) to metal or plastic substrates. To complete coating removal, the substrate is wiped down with rags. Currently, USA-NSLD uses five gallons of Miller Stevenson-171 and two quarts of McGean-Rocoh CEEBE 228-D epoxy stripper a year. The vast majority of work conducted by USA-NSLD is spot stripping. Rags contaminated with dichloromethane are collected and laundered.

Coating removal is also conducted within a blast cabinet using an abrasive media blast. Spent media blast has been determined to be characteristically hazardous for lead and chromium.

vi. Cable Fabrication

Target Product or Constituent: ***1,2-Dimethoxyethane and Teflon â -coated Cables***

USA-NSLD fabricates electrical cables used in flight hardware. Cable fabrication involves the use of Tetra-etch® to ensure the bonding of Teflon®-coated cables. Small volumes of waste Tetra-etch® are generated from cable fabrication. In June 1999, USA-NSLD disposed of one 55-gallon drum of contaminated Tetra-etch®. Oily rags generated from cable fabrication are collected and laundered.

vii. General Cleaning

Target Product or Constituent: ***MEK, Isopropanol and Hazardous Rags***

To ensure cleanliness, Orbiter components are physically wiped down with rags or ripple cloths. Physical wipedowns consist of hand wiping components with MEK or isopropanol. Contaminated rags are laundered and reused. However, contaminated ripple cloths are containerized and disposed of as a hazardous waste. CFC-113 is no longer used in wiping procedures.

viii. Printed Circuit Board Repair

Target Product or Constituent: ***Lead Solder***

USA-NSLD occasionally repairs printed circuit boards. Repair procedures include surface preparation, etching and layering of printed circuit boards. Soldering is also accomplished. All lead solder is recycled. Wastes generated from printed circuit board repair include contaminated rags and waste isopropanol. Contaminated rags are managed as a hazardous waste.

ix. Photoprocessing

Target Product or Constituent: ***Silver***

To support the NDE of flight hardware, USA-NSLD performs small scale, infrequent in-house photographic development. Prior to disposal to the sewer system, waste photographic fixer (contaminated with silver) is processed with silver recovery units.

x. Inventory Control

Target Product or Constituent: ***Off-Specification and Out-of-Shelf Life Materials***

USA-NSLD has improved inventory management of hazardous chemicals. Improved inventory management has reduced the generation of off-specification and out-of-shelf life materials. USA-NSLD purchases certain materials on an “just-in-time” basis. In addition, USA-NSLD has a shelf life extension program. If practicable, certain off-specification materials are tested and re-certified for future use. Materials that do not meet qualification standards are disposed of.

xi. Machining

Target Product or Constituent: ***Cutting Fluids and Oil Lubricants***

Machining procedures use a limited amount of cutting fluids and oil lubricants. Certain water-soluble cutting fluids are recycled (by filtration) and reused. Once cutting fluids become contaminated (and unrecyclable), they are pre-treated and discharged to the sewer system. Contaminated oil lubricants are managed as a used oil. In June 1999, USA-NSLD disposed of three 55-gallon drums of used machining oil. Other cutting fluids that do not undergo recycling are treated and discharged to the sewer system. Oily rags generated from maching procedures are collected and laundered.

xii. Sealing/Adhesives

Target Product or Constituent: ***Excess and Off-Specification Epoxies and Sealants***

The majority of excess and off-specification epoxies and sealants are cured and disposed of to the dumpster. Epoxy solders that contain silver are managed as a hazardous waste. Epoxies and sealants are used to repair or maintain flight hardware, GSE or facilities.

3.3.3 Space Station and Shuttle Payloads (NN)

A. <u>BOEING PGOC</u>

The Boeing Payload Ground Operations Contract (PGOC) performs payload-processing activities for Shuttle, Expendable Launch Vehicle (ELV) and ISS payloads in accordance with KSC designated responsibilities. In addition, Boeing PGOC provides ELV telemetry and data systems support at any geographic location. ELV support responsibilities include the operation and maintenance of associated facilities and ground systems. Boeing PGOC performs the following processes:

i. Fueling

Target Product or Constituent: ***Hydrazine, Nitrogen Tetraoxide and Rinsates***

Boeing PGOC conducts large scale, infrequent hypergolic fueling of payloads. Prior to hypergolic fueling, payload hardware is flushed with anhydrous alcohol to eliminate contamination. After the alcohol flush, hypergolic fuel (hydrazine or monomethyl hydrazine) is loaded. If necessary, an oxidizer (nitrogen tetroxide) is added. Unused fuels and oxidizers are reused by Space Gateway Support (SGS). Flushing fueling equipment & lines with demineralized water and/or alcohol completes the hypergolic fueling process. Hazardous waste generated from payload fueling include rinsates (hydrazine, alcohol, oxidizer), hydrazine solids (contaminated absorbent materials and tyvek suits) and oxidizer solids. Approximately 550 gallons of rinsates were generated in 1998.

Boeing PGOC rarely conducts a periodic changeout of the air scrubber units. Biocide added to the air scrubber units has significantly extended liquor life (citric acid for fuel scrubbers and sodium hydroxide for oxidizer scrubbers).

Process Locations:

M7-1104 Multi-Payload Processing Facility Highbay
M7-1210 Spacecraft Assembly and Encapsulation Facility #2 Highbay
M7-1354 Payload Hazardous Servicing Building Highbay

ii. Metal Finishing

Target Product or Constituent: ***Chromic Acid***

<u>Alodine® Anodizing</u>

Prior to paint application, aluminum alloys on Payloads and GSE are anodized with Alodine®. Alodine® anodizing is conducted by hand applying/touching up (with wipes) aluminum with Alodine® 1200. Approximately 220 gallons of hazardous Alodine® wipes were generated in 1998. Alodine® wipes are neutralized and kept in aqueous solution to prevent spontaneous combustion.

Process Locations:

M7-355 Operations and Checkout Highbay
M7-360 Space Station Processing Facility Highbay

iii. Precision Cleaning

Target Product or Constituent: ***TCE***

Gauge Cleaning

Boeing PGOC occasionally performs high purity cleaning of gauges used in facility, GSE and payload operations. Prior to cleaning, gauges are physically inspected. If a gauge is not defective, it is attached to a closed-loop filtration system and flushed with trichloroethylene (TCE). After flushing, the gauge undergoes a particle count and Non-Volatile Residue (NVR) testing. The cleaning process is completed when the gauge is cleaned to 300A. If the gauge is not cleaned to 300A, it is recleaned. Waste TCE is reclaimed and reused for future cleanings. Approximately four liters of TCE is used a year. Boeing PGOC is considering substituting TCE with HFE-7100. Acceptance testing of HFE-7100 is ongoing.

Process Locations:

M7-505 PGOC Calibration Laboratory
Cable Fabrication Shop

iv. Surface Preparation Coating Application General Cleaning

Facilities and GSE Maintenance Painting

Target Chemicals or Products: ***Waste Solvents, TCLP metals, Hazardous Rags, MEK, and Hazardous Solid Debris***

Boeing PGOC facilities and assigned GSE frequently require repair, maintenance, modification, construction and/or touch up painting procedures. Facilities and GSE maintenance procedures include hand or powered surface preparation (e.g., sanding, needle gun, blasting), surface cleaning and wipedown (alcohol, organic solvent or water) and paint application (hand, roller or aerosol paint). Depending on the paint materials applied, aqueous or solvent-based agents are used to clean equipment.

Hazardous waste generated from facilities and GSE maintenance painting includes solid debris contaminated with TCLP metals (barium, cadmium, chromium and lead), solvent rags, paint stripper and debris, waste paint and MEK/paint rinsate. Solid debris contaminated with lead or TCLP metals is generated from a physical paint stripping process. Approximately 355 gallons of solid debris contaminated with lead and 175 gallons of solid debris contaminated with TCLP metals were generated in 1998. Hazardous solvent rags (contaminated with MEK) are generated from wipedown procedures. Approximately 134 gallons were generated in 1998. Hand surface preparation generates waste paint stripper and debris. Waste MEK and paint rinsate is generated from equipment clean-up.

Process Locations:

M7-453 PGOC Maintenance
M7-458 PGOC Maintenance

v. Cable Fabrication/Repair

Target Product or Constituent: ***1,2-Dimethoxyethane, Lead Solder, Hazardous Rags, Epoxies, Waste Aerosol Cans and Teflonâ -coated Cables***

Boeing PGOC performs small scale, frequent fabrication and repair of cable assemblies used in facility, GSE and payload operations. Cable fabrication and repair involves the use of epoxies and sealants, lubrication, hand solvent cleaning and hand soldering. Waste generated from cable fabrication and repair include solvent rags, waste flammable liquid, oily rags, lead solder, cured epoxy, waste aerosol cans and alcohol rags. Solvent rags, waste flammable liquid and oily rags are properly disposed. All lead solder is recycled. All cured epoxy materials are disposed as solid waste. Aerosol cans are punctured, drained and recycled for metal content. Alcohol rags are reused for cleanup.

Process Locations:

M7-505 PGOC Calibration Laboratory
Cable Fabrication Shop

vi. Machining

Target Product or Constituent: ***Machine Coolants and Oily Rags***

Boeing PGOC occasionally fabricates and modifies steel or aluminum parts used to support facility, GSE and payload operations. Machining procedures use a limited amount of machine coolants and cutting fluids. Wastes generated from machining consist of cutting oils and oily rags.

Process Location:

M7-505 PGOC Machine Shop

vii. Inventory Control

Target Product or Constituent: ***Flammable Adhesives***

Boeing PGOC frequently disposes full or partially full small containers of off-specification and/or out-of-shelf life materials from various payload, facility, GSE and/or maintenance operations. Containers determined to be off-specification and/or out-of-shelf life are lab-packed.

To reduce the volume of materials disposed, Boeing PGOC offers unopened materials to all potential users (Boeing PGOC facilities and other KSC contractors). If the material meets specification, it is reused. Partially full containers used for non-flight applications are disposed of. Approximately 215 gallons of hazardous lab-packed materials and 111 gallons of flammable adhesives were disposed of in 1998. Boeing PGOC has also required procurement to purchase materials in small quantities.

Process Locations:

M7-698 Supply Warehouse #2
M6-794 Supply Warehouse #1
M7-505 PGOC Flight Warehouse
M7-554 PGOC POL

viii. Payload Assembly/Repair Sealing/Adhesives

Target Product or Constituent: ***Epoxies and Sealants***

Boeing PGOC uses a wide variety of epoxies and sealants for payload assembly and facility/GSE repair. All epoxies are processed through Boeing PGOC. Control of specifications and procurement are only maintained for epoxies and sealants used for facilities/GSE repairs. Epoxies and sealants used for payload assembly are usually specified and supplied by the payload customer or Boeing PGOC. Waste generated from payload assembly and facility/GSE repair include unused or uncured resins and catalysts.

Process Locations:

M7-355 Operations and Checkout Highbay
M7-360 Space Station Processing Facility Highbay
M7-1104 Multi-payload Processing Facility Highbay
M7-1210 Spacecraft Assembly and Encapsulation Facility #2 Highbay
M7-1354 Payload Hazardous Servicing Building Highbay

ix. General Cleaning

Target Product or Constituent: ***Waste Ethanol and Hazardous Rags***

Payload/Facility Cleaning/Wipedown

To ensure cleanliness, payload hardware, GSE and assigned clean room areas are wiped down. Physical wipedowns consist of hand wiping hardware and/or walls or floors with an 80% water and 20% isopropanol mixture, ethanol, methanol or MEK. Rags contaminated with isopropanol, ethanol or methanol are air dried and reused in maintenance operations. Rags contaminated with MEK are containerized and disposed of as a hazardous waste. Approximately 104 gallons of contaminated solvent rags were generated in 1998. Waste ethanol and water from payload wipedowns is occasionally generated.

Process Locations:

M7-355 Operations and Checkout Highbay
M7-360 Space Station Processing Facility Highbay
M7-1104 Multi-payload Processing Facility Highbay
M7-1210 Spacecraft Assembly and Encapsulation Facility #2 Highbay
M7-1354 Payload Hazardous Servicing Building Highbay

x. Vehicle/Equipment Maintenance

Target Products or Constituents: ***Used Oil and Tern Oil Filters***

Boeing PGOC frequently maintains service vehicles (i.e., trucks, forklifts, transporters, highlifts, etc.), facilities (cranes and highbay doors) and GSE. Servicing procedures include oil changes, oil filter changes, lubrication and clean-up. Boeing PGOC does not service fleet vehicles.

Wastes generated from vehicle/equipment maintenance procedures include tern oil filters, industrial wastewater, used oil (industrial and automotive), oily rags, non-tern oil filters, diesel fuel and cooling tower sludge. Tern filters are managed as a hazardous waste since Boeing PGOC cannot confirm the status or content of industrial filters. Industrial wastewater is generated from elevator pumpouts, cleaning (janitorial operations) and removal of water from an on-site chiller system. Approximately 1920 gallons of industrial wastewater was generated and shipped off-site in 1998. Cooling tower sludge is generated from cooling tower equipment cleanouts.

Process Locations:

M7-453 PGOC Maintenance
M7-458 PGOC Maintenance

xi. Photoprocessing/Graphics

Target Product or Constituent: ***Silver***

To support Payload and Facility operations, Boeing PGOC performs small scale, infrequent in-house photographic development. Approximately 50 gallons of waste photographic fixer (contaminated with silver) was generated in 1998. Waste photographic fixer is shipped to SGS for silver reclamation.

Process Location:

M7-355 Operations and Checkout Boeing Graphics

xii. Printed Circuit Board Fabrication/Repair

Target Product or Constituent: ***Lead Solder***

Boeing PGOC occasionally fabricates and repairs printed circuit boards for payload, GSE and facility operations. Printed circuit board fabrication and repair consists of surface preparation, etching and layering of printed circuit boards. Soldering is also accomplished. All lead solder is recycled. Boeing PGOC has recently decided to outsource printed circuit board fabrication to outside vendors.

Process Locations:

M6-342 Central Instrumentation Facility
M7-505 Electronic Repair Center
66330 Apollo Warehouse (CCAS)

xiii. Lighting Retrofit

Target Product or Constituent: ***Mercury***

Boeing PGOC is currently supporting the NASA/EPA Green Lights energy conservation program. This program involves replacing older, less energy efficient lighting fixtures with high efficiency units at PGOC operated facilities. Wastes generated from lighting retrofitting include broken and unbroken fluorescent lamps, HID bulbs and PCB ballasts (leaking and non-leaking). Intact fluorescent lamps and HID bulbs are recycled as a universal waste. Broken fluorescent lamps are disposed as a hazardous waste. PCB ballasts are disposed of as a regulated waste. The majority of these wastes would not normally be generated without this program.

Process Locations:

M7-505 PGOC Flight Warehouse (Complete)
M7-355 Operations and Checkout Altitude Chamber

xiv. Experiment Processing/Accident Cleanup

Target Product or Constituent: ***Biomedical Waste***

Boeing PGOC occasionally processes laboratory/biological experiment (animals & human) payloads for Space Shuttle mid-decks. Miniscule chemical components are segregated and disposed within existing PGOC wastestreams. Wastes generated from experiment processing include contaminated sharps and other biomedical wastes. Blood contaminated materials are generated from minor industrial accidents. Due to the sporadic nature of shuttle flights/landings and a 30-day storage limit on-site, the majority of 14-gallon boxes shipped off-site are not full. Approximately 585 gallons of biomedical waste was generated in 1998.

Process Locations:

M7-355 Operations and Checkout Off-line Laboratories
M7-360 Space Station Processing Facility Off-line Laboratories

xv. Steam Cleaning

Target Product or Constituent: ***Industrial Wastewater***

Boeing PGOC occasionally steam cleans payload transporters, payload canisters and GSE. Approximately 4000 gallons of industrial wastewater was generated in 1998. This process is being modified into a closed loop filtration system.

Process Location:

M7-777 Transporter/Canister Facility

xvi. Battery Maintenance/Changeouts

Target Product or Constituent: ***Nickel-Cadmium Batteries***

Boeing PGOC maintains and replaces various batteries used in facility and GSE equipment. Equipment requiring battery maintenance includes vehicles, emergency lighting, UPS systems and computers. All lead acid and nickel-cadmium batteries are recycled. Other types of batteries are disposed of as a universal waste.

Process Location:

M7-453 PGOC Maintenance

xvii. Welding/Cutting

Target Product or Constituent: ***Beryllium Contaminated Debris***

Boeing PGOC conducts small scale, infrequent welding of steel or aluminum parts used in supporting facility and GSE operations. Welding procedures use a limited number of welding rods. All used welding rods are recycled for their metal content. In 1998, a one time drilling of beryllium produced 35 gallons of beryllium contaminated debris.

Process Location:

M7-505 PGOC Machine Shop

xvii. Materials and Processes Lab

Target Product or Constituent: ***Hazardous Chemicals***

To ensure quality, Boeing PGOC conducts infrequent chemical analyses of materials used in facility, GSE and payload operations. A wide variety of chemicals are used in small quantities. Waste generation is negligible.

Process Location:

M7-505 PGOC Materials and Processes Laboratory

xix. Refrigeration Servicing/Maintenance

Target Product or Constituent: ***CFCs and HCFCs***

Boeing PGOC performs small scale, infrequent HVAC and refrigeration servicing and maintenance of facility and GSE operations. Various CFCs and HCFCs are used in servicing and maintenance procedures. Due to the environmental and economic impact of wasting CFCs and HCFCs, no significant wastes are generated. All CFCs are reclaimed, reused or transferred for reuse. The total volume of CFCs shipped off-site is insignificant.

Process Location:

M7-453 PGOC Maintenance

xx. Ammonia Servicing

Target Product or Constituent: ***Anhydrous Ammonia***

Select International Space Station (ISS) elements are serviced with anhydrous ammonia. Prior to anhydrous ammonia servicing, the ISS element is flushed with anhydrous ammonia to eliminate contamination. After the anhydrous ammonia flush, high purity anhydrous ammonia is loaded into the ISS element. Unused ammonia is usually vented off-site. To complete the servicing process, a vacuum is pulled on the loading equipment and lines. Contaminated ammonia is also generated and vented off-site.

Process Location:

M7-360 Space Station Processing Facility Intermediate Bay

xxi. Printer Servicing

Target Product or Constituent: ***Laser Printer Cartridges***

The majority of laser printer cartridges from frequent internal servicing are recycled. However, small quantities may be disposed of as solid waste. All copiers are subcontracted for servicing. Used toner is disposed of as a solid waste.

Process Location:

M7-355 Operations and Checkout Boeing Information Network Services

3.3.4 Joint Performance Management Office (JP)

A. <u>SGS Corrosion Control</u>

SGS Corrosion Control, located on Ransom Road is contracted to perform surface preparation and coating of various facilities, towers, structures and equipment. Objects which require corrosion control include flight hardware, Space Shuttle components, GSE, overhead and gantry cranes, lifting devices, house trailers, box cars, guard shacks, office buildings, electric motors, generators and roll up doors (in facilities). SGS Corrosion Control customers include USA Ground Operations, USA-SRB, Boeing PGOC and SGS. SGS Corrosion Control uses approximately 107 hazardous materials. Materials used in corrosion control procedures are specification or customer driven. SGS Corrosion Control performs the following processes:

i. Receiving

After arriving at SGS Corrosion Control, equipment undergoing corrosion control is inspected for degreasing cleanliness and detailed disassembly. After inspection, equipment is assigned a customer control number, tagged and moved to a customer color-coded area. The receiving process is completed with final documentation and scheduling.

ii. Surface Preparation

Target Product or Constituent: ***TCLP metals and Spent Blast Media***

After final documentation and scheduling, equipment is moved to the appropriate surface preparation area. Equipment is then examined for the type of surface preparation required. Once determined, it is inspected for cleanliness and prepared for coating application. Surface preparation procedures undergo quality control prior to coating application.

Surface preparation involves coating removal using plastic blast media, star blast, steel grit or high-pressure water. Spent blast media determined to be characteristically hazardous for barium, cadmium, chromium and/or lead is disposed of off-site. In the first nine months of 1999, two hundred and one 55-gallon drums of spent media blast were generated. In September 1999, SGS Corrosion Control decided to begin recycling spent plastic blast media contaminated with barium, cadmium, chromium and/or lead. Spent media blast will be shipped to Poly Pacific International, Inc. (Poly Pacific) of Edmonton, Alberta for use as a feed stock. Poly Pacific will use spent plastic blast media to maunfacture plastic products. The decision to ship spent blast media for use as a feed stock will eliminate the majority of hazardous waste generated by SGS Corrosion Control. SGS Corrosion Control will continue generating spent star blast and steel grit contaminated with TCLP metals. Spent blast media determined to be non-hazardous is disposed at a local landfill.

iv. Coating Application

Target Product or Constituent: ***Waste Solvents (MEK, Toluene and Xylene), Hazardous Solid Debris, Paint Residues and Waste Latex Paint***

If equipment passes surface preparation quality control, a coating system is applied. Coating application involves the following procedures:

- Determine coating system
- Inspect for proper masking
- Apply primer (if required) and inspect
- Apply intermediate coat(s) (if required) and inspect
- Apply topcoat(s) (if required) and inspect

HVLP and standard spray guns are used to apply primer, intermediate coats and top coats. Waste solvents (xylene, toluene, MEK or mineral spirits) are generated from cleaning spray guns used in spray application. One to two 55-gallon drums of waste solvent are generated a month from equipment clean-up. In the first nine months of 1999, eight 55-gallon drums of waste solvents were generated.

Waste masking material, spent rollers, contaminated personal protective equipment (PPE), contaminated rags, Kraft paper (used to capture overspray) and other hazardous solid debris is generated from the application of coatings. In the first nine months of 1999, twenty-six 55-gallon drums of hazardous solid debris were generated. Spent paint filters generated from coating application were determined to be non-hazardous.

SGS Corrosion Control also generates waste latex paint (non-regulated) and paint residues from aerosol can puncturing. In the first nine months of 1999, SGS Corrosion Control generated six 55-gallon drums of waste latex paint and five 55-gallon drums of paint residues.

iv. Staging and Final Inspection

After coating application, equipment is placed in a color-coded customer area and flagged for final inspection. Final inspection requires approval from the project painter, NACE inspector (if required), supervisor and quality personnel. If equipment passes inspection, work authorization documents (WADs) are completed. Finished equipment is then released to the customer.

3.4 Existing Pollution Prevention Initiatives

Process owners at KSC have implemented waste reduction strategies, material substitutions, process improvements and other pollution prevention opportunities. These initiatives have reduced waste generation, lowered disposal costs and improved worker safety. The following pollution prevention opportunities have been implemented at KSC:

3.4.1 Shuttle Processing (PH)

A. USA Ground Operations

i. Fueling

Pollution Prevention Opportunities

Equipment Layout and Automation
Waste Reduction

USA Ground Operations uses sodium hydroxide to neutralize hypergolic oxidizer (nitrogen tetraoxide). Once the sodium hydroxide reaches a pH equal or greater than 13, it is changed out. Approximately 145,449 pounds of spent oxidizer scrubber liquor is generated a year. To eliminate the off-site disposal of spent oxidizer scrubber liquor, USA Ground Operations is considering a product or process that transforms spent oxidizer scrubber liquor to fertilizer. The production of fertilizer could reduce or eliminate hazardous waste generation and future fertilizer purchases at KSC. Estimated project cost is between $150,000 and $180,000.

Process Substitution

To reduce the generation of MMH-contaminated rinse waters from MMH system and component washdown, USA Ground Operations is considering spray rinsing rather than flush rinsing. It is estimated that spray-rinsing procedures would reduce rinse waters generation by 85 to 90 percent. Testing, acceptance and implementation of spray rinsing is required. Approximately 42,865 pounds of MMH-contaminated rinse waters are generated a year.

Out-Process Recycling/ Reuse

The washing of tools, equipment and components with nitrogen tetraoxide generates approximately 30,521 pounds of neutralized oxidizer rinsate a year. To eliminate the off-site disposal of neutralized oxidizer rinsate, USA Ground Operations is determining if it can be used as make-up water (to supplement the new scrubber process). Implementation requires regulatory approval and engineering acceptance. In addition, USA Ground Operations is considering spray washing rather than flush washing. USA Ground Operations estimates that spray washing would reduce rinse water generation by 85 to 90 percent.

ii. Coating Application

Pollution Prevention Opportunities

In-Process Recycling/ Reuse
Input Material Substitution

Waste solvents (xylene, toluene and MEK) are generated from cleaning spray guns. To reduce waste solvent generation, USA Ground Operations purchased solvent reclamation units. Prior to solvent reclamation, USA Ground Operations generated approximately 4000 gallons of waste solvents a year. Currently, 200 gallons of waste solvents are generated a year. Two-part polyurethane usage has also reduced waste solvent generation.

In-process Recycling/ Reuse
Waste Reduction

Solvent reclamation units are also used to capture solvents from unused paint-related material. USA Ground Operations estimates that 800 to 1500 gallons of usable solvents are captured a year. Prior to solvent reclamation, USA Ground Operations generated approximately 34,949 pounds of unused paint-related material a year. In addition, USA Ground Operations has implemented strategies that improve planning and material usage.

Waste Segregation

Coating application procedures generate dried paint, contaminated media and other hazardous solid debris. To reduce hazardous waste generation, USA Ground Operations began segregating waste. As a result, moderate reductions of hazardous solid debris have been achieved. In addition, USA Ground Operations estimates that a better understanding of procurement practices and chemical usage will result in further reductions. Prior to implementation, approximately 22,647 pounds of hazardous solid debris were generated a year.

iii. General Cleaning

Pollution Prevention Opportunity

Input Material Substitution

To ensure cleanliness, the Orbiter, SRB and other components are physically wiped down. Due to F-listed solvent usage and contamination with lead-based greases, wiping procedures generated large volumes of hazardous waste. To eliminate hazardous waste generation, USA Ground Operations switched to terpenes and Vertrel®. This substitution has eliminated the generation of hazardous waste.

In addition, the MBMR Shop previously used MEK and dichloromethane to clean and maintain Orbiter tire rims. Currently, terpene or citrus-based cleaners are used. This substitution has eliminated the generation of hazardous waste.

iv. General Cleaning
Coating Application
Resins

Pollution Prevention Opportunity

Out-Process Recycling/ Reuse

USA Ground Operations uses rags to accomplish general cleaning, coating application and resin procedures. To reduce hazardous and solid waste generation, USA Ground Operations collects and launders rags contaminated with solvents and oil.

v. Purge Gas

Pollution Prevention Opportunity

Input Material Substitution

Aerosols that contain CFC-11 and HCFC-22 were previously used to remove dust from personal computers and other equipment. To eliminate CFC-11 and HCFC-22 usage, USA Ground Operations switched to HFC-134a. Attrition of aerosols that contain CFC-11 and HCFC-22 is complete.

vi. Inventory Control

Pollution Prevention Opportunities

Waste Reduction

By creating a hazardous materials pharmacy within the Orbiter Processing Facility, USA Ground Operations has changed how hazardous materials are dispensed to operational groups. A hazardous materials pharmacy allows unused materials to be returned (to a central location) for reissue or disposal.

USA Ground Operations has improved inventory management of hazardous chemicals. Improved inventory management has reduced the generation of off-specification and out-of-shelf life materials. In addition, USA Ground Operations is purchasing certain materials on an “just-in-time” basis.

USA Ground Operations also has a shelf life extension program. If practicable, certain off-specification materials are tested and re-certified for future use. Materials that do not meet qualification standards are disposed of.

vii. Machining

Pollution Prevention Opportunity

Input Materiel Substitution

Cutting fluids that contain 1,1,1 trichloroethane will be eliminated by attrition and replaced with vegetable oil. Other cutting fluids have been replaced with aqueous cutting and tapping solutions.

B. USA-SRB

i. Metal Finishing

Spray Application

Pollution Prevention Opportunities

Input Material Substitution

On December 6 and 7, 1999, USA-SRB began testing non-chromate alternatives (Alodine® 5700 and CHEMIDIZE® 727 ND) to Alodine® 1200. The evaluation process involves the application of both alternatives to an Aft Skirt. The Aft Skirt will be inspected to compare the candidate conversion coatings to Alodine® 1200.

Equipment Layout and Automation

To reduce the generation of wastewater from rinsing procedures, USA-SRB has installed industrial nozzles on the Alodine® rinse water hoses. Industrial nozzles encourage water conservation through improved water dispersion. Nozzle performance is also dependent of each individual operator.

Procedures/Scheduling

USA-SRB no longer pre-treats the inside of the Forward Skirt after every flight. The Forward Skirt is now treated every five flights. This scheduling change has reduced Alodine® wastewater generation.

Dip Application

Pollution Prevention Opportunities

In-Process Recycling/Reuse

Since Alodine® 1200 is lost to evaporation, wastewater is now reused to replenish the Alodine® 1200 tank. Approximately 15 gallons of Alodine® wastewater is placed in the Alodine® 1200 tank a week. Replenishment of the Alodine® 1200 tank has reduced Alodine® wastewater generation.

Waste Reduction

During dip applications of aluminum components, USA-SRB uses a spray gun to rinse SRB components. The implementation of a rinse spray gun has reduced the total volume of water used in rinsing procedures.

Equipment Layout and Automation

To prevent contamination, USA-SRB has replumbed the Alodine® process line. Prior to replumbing, USA-SRB has disposed of contaminated Alodine® 1200.

Maintenance/Housekeeping

On a weekly basis, USA-SRB analyzes Alodine® 1200 to determine its specification. If it meets the desired specification, it is used to treat aluminum. USA-SRB previously disposed Alodine® 1200 once a year.

ii. Coating Application

Pollution Prevention Opportunities

Input Material Substitution

On December 8, 1999, USA-SRB began testing non-chromate primers and topcoats. The evaluation process involves the application of several alternatives to an Aft Skirt. The Aft Skirt will be inspected to compare the candidate alternatives to current topcoats and primers.

A dry film lubricant is used to protect SRB Hardware. In June 1999, USA-SRB switched from using lead-based Lube-lock to lead-free Booster-lube. By replacing Booster-Lube, USA-SRB anticipated eliminating 240 pounds of hazardous air emissions and 1500 pounds of hazardous waste a year. On October 13, 1999, USA-SRB ceased using Booster-Lube since it separates prior to spray application. Currently, USA-SRB has reverted back to using Lube-lock until the problems with Booster-Lube have been solved.

To provide thermal protection, Marshall Conversion Coating (MCC) is spray applied (by a robot) to the SRB. Equipment lines are cleaned with dichloromethane after each application. In November 1999, USA-SRB began cleaning equipment lines with hot water. In the first nine months of 1999, approximately 100 pounds of waste dichloromethane was generated.

In December 1998, USA-SRB eliminated the use of Rust-O-leum paints. This substitution has reduced the volume of toxic air pollutants released to the atmosphere.

iii. Sealing/Adhesives

Pollution Prevention Opportunities

Waste Reduction
Input Material Substitution

USA-SRB has ceased purchasing cadmium-plated fasteners. However, an inventory of cadmium-plated fasteners still exists. Since the use of cadmium-plated fasteners is being phased out over time, it is possible that spent bead blast media will no longer be contaminated with cadmium. If USA-SRB eliminates the use of lead-based Lube-lock, it is possible that spent bead blast media will no longer be contaminated with lead.

Input Material Substitution

Certain SRB fasteners are sealed (for corrosion prevention) with chromium-based PR-1422. USA-SRB has switched to chromium-free PR-870 for sealing applications that do not require PR-1422. USA-SRB still uses PR-1422 for critical applications.

Waste Reduction

Since an adequate protective coating was already applied, USA-SRB decided that it was unnecessary to seal every fastener. The decision to seal certain fasteners has resulted in a 90 % reduction in PR-1422 usage. USA-SRB still uses PR-1422 for critical applications.

iv. Inventory Control

Pollution Prevention Opportunity

Waste Reduction

By creating a hazardous materials pharmacy, USA-SRB has changed how hazardous materials are dispensed to operational groups. A hazardous materials pharmacy allows unused materials to be returned (to a central location) for reissue or disposal.

v. Institutional

Pollution Prevention Opportunity

Out-Process Recycling/Reuse

USA-SRB previously directed 30,000 gallons of wastewater (from the PRF water treatment tank) to the sewer system. In the Spring 1999, USA-SRB began directing wastewater to the O & C water-cooled chiller for use as cooling tower make-up water.

C. Wiltech Corporation

i. Component Refurbishment

Pollution Prevention Opportunities

In-Process Recycling/ Reuse

USA Ground Operations recently purchased a molecular sieve (for use at Wiltech) to regenerate waste isopropanol. Currently, Wiltech generates approximately 15,741pounds of waste isopropanol a year. USA Ground Operations estimates that regeneration could reduce waste isopropanol generation by 85 to 90 percent. In addition, isopropanol usage is expected to increase with the input material substitution of CFC-113. Implementation of the molecular sieve is pending.

Maintenance/Housekeeping

To prevent the premature disposal of aqueous cleaning solutions, Wiltech analyzes (on a weekly basis) Turco solutions, sodium hydroxide, Hydrite 4000 and phosphoric acid. If they meet the desired specification, they are used in aqueous precision cleaning procedures.

ii. Institutional

Pollution Prevention Opportunities

Equipment Layout and Automation
Input Material Substitution

Prior to January 1997, industrial wastewaters processed with the LICON® treatment system were characteristically hazardous for cadmium. To eliminate this characteristic, Wiltech modified certain precision cleaning procedures and began using non-toxic greases and solvents. As a result, cadmium was eliminated from industrial wastewater. Prior to implementation, Wiltech generated approximately 25,100 pounds of characteristically hazardous wastewater a year.

3.4.2 Logistics Operations (LO)

A. USA-NASA Shuttle Logistics Depot

i. Metal Finishing

Pollution Prevention Opportunity

Maintenance/Housekeeping

On a weekly basis, USA-NSLD analyzes Alodine® 1200S to determine its specification. If it meets the desired specification, it is used to pre-treat aluminum. USA-NSLD previously disposed Alodine® 1200S prematurely.

ii. General Cleaning

Pollution Prevention Opportunity

Input Material Substitution

To ensure cleanliness, Orbiter components are wiped down with rags or ripple cloths. USA-NSLD previously used CFC-113 for physical wipedowns. This substitution has eliminated the use of a Class I ODS.

iii. Machining

Pollution Prevention Opportunity

Out-Process Recycling/ Reuse

USA-NSLD has installed a machine tool coolant preservation system. This system filters and purifies coolant in-situ for future reuse. It is estimated that this system will eliminate approximately 6000 pounds of waste coolant a year.

iv. Inventory Control

Pollution Prevention Opportunity

Waste Reduction

USA-NSLD has improved inventory management of hazardous chemicals. Improved inventory management has reduced the generation of off-specification and out-of-shelf life materials. In addition, USA-NSLD is purchasing certain materials on an "just-in-time" basis.

USA-NSLD also has a shelf life extension program. If practicable, certain hazardous chemicals are re-certified for future use. Materials that do not meet qualification standards are disposed of.

v. Surface Preparation
General Cleaning
Machining
Cable Fabrication

Pollution Prevention Opportunity

Out-Process Recycling/ Reuse

USA-NSLD uses rags to accomplish surface preparation, general cleaning, machining and cable fabrication procedures. To reduce hazardous and solid waste generation, USA-NSLD collects and launders rags contaminated with solvents and oil. Currently, only certain processes collect and launder contaminated rags.

3.4.3 Space Station and Shuttle Payloads (NN)

A. BOEING PGOC

i. Precision Cleaning

Pollution Prevention Opportunity

Input Material Substitution

Boeing PGOC performs high purity cleaning of gauges with TCE. Recently, Boeing PGOC substituted TCE with HFE-7100. Boeing PGOC will permanently replace TCE if HFE-7100 is determined to be an acceptable substitute.

ii. General Cleaning

Pollution Prevention Opportunities

Input Material Substitution

To ensure cleanliness, payload hardware, GSE and assigned clean rooms are wiped down. Boeing PGOC previously used a 100 % isopropanol solution for physical wipedowns. Currently, an 80 % water and 20% isopropanol mixture is used. Waste isopropanol is characteristically hazardous for ignitability. As a result, this substitution has eliminated the generation of hazardous waste.

In-Process Recycling/Reuse

Boeing PGOC occasionally steam cleans payload transporters, payload canisters and GSE. In 1998, approximately 4000 gallons of industrial wastewater was disposed of. Currently, this process is being modified into a closed loop filtration system. Wastewater generated from steam cleaning will be reused for future cleanings.

Out-Process Recycling/Reuse

Dirty alcohol rags generated from general cleaning are air-dried and reused for maintenance cleanups.

iii. Inventory Control

Pollution Prevention Opportunities

Input Material Substitution

Boeing PGOC has expanded their Affirmative Procurement program by increasing the purchase and use of re-refined oil, recycled antifreeze and high fly ash concrete.

Waste Reduction

Boeing PGOC has improved inventory management of hazardous chemicals. Improved inventory management has reduced the generation of off-specification and out-of-shelf life materials. In addition, Boeing PGOC is purchasing certain materials on an “just-in-time” basis.

Boeing PGOC also has a shelf life extension program. If practicable, certain hazardous chemicals are re-certified for future use. Materials that do not meet qualification standards are disposed of.

Procedures/Scheduling

To reduce the volume of materials disposed, Boeing PGOC offers unopened materials to all potential users (Boeing PGOC facilities and other KSC contractors). If the material meets specification, it is reused. Boeing PGOC also requires procurement to purchase materials in small quantities.

iv. Printed Circuit Board Manufacturing

Pollution Prevention Opportunity

Process Elimination

Boeing PGOC has decided to cease manufacturing printed circuit boards. Printed circuit boards used in future payloads, GSE and facility operations will be manufactured by outside vendors. As a result, wastes generated from manufacturing will be eliminated. Boeing PGOC will continue to repair printed circuit boards.

v. Refrigeration

Pollution Prevention Opportunity

In-Process Recycling/Reuse

Boeing PCOG is considering eliminating certain CFCs used in refrigeration servicing and maintenance. Phased-out CFCs will be transferred to other NASA contractors (for recycling and reuse) or traded with subcontractors to offset project costs.

vi. Institutional

Pollution Prevention Opportunities

Waste Reduction

To prolong scrubber liquor life, Boeing PGOC starting adding Biocide to their fuel and oxidizer scrubber liquors. As a result, Boeing PGOC rarely changes out scrubber liquors.

Waste Segregation

Wastewater generated from chiller blow-down is diverted to the sewer system. In the past, wastewater was disposed off-site or diverted to the sewer system.

Maintenance/Housekeeping

To prolong the life of oil/water separator filters, Boeing PGOC has adjusted preventative maintenance schedules.

vii. Printing

Pollution Prevention Opportunity

Waste Reduction

Boeing PGOC recycles the vast majority of laser printer cartridges from frequent internal servicing.

viii. Other

Pollution Prevention Opportunity

Input Material Substitution

In certain applications, Boeing PGOC has discontinued using mercury thermometers. Alcohol thermometers are used in non-critical applications.

3.4.4 Joint Performance Management Office (JP)

A. SGS Corrosion Control

i. Coating Application

Pollution Prevention Opportunities

Input Material Substitution

SGS Corrosion Control is currently investigating the use of water born acrylics, polyurethanes and siloxanes. These substitutions would eliminate the use of zinc-rich coatings.

In-Process Recycling/Reuse

To reduce virgin solvent usage and hazardous waste disposal costs, SGS Corrosion Control has decided to purchase solvent reclamation units. Spent solvents generated from equipment cleaning are disposed of as hazardous waste. Solvent reclamation and reuse will reduce the generation of hazardous waste.

Waste Reduction

To reduce the volume of solvents used in equipment cleaning, SGS Corrosion Control has decided to purchase paint gun washers. Currently, SGS Corrosion Control uses virgin solvent for each cleaning application. The use of paint gun washers will reduce virgin solvent usage and hazardous waste disposal costs.

SGS Corrosion Control plans on purchasing a computerized paint mixing and dispensing system. This system will precisely mix and dispense color specific paints. As a result, excess and unused paints will not be generated. In addition, computerized paint mixing will eliminate the ordering of color specific paints.

Equipment Layout and Automation

To improve the transfer efficiency of coatings being sprayed, SGS Corrosion Control has purchased HVLP (high-volume, low-pressure) spray guns. Improved transfer efficiency reduces the amount of paint overspray coming in contact with solids. Additional HVLP guns will be purchased.

ii. Surface Preparation

Pollution Prevention Opportunities

Equipment Layout and Automation
Process Substitution

SGS Corrosion Control has purchased a B.O.S.S. (Bicarbonate of Soda Stripper) Aqua miser. The B.O.S.S. Aqua miser is a high-pressure (15,000 to 40,000 psi) water system used to prepare surfaces for coating application. Water used in pressure washing is recycled and reused for future cleanings. In addition, the B.O.S.S. Aqua miser may also be used for coating removal. Coating removal is accomplished by adding abrasive substrates to the water used to remove the coating system. This substitution will eliminate the generation of spent plastic blasting agents (plastic or steel).

Process Substitution

SGS Corrosion Control is currently investigating a new coating removal technology. Coating removal is accomplished with a stripping gel. This substitution will eliminate the generation of spent blasting media (plastic and steel).

Out-Process Recycling/Reuse

Surface preparation involves coating removal using plastic blast media, star blast, steel grit or high-pressure water. In September 1999, SGS Corrosion Control decided to begin recycling spent blast media contaminated with barium, cadmium, chromium and/or lead. Spent blast media will be shipped to Poly-Pacific International, Inc. (Poly-Pacific) of Edmonton, Alberta for use as a feed stock. Poly-Pacific will use spent bead blast to manufacture plastic products. The decision to ship spent bead blast for reuse will eliminate the majority of hazardous waste generated by SGS Corrosion Control. SGS Corrosion Control will continue to generate spent star blast and steel grit contaminated with TCLP metals.

3.5 Process Owner Identified Needs

The P2 questionnaire requested process owners to provide a list of hazardous chemicals, hazardous wastes or processes that were targeted for waste reduction, material substitution or process improvement. The following waste streams or processes have been identified for investigation and consideration:

3.5.1 Shuttle Processing (PH)

A. <u>USA Ground Operations</u>

For the last several years, USA Ground Operations have contributed to the pollution prevention goals of KSC. In an on-going effort to reduce the total volume of hazardous waste generated at KSC, USA Ground Operations has expressed an interest in reducing the following waste streams:

- *Chromium-bearing rinse waters from Alodine® anodizing*
- *Media blast and debris contaminated with toxic paint residues*
- *Spent alkali from metal cleaning*
- *Waste chemical products*
- *Oxidizer scrubber liquor and rinsate*
- *Spent nitric acid*
- *Monomethylhydrazine solutions*
- *Unused paints and solvents*

To further reduce waste generation and disposal costs, USA Ground Operations has expressed an interest in the following pollution prevention initiatives:

<u>Input Material Substitution</u>

To neutralize heavy metals encountered in launch water, USA Ground Operations is interested in treating launch water with acids (nitric and phosphoric) and sodium hydroxide. Prior to implementation, a study of this substitution is required.

USA Ground Operations is interested in processing paint solids for use as components in plastic manufacturing. Prior to implementation, a study of this substitution is required.

<u>In-Process Recycling/Reuse</u>

USA Ground Operations is interested in procuring and installing ten oil/water separators.

<u>Waste Segregation</u>

USA Ground Operations is interested in using industrial wastewater for cooling tower make-up water. This segregation would require the implementation of a water recovery system that uses existing plant equipment and facilities.

B. <u>USA-SRB</u>

USA-SRB is committed to pollution prevention initiatives for all SRB operations. USA-SRB is interested in the following pollution prevention initiatives:

- *Process Substitution*
- *Input Material Substitution*
- *Waste Reduction*

- *In Process Recycling*
- *Equipment Layout and Automation*

To further reduce hazardous waste generation and disposal costs, USA-SRB has expressed an interest in the following pollution prevention initiatives:

Input Material Substitution

USA-SRB is interested in finding an acceptable substitute for Gacoflex Hypalon® HFR-2100 (Hypalon®). Hypalon® is used to seal the Thermal Protection System (TPS) of the SRB. After flight, the TPS and seal coat is removed. Hypalon® contains 74 % tetrachloroethylene by volume. USA-SRB has determined that TPS debris is characteristically hazardous for tetrachloroethylene.

In addition, certain hazardous chemicals will be eliminated through an attrition of current inventories. USA-SRB has instituted input material substitutions that do not affect critical applications.

C. Wiltech Corporation

To reduce hazardous waste generation and disposal costs, Wiltech Corporation (Wiltech) is interested in the following pollution prevention initiatives:

Waste Reduction

Wiltech is interested in reducing the generation of spent alkali from metal cleaning procedures. Research and study of current procedures and waste generation is required. Approximately 10,160 kilograms of spent alkali is generated a year.

3.5.2 Logistics Operations (LO)

A. USA-NASA Shuttle Logistics Depot (NSLD)

To reduce or eliminate hazardous waste generation and regulatory concerns, USA-NSLD is interested in the following pollution prevention initiatives:

Input Material Substitution

USA-NSLD is interested in substituting TCLP metal-based coatings with TCLP metal-free alternatives. This substitution would eliminate the generation of hazardous solid debris contaminated with TCLP metals and reduce hazardous waste disposal costs.

Equipment Layout/Automation

To ensure compliance with local sewer pre-treatment agreements, USA-NSLD is interested in purchasing silver reclamation units that treat photographic fixer below regulatory limits.

3.5.3 Space Station and Shuttle Payloads (NN)

A. Boeing PGOC

To further reduce waste generation and disposal costs, Boeing PGOC has expressed an interest in the following pollution prevention initiatives:

Input Material Substitution

Boeing PGOC is currently investigating acceptable substitutes for Alodine® 1200. This substitution would eliminate the generation of hazardous Alodine® wipes from Alodine® anodizing.

Waste Reduction

Boeing PGOC is interested in purchasing pre-soaked alcohol rags for general cleaning procedures. Pre-soaked alcohol rags would reduce current alcohol usage.

Out-Process Recycling/Reuse

Boeing PGOC is interested in laundering and reusing oily rags. This would reduce an additional 6% of their total non-RCRA waste.

Boeing PGOC is currently working with SGS to recycle antifreeze generated from vehicle/equipment maintenance procedures. Boeing PGOC generates approximately 300 gallons of waste antifreeze a year.

3.5.4 Joint Performance Management Office (JP)

A. SGS Corrosion Control

SGS Corrosion Control is interested in reducing hazardous waste generation and disposal costs. The largest waste stream generated from corrosion control activities is spent media blast contaminated with TCLP metals. SGS Corrosion Control is interested in the following pollution prevention initiatives:

Input Material Substitution

SGS Corrosion Control requests that their customers investigate what input material substitutions are feasible. Certain hazardous materials used for corrosion prevention are hazardous for TCLP metals. Input material substitutions could eliminate the generation of hazardous waste. Materials used in corrosion control procedures are specification or customer driven.

SGS Corrosion Control has determined that virgin Kraft paper used to capture overspray is above RCRA regulatory levels for lead. SGS Corrosion Control is interested in finding a virgin Kraft paper that is below RCRA regulatory levels for lead.

4.0. Common Pollution Prevention Opportunities at KSC

4.1 Common Pollution Prevention Opportunities Methodology

Facility assessments conducted between September and December 1999 identified common pollution prevention opportunities between KSC organizational elements. To quantify common pollution prevention opportunities, a *"Common Pollution Prevention Opportunities Table"* (CPPOT) was developed. The table is provided in Section 4.2. The intent of the table is to develop a working relationship between KSC organizational elements and contractors. Improved working relationships may increase the likelihood of project implementation.

The CPPOT also identifies pollution prevention opportunities that require immediate attention. Hopefully, this identification will assist in executing successful P2 programs at KSC. The identification of common pollution prevention opportunities at KSC is an initial step in determining common P2 needs across NASA. A CPPOT will be constructed for each NASA Center.

Table 1

	Directorate and Contractor					
	PH			LO	NN	JP
	USA-SRB	USA Ground Operations	Wiltech Corporation	USA-NSLD	Boeing PGOC	SGS Corrosion Control
Fueling						
Material Substitution of Monomethylhydrazine	X				X	
Testing						
Material Substitution of Monomethylhydrazine	X					
Foam Application						
Material Substitution of HCFC-141b propellant		X		X		
Metal Finishing						
• *Hand Application*						
Material Substitution of Alodine® 1200 and Pasa-jell		X		X	X	
• *Dip Application*						
Material Substitution of Alodine® 1200	X	X		X		
• *Spray Application*						
Material Substitution of Alodine® 1200	X					
Precision Cleaning						
Material Substitution of TCE with HFE-7100 for cleaning gauges					X	
Reclamation of Isopropanol	X		X			
Material Substitution of CFC-113 with HFE-7100 or Vertrel®			X	X		
General Cleaning						
Material Substitution of MEK	X			X	X	
Laundering of solvent contaminated rags (MEK)	X			X	X	
Coating Removal						
Material Substitution of Hypalon (Tetrachloroethylene)	X					
Material Substitution of TCLP Metal-Based Coatings	X					
Surface Preparation						
Material Substitution of TCLP Metal-Based Coatings				X	X	
Implementation of Supplemental Coating Removal Process				X		X
Material Substitution of 1,1,1-Trichloroethane (J-Seal)		X				
Product Substitution of Miller Stevensen-171 and CEEBE 228-D used for Chemical Stripping (Dichloromethane)				X		
Laundering of solvent contaminated rags (Dichloromethane)				X		
Coating Application						
Material Substitution of Hypalon (Tetrachloroethylene)	X	X				
Material Substitution of Deft IS-248 (SRB)	X					
Material Substitution of Lube-lock (Lead and Cadmium)	X					
Material Substitution of TCLP Metal-Based Coatings				X	X	X
Laundering of solvent contaminated rags				X		
Installation of HVLP paint guns						X
Solvent reclamation						X
Installation of paint gun washers						X
Installation of a computerized paint mixing						X
Sealing/Adhesives						
Material Substitution of Adhesives containing Hazardous Constituents					X	
Material Substitution of 1,1,1-Trichloroethane		X				
Product Substitution for PR-1422 (chromium-based)	X					
Machining						
Laundering of Oily Rags					X	

Table 1	Directorate and Contractor					
	PH			LO	NN	JP
	USA-SRB	USA Ground Operations	Wiltech Corporation	USA-NSLD	Boeing PGOC	SGS Corrosion Control
Machining (continued)						
Substitution of hazardous chemicals: 1,1,1-Trichloroethane, TCE, HCFC-141b, Dichloromethane or Tetrachloroethylene		X			X	
Cable Fabrication						
Material Substitution Tetra-Etch®				X	X	
Material Substitution of Teflon®-Coated cables with non Teflon®-coated cables				X	X	
Laundering of contaminated rags					X	
Vehicle and Equipment Maintenance						
Laundering of Oily Rags					X	
Printed Circuit Board Manufacturing						
Elimination of Printed Circuit Board Manufacturing					X	
Laundering of solvent contaminated rags				X		
Inventory Control						
Creation of Hazardous Materials Pharmacy					X	
Payload Assembly						
Material Substitution of Hazardous Adhesives					X	

5.0. Pollution Prevention Opportunity Prioritization

5.1 Prioritization Methodology

The John F. Kennedy Space Center is the NASA Lead Center for AP2 activities. To assist NASA AP2 Office personnel in identifying and prioritizing the implementation of potential P2 projects at all NASA Centers, the *"Pollution Prevention Opportunity Prioritization Table"* (PPOPT) was developed. To better understand and identify potential P2 opportunities, the PPOPT was applied to resident routine and non-routine operations at KSC. These operations support launch operations and programs relating to manned space missions.

The PPOPT uses an objective scoring system to assign numerical values to process specific chemical constituents. These values are assigned to the following three categories:

- Health effect(s)
- Potential environmental impact(s)
- Actual disposal impact(s)

Numerical risk/hazard ratings were assigned for each identified process constituent. Assignments reflect the perceived hazard(s) and/or risk(s) associated with the targeted constituent. Scoring values used for prioritization are provided in Table 2.

i. Health Effects

Health effects were determined for each constituent according to their associated risk for cancer and associated health risks. The *"Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man"* and the *"Integrated Risk Information System"* (IRIS) were both utilized during numerical risk/hazard assignment for cancer. Potential health effects were numerically ranked using the *"National Fire Protection Association"* (NFPA) Health Ranking System and OSHA Permissible Exposure Limit.

Cancer Risk

To quantify human health risks, chemicals are characterized as carcinogens (i.e. chemicals with demonstrated propensity for cancer induction) and non-carcinogens. Since carcinogens tend to dominate public concerns about health risk, they will receive the highest score. Due to a lack of experimental data, several hazardous constituents appearing within the PPOPT were determined to have unclassifiable carcinogen rankings.

The experimental research effort involved in developing a new dose-response relationship for a toxic substance takes considerable time. To determine cancer risk, information from International Agency for Research on Cancer (IARC): *"Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man"* and United States Environmental Protection Agency: *"Integrated Risk Information System"* was used. These rankings ranged from zero to four. The following values were assigned: "0" = non-carcinogenic; "1" = unclassifiable as to carcinogenity; "2" = possible carcinogen; "3" = probable carcinogen; and "4" = human carcinogen. Definitions and scores assigned for cancer risk are provided in Tables 3 and/or 4.

National Fire Protection Association Health Rating

The hazard posed by a chemical or waste is a function of its toxicity, mobility and persistence. To understand potential health effects of a chemical, the hazard rating (the intrinsic capability of a hazardous chemical to cause harm) should be determined. Sources used to determine health risk include NFPA Chemical Hazard Labels and a Chemical Container Label Database maintained by

Genium Publishing Corporation. The NFPA Chemical Hazard Label provides the health, flammability and reactivity hazards of chemicals. As with the IARC and IRIS systems, the NFPA numeric values ranged from zero to four. An assigned value of "0" indicates the lowest hazard potential contrasted by an assigned value of "4". A value of "4" represents the most significant health hazard. Scores based on the NFPA Chemical Hazard Label are provided in Tables 3 or 4.

OSHA Permissible Exposure Limit

The Occupational Safety and Health Administration (OSHA) has established *"Permissible Exposure Limits"* (PELs). Permissible Exposure Limits have been calculated from data sets for exposure to a chemical hazard. An exposure limit may be a time-weighted average (TWA) or a maximum concentration exposure limit. OSHA PEL values are enforceable under federal law and should not be exceeded during an eight-hour workday. In addition, OSHA PEL values are intended to express the harmful effects of chemical exposure. Chemicals with low PELs have a greater risk of causing negative health effects. OSHA PEL numeric values were assigned scores ranging from zero to four. An assigned value of "0" indicates a chemical with a high OSHA PEL. An assigned values of "4" represents a chemical with a low OSHA PEL. Scores relating to OHSA Permissible Exposure Limits are provided in Tables 3 or 4.

ii. Environmental Impact

Each hazardous constituent was evaluated for its potential to impact the environment through accidental release and/or fugitive emissions. Five methods of environmental fate and transport were evaluated during environmental impact analysis. They include the following:

1) Atmospheric Fate
2) Terrestrial Fate
3) Soil Mobility
4) Aquatic Fate
5) Bioconcentration Factor

Numerical values used for environmental impact assignment were obtained from the *"Hazardous Substance Data Bank"* (HSDB), a data file within the *"Toxicology Data Network"* (TOXNET®). The National Library of Medicine (NLM) maintains TOXNET®. Definitions relating to environmental impact are provided in Table 5.

Atmospheric Fate

Hazardous constituents are discharged to the atmosphere as gases or particulate matter. Once introduced, they undergo chemical transformations that deleteriously affect the atmosphere. Since transformations vary between chemicals, the extent of impact occurring in the atmosphere relates to chemical persistence.

Atmospheric fate scores range from zero to seven. Hazardous constituents with a longer half-life receive a higher score. Since the atmospheric half-life of an ODS exceeds three years, a score of seven was assigned. In addition, it was determined that chemical degradation by reaction with hydroxyl radicals or gravitational settling is responsible for reducing or eliminating hazardous constituents from the atmosphere. Scores relating to atmospheric persistence are provided in Table 6.

Terrestrial Fate

Another mechanism by which hazardous constituents can be transported is volatilization. Volatilization is the transfer of a chemical substance from a liquid phase to a gaseous phase. Vapor pressure provides an indication on the extent that hazardous constituent will volatilize. Soil and environmental conditions influence the vapor pressure of a contaminant. Hazardous constituents with higher vapor pressures are easily transported through soil to groundwater.

Scores assigned for terrestrial fate range from zero (stable in soil) to one (volatilization and leaching). Stable in soil refers to hazardous constituents that remain in the upper layer (two to five cm) of soil. Volatilization and leaching represents hazardous constituents that are transported to groundwater. Scores relating to terrestrial fate are provided in Table 6.

Soil Mobility

One of the most important processes determining how hazardous constituents are transported in the subsurface is adsorption. Adsorption is the adherence of atoms, ions or molecules of a gas or liquid to the surface of another substance. If a hazardous constituent is strongly adsorbed to soil, the contaminant is relatively immobile and will not migrate within the soil. If the contaminant is weakly adsorbed, it is relatively mobile and may contaminate groundwater. Soil adsorption rates are based on scientifically determined Koc values. The scores assigned for soil mobility range from zero (very high adsorption) to seven (very low or no adsorption). Hazardous constituents scored between one through six were determined to have soil adsorption values between the two extremes. Scores relating to soil mobility are provided in Table 6.

Aquatic Fate

Once a hazardous constituent is introduced to an aquatic system, it may undergo volatilization. Volatilization half-life refers to the time required for half of a hazardous constituent to undergo volatilization. Scores for aquatic fate range from zero (half-life of less than one day) to seven (deposited in sediment). A score of zero through six represents hazardous constituents that have a volatilization half-life. A score of seven represents hazardous constituents that undergo sediment deposition. Sediment deposition was assigned the highest score due to probable bioaccumulation within an aquatic system. Scores relating to aquatic fate are provided in Table 6.

Bioconcentration Factor

The bioconcentration factor indicates the amount of a chemical that is likely to accumulate in aquatic organisms. It varies from species to species and is affected by the organism's metabolism. Scores assigned for the bioconcentration factor range from zero (no bioconcentration) to seven (very high bioconcentration). The bioconcentration factor is an essential component in determining risk. Scores relating to bioconcnetration factor are provided in Table 6.

iii. Disposal Impact

NASA has emphazised the importance of implementing cost effective waste reduction strategies. In order to accomplish these goals, hazardous waste generation and subsequent disposal impacts must be examined.

To delineate disposal impacts at KSC, a numerical rating system was developed to rank disposal volumes of identified resident waste streams. Data used to determine disposal impact was obtained from the "*KSC Hazardous Waste Report*". The data sets included in the aforementioned publication were collected and generated by SGS. The subject publication may be found in the *"Environmental Management Section of Waste World Online"*. Disposal volumes for the last four reported quarters (fourth quarter 1998 through the third quarter 1999) were used to develop disposal impact scores. If disposal volumes were not avaliable on *Waste World Online*, they were obtained from the process owner. Disposal volumes used in prioritization do not reflect the total volume of waste generated at KSC. They reflect processes with identified pollution prevention opportunities.

Disposal impact rankings are based on the total percentage of waste generated from processes with identified pollution prevention opportunities. Eleven scoring ranges were established and assigned a value from zero to ten. An assigned value of “10” represents the greatest percentage of waste generated from a process with an identified pollution prevention opportunity. Numerical values were based on 27 of the 29 processes with identified pollution prevention opportunities. The spray application of Alodine® and surface preparation with blast media (two remaining processes) account for 57.95 percent of waste currently generated. To eliminate statistical outliers, these percentages were not used to calculate the scoring range. This creates a rating system that accurately scores processes with identified pollution prevention opportunities. Identified processes with waste volume, waste description, total percentage and/or score are provided in Tables 7 and/or 8.

SGS operates a centralized waste management system. This system leads to inherent challenges when assigning waste codes to identified pollution prevention opportunities. Several waste codes may relate to a single process under the current reporting system. In addition, certain waste streams are assigned several waste codes. In some instances, it is difficult to link a waste stream to a specific process. Waste code assignment was accomplished by examining SGS waste code definitions and reviewing identified pollution prevention opportunities.

Three processes with identified pollution prevention opportunities were found to generate no or negligible amounts of hazardous waste. However, they use ODSs and other hazardous constitutents of significant importance. These processes include the following:

- Precision Cleaning*:* ***Input material substitution of CFC-113***
- Precision Cleaning ***Input material substitution of Trichloroethylene***
- Foam Application*:* ***Input material substitution of HCFC-141b***

When a process generates no or negligible amounts of hazardous waste, it is difficult to assign numerical rankings for disposal impact. Since these processes do not have rankings for all three categories, they were not included in the final prioritization table. Due to their potential environmental impact, the NASA AP2 Office strongly recommends their elimination and/or substitution. Table 9 provides KSC pollution prevention opportunity prioritization information.

Table 2: Scoring Values for Prioritization

HEALTH EFFECTS

Cancer Risk	Health	OSHA PEL
4= Human carcinogen	4= May be fatal on short exposure	4= 0 to 1ppm
3= Probable carcinogen	3= Corrosive or toxic	3= 1ppm to 10ppm
2= Possible carcinogen	2= May be harmful if inhaled or absorbed	2= 10 ppm to 50ppm
1= Unclassifiable as to carcinogenity	1= May be irritating	1= 50 ppm to 500ppm
0= Non-carcinogen	0= Non-unusual hazard	0= > 500ppm

ENVIRONMENTAL IMPACT

Terrestrial Fate	Aquatic Fate	Atmospheric Fate	Soil Mobility	Bioconcentration
1= Volatilization and Leaching	7= Deposited in sediment	7= 3 years and up	7= Very high	7= Very high
0= Stable in soil	6= 36 days and up	6= 1 to 3 years	6= High	6= High
	5= 29 to 35 days	5= 181 to 365 days	5= Moderate to High	5= Moderate to High
	4= 22 to 28 days	4= 61 to 180 days	4= Moderate	4= Moderate
	3= 15 to 21 days	3= 15 to 60 days	3= Low to Moderate	3= Low to Moderate
	2= 8 to 14 days	2= 1 to 14 days	2= Low	2= Low
	1= 1 to 7 days	1= < 1 day	1= None to Low	1= None to Low
	0= < 1 day	0= Gravitational settling	0= None	0= None

DISPOSAL IMPACT

Percent of Total Waste
10= > 4.50
9= 4.05 to 4.49
8= 3.60 to 4.04
7= 3.15 to 3.59
6= 2.70 to 3.14
5= 2.25 to 2.69
4= 1.80 to 2.24
3= 1.35 to 1.79
2= 0.90 to 1.34
1= 0.45 to 0.89
0= 0.00 to 0.44

Table 3: Health Effects Worksheet

Hazardous Constituent	Carcinogen Ranking[1, 2]	Health[3, 4]	OSHA PEL[5]
Isopropanol	Unclassifiable carcinogen	1	400 ppm
Dichloromethane	Possible carcinogen	2	25 ppm
Tetrachloroethylene	Probable carcinogen	2	100 ppm
Lead	Probable carcinogen	3	50 ug/m^3
Methyl Ethyl Ketone	Unclassifiable as to carcinogenicity	1	200 ppm
Trichloroethylene	Probable carcinogen	2	100 ppm
Cadmium	Human carcinogen	3	5 ug/m^3
1,1,1-Trichloroethane	Unclassifiable as to carcinogenicity	2	350 ppm
Chromic Acid	Human carcinogen	3	0.1 mg/m^3
Chromium	Unclassifiable as to carcinogenicity	2	0.5 mg/m^3
Monomethylhydrazine	Possible carcinogen	4	0.2 ppm
Xylene	Unclassifiable as to carcinogenicity	2	100 ppm
Toluene	Unclassifiable as to carcinogenicity	2	200 ppm
1,1-Dichloroethylene	Unclassifiable as to carcinogenicity	2	100 ppm
1,2-Dichloroethane	Possible carcinogen	2	50 ppm
CFC 113	Unclassifiable as to carcinogenicity	2	1000 ppm
HCFC 141b	Unclassifiable as to carcinogenicity	2	1000 ppm
1,2-Dimethoxyethane	Unclassifiable as to carcinogenicity	2	100 ppm

Sources:

1 International Agency for Research on Cancer: Monographs on the Evaluation of the Carcinogen Risk of Chemicals to Man.

2 US Environmental Protection Agency: Integrated Risk Information System.

3 The National Fire Protection Association Chemical Hazard Labels.

4 Genium Publishing Corporation: Chemical Container Label Database.

5 US Department of Labor: Occupational Safety and Health Administration.

Table 4: Health Effects Worksheet with Scores

Hazardous Constituent	Carcinogen Ranking[1, 2]	Health[3, 4]	OSHA PEL[5]	Score
1,1,1-Trichloroethane	1	2	1	**4**
1,1-Dichloroethylene	1	2	1	**4**
1,2-Dichloroethane	2	2	2	**6**
1,2-Dimethoxyethane	1	2	1	**4**
Cadmium	4	3	4	**11**
CFC-113	1	2	0	**3**
Chromic Acid	4	3	4	**11**
Chromium	1	2	4	**7**
Dichloromethane	2	2	2	**6**
HCFC-141b	1	2	0	**3**
Isopropanol	1	1	1	**3**
Lead	3	3	4	**10**
Methyl Ethyl Ketone	1	1	1	**3**
Monomethylhydrazine	2	4	4	**10**
Tetrachloroethylene	3	2	1	**6**
Toluene	1	2	1	**4**
Trichloroethylene	3	2	1	**6**
Xylene	1	2	1	**4**

Sources:

1 International Agency for Research on Cancer: Monographs on the Evaluation of the Carcinogen Risk of Chemicals to Man.

2 U.S. Environmental Protection Agency: *Integrated Risk Information System.*

3 The National Fire Protection Association Chemical Hazard Labels.

4 Genium Publishing Corporation: *Chemical Container Label Database.*

5 U.S. Department of Labor: *Occupational Safety and Health Administration.*

Table 5: Environmental Impact Definitions

Hazardous Constituent	Terrestrial Fate	Aquatic Fate	Atmospheric Fate	Soil Mobility	Bioconcentration
Isopropanol	Volatilization and Leaching	Volatilizes (Half-life of 5 days)	Degradation by reaction with hydroxyl radicals (Half-life of several days)	Low	None
Dichloromethane	Volatilization and Leaching	Volatilizes (Half-life of several hours)	Degradation by reaction with hydroxyl radicals (Half-life of several months)	Low	None
Tetrachloroethylene	Volatilization and Leaching	Volatilizes (Half-life of 32 days)	Degradation by reaction with hydroxyl radicals (Half-life of several months)	Low to Medium	None
Lead	Stable in soil	Deposited in sediment	Gravitational settling	None to Low	High
Methyl Ethyl Ketone	Volatilization and Leaching	Volatilizes (Half-life of 8 days)	Degradation by reaction with hydroxyl radicals (Half-life up to 14 days)	High	Low
Trichloroethylene	Volatilization and Leaching	Volatilizes (Half-life of hours)	Degradation by reaction with hydroxyl radicals (Half-life up to 8 days)	Moderate to High	Moderate
Cadmium	Stable in soil	Deposited in sediment	Gravitational settling	None to Low	High
1,1,1-Trichloroethane	Volatilization and Leaching	Volatilizes (Half-life 24 days)	Degradation by reaction with hydroxyl radicals (Half-life up to 25 years)	High	None to Low
Chromic Acid	Stable in soi	Deposited in sediment	Gravitational settling	None	High
Chromium	Stable in soil	Deposited in sediment	Gravitational settling	None	Moderate to High
Monomethylhydrazine	Volatilization and Leaching	Volatilizes (Half-life of 24 days)	Degradation by reaction with hydroxyl radicals (Half-life of 6 hours)	Very high	Low
Xylene	Volatilization and Leaching	Volatilizes (Half-life of 4 days)	Degradation by reaction with hydroxyl radicals (Half-life up to 2 days)	Moderate to High	Low
Toluene	Volatilization and Leaching	Volatilizes (Half-life of several weeks)	Degradation by reaction with hydroxyl radicals (Half-life up to 1 day)	High	Low
1,1-Dichloroethylene	Volatilization and Leaching	Volatilizes (Half-life of 6 days)	Degradation by reaction with hydroxyl radicals (Half-life up to 11 hours)	Moderate	None

Table 5: Environmental Impact Definitions

Hazardous Constituent	Terrestrial Fate	Aquatic Fate	Atmospheric Fate	Soil Mobility	Bioconcentration
1,2-Dichloroethane	Volatilization and Leaching	Volatilizes (Half-life of 10 days)	Degradation by reaction with hydroxyl radicals (Half-life up to 1 month)	Moderate	None
CFC 113	Volatilization and Leaching	Volatilizes (Half-life of 4 hours)	Photolysis and reaction with singlet oxygen (Lifetime 63 to122 years)	Moderate	None
HCFC 141b	Volatilization and Leaching	Volatilizes (Half-life of 3.2 hours)	Degradation by reaction with hydroxyl radicals (Half-life of 1000 days)	Moderate to High	None
1,2-Dimethoxyethane	Volatilization and Leaching	Volatilizes (Half-life 240 days)	Degradation by reaction with hydroxyl radicals (Half-life of 25 hours)	Very high	Low

Source: National Library of Medicine. Toxicology Data Network: *Hazardous Substance Data Bank*

Table 6: Environmental Impact Worksheet With Scores

Hazardous Constituent	Terrestrial Fate	Aquatic Fate	Atmospheric Fate	Soil Mobility	Bioconcentration	Score
Isopropanol	1	1	3	2	0	**7**
Dichloromethane	1	0	5	2	0	**8**
Tetrachloroethylene	1	5	5	3	0	**14**
Lead	0	7	0	1	6	**14**
Methyl Ethyl Ketone	1	2	2	6	2	**13**
Trichloroethylene	1	0	2	5	4	**12**
Cadmium	0	7	0	1	6	**14**
1,1,1-Trichloroethane	1	4	7	6	1	**19**
Chromic Acid	0	7	0	0	6	**13**
Chromium	0	7	0	0	5	**12**
Monomethylhydrazine	1	4	1	7	2	**15**
Xylene	1	1	2	5	2	**11**
Toluene	1	5	2	6	2	**16**
1,1-Dichloroethylene	1	1	1	4	0	**7**
1,2-Dichloroethane	1	2	3	4	0	**10**
CFC 113	1	0	7	4	0	**12**
HCFC 141b	1	1	7	5	0	**14**
1,2-Dimethoxyethane	1	6	2	7	2	**18**

Source: National Library of Medicine. Toxicology Data Network: *Hazardous Substance Data Bank*

Table 7: Disposal Impact Worksheet

Identified Processes With Volume, Waste Description and Total Percentage

Process: *Metal Finishing: Hand Application of Alodine® and Pasa-jell*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
PH	USA Ground Operations	HD0033	Neutralized chromic acid debris (free liquids)	677.6	20.92%	
PH	USA Ground Operations	HC0005	Neutralized chromic acid debris (no free liquids)	620.4	19.16%	
PH	USA-SRB	HC0005	Neutralized chromic acid debris (no free liquids)	459.8	14.20%	
NN	Boeing PGOC	HC0005	Neutralized chromic acid debris (no free liquids)	1480.6	45.72%	
			Total	**3238.4**	100.0%	**0.93%**

Process: *Metal Finishing: Dip Application of Alodine®*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations	HD0033	Neutralized chromic acid debris (free liquids)	677.6	12.47%	
PH	USA Ground Operations	HC0005	Neutralized chromic acid debris (no free liquids)	620.4	11.42%	
PH	USA Ground Operations	HA0019	Nitric and chromic acid mixture	1982.2	36.48%	
PH	USA-SRB	HA0019	Nitric and chromic acid mixture	1694.0	31.17%	
PH	USA-SRB	HC0005	Neutralized chromic acid debris (no free liquids)	459.8	8.46%	
			Total	**5434.0**	100.0%	**1.56%**

Process: *Metal Finishing: Spray Application of Alodine®*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HC0004	Chromate solutions	103468.2	97.96%	
PH	USA-SRB	HA0019	Nitric and chromic acid mixture	1694.0	1.60%	
PH	USA-SRB	HC0005	Neutralized chromic acid debris (no free liquids)	459.8	0.44%	
			Total	**105622.0**	100.0%	**30.40%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *Precision Cleaning: Isopropanol*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
PH	USA Ground Operations	HJ0004	Isopropanol	5423.0	51.98%	
PH	USA-SRB	HJ0004	Isopropanol	4672.8	44.79%	
PH	Wiltech Corporation	HJ0004	Isopropanol	336.6	3.23%	
			Total	**10432.4**	100.0%	**3.00%**

Process: *Precision Cleaning: CFC-113*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations	HJ0048	Non-recoverable CFC-113	**866.8**	100.0%	**0.25%**

Process: *Precision Cleaning: Trichloroethylene*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
NN	Boeing PGOC		Solvent contaminated debris	**0**	0.00%	**0.00%**

Process: *Foam Application: HCFC 141b*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations		No hazardous waste	0		
LO	USA-NSLD		No hazardous waste	0		
			Total	**0**	0.00%	**0.00%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *Fueling: Monomethylhydrazine*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
PH	USA-SRB	HF0003	Water/ Hydrazine solutions	10111.2	58.10%	
PH	USA-SRB	HF002	Isopropanol containing hydrazine residues	684.2	3.93%	
PH	USA Ground Operations	HB0002	Discarded excess fuel (non-recoverable)	2723.6	15.65%	
PH	USA Ground Operations	HF0020	MMH and water (0.3% to 65%)	103.4	0.59%	
PH	USA Ground Operations	HF0021	MMH and water (< 0.3%)	873.4	5.02%	
NN	Boeing PGOC	HF0003	Water/ Hydrazine solutions	1456.4	8.37%	
NN	Boeing PGOC	HF002	Isopropanol containing hydrazine residues	327.8	1.88%	
NN	Boeing PGOC	HF0007	Solids contaminated with hydrazine	189.2	1.09%	
NN	Boeing PGOC	HX0006	Neutralized oxidizer rinsewaters	519.2	2.98%	
NN	Boeing PGOC	HX0002	Oxidizer solids	415.8	2.39%	
			Total	**17404.2**	100.0%	**5.01%**

Process: *Testing: Monomethylhydrazine*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HF0003	Water/ Hydrazine solutions	10111.2	69.75%	
PH	USA-SRB	HF002	Isopropanol containing hydrazine residues	684.2	4.72%	
PH	USA Ground Operations	HB0002	Discarded excess fuel (non-recoverable)	2723.6	18.79%	
PH	USA Ground Operations	HF0020	MMH and water (0.3% to 65%)	103.4	0.71%	
PH	USA Ground Operations	HF0021	MMH and water (< 0.3%)	873.4	6.03%	
			Total	**14495.8**	100.0%	**4.17%**

Process: *Cable Fabrication: 1,2-Dimethoxyethane*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
NN	Boeing PGOC	HK0009	Solvent contaminated debris	**171.6**	100.0%	**0.05%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *Surface Preparation: TCLP Metal -Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
NN	Boeing PGOC	HK0014	Solid debris with TCLP metals	561.0	86.73%	
NN	Boeing PGOC	HK0012/HK0017	Toxic paint debris (paint residues)	85.8	13.27%	
			Total	**646.8**	100.0%	**0.19%**

Process: *Surface Preparation: TCLP Metal -Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
JP	SGS Corrosion Control	HD0008	Blasting media and debris with toxic paint residue	78513.6	82.03%	
JP	SGS Corrosion Control	HK0012/HK0017	Toxic paint debris (paint residues)	4950.0	5.17%	
PH	USA Ground Operations	HK0012/HK0017	Toxic paint debris (paint residues)	12254.0	12.80%	
			Total	**95717.6**	100.0%	**27.55%**

Process: *Surface Preparation: 1,1,1-Trichloroethane*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations		Negligible amount of hazardous waste	**0**		**0.00%**

Process: *Surface Preparation: Dichloromethane*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations		Flammable solvents	**171.6**	100.0%	**0.05%**

Process: *Surface Preparation: TCLP Metal -Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations	HK0012/HK0017	Toxic paint debris (paint residues)	**12254.0**	100.0%	**3.53%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *Surface Preparation: TCLP Metal -Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
NN	Boeing PGOC	HK0014	Solid debris with TCLP metals	561.0	10.02%	
NN	Boeing PGOC	HK0012/HK0017	Toxic paint debris (paint residues)	85.8	1.53%	
JP	SGS Corrosion Control	HK0012/HK0017	Toxic paint debris (paint residues)	4950.0	88.44%	
			Total	**5596.8**	100.0%	**1.61%**

Process: *Surface Preparation: TCLP Metal -Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations	HK0012/HK0017	Toxic paint debris (paint residues)	**12254.0**	100.0%	**3.53%**

Process: *Coating Application: Waste Solvents (Xylene, Toluene, MEK or mineral spirits)*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
JP	SGS Corrosion Control	HJ0055/HJ0056	Spent paint solvents	**6091.8**	100.0%	**1.75%**

Process: *Coating Application: Waste Solvents (Xylene, Toluene, MEK or mineral spirits)*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
JP	SGS Corrosion Control	HJ0055/HJ0056	Spent paint solvents	**6091.8**	100.0%	**1.75%**

Process: *Coating Application: Coatings and Paints*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
JP	SGS Corrosion Control	HJ0055/HJ0056	Spent paint solvents	6091.8	55.17%	
JP	SGS Corrosion Control	HK0012/HK0017	Toxic paint debris (paint residues)	4950.0	44.83%	
			Total	**11041.8**	100.0%	**3.18%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *Coating Application: Coatings and Paint*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
JP	SGS Corrosion Control	HK0012/HK0017	Toxic paint debris (paint residues)	**4950.0**	100.0%	**1.42%**

Process: *Coating Application: Hypalon®*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB		Paint solids with Hypalon®	2290.2	56.73%	
PH	USA-SRB		Excess Hypalon®	1551.0	38.42%	
PH	USA Ground Operations		Hypalon®	195.8	4.85%	
			Total	**4037.0**	100.0%	**1.16%**

Process: *Coating Application: Lube-Lock*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HK0014	Solid debris with TCLP metals	**250.8**	100.0%	**0.07%**

Process: *Coating Removal: Hypalon®*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HK0012/HK0017	Toxic paint debris (paint residues)	**2534.4**	100.0%	**0.73%**

Process: *Coating Removal: TCLP Metal-Based Coatings*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HD0008	Blasting media and debris with toxic paint residue	**6373.4**	100.0%	**1.83%**

* Percentage of waste generated from processes with identified P2 opportunities

Table 7: Disposal Impact Worksheet

Process: *General Cleaning: MEK*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	Percent*
PH	USA-SRB	HJ0055/HJ0056	Spent paint solvents	7187.4	33.70%	
PH	USA-SRB	HJ0030/HJ0031	Paint solvent mixture (FP<73 and FP 73-141)	385.0	1.81%	
PH	USA Ground Operations	HJ0055/HJ0056	Spent paint solvents	13567.4	63.61%	
NN	Boeing PGOC	HK0009	Solvent contaminated debris	171.6	0.80%	
NN	Boeing PGOC	HJ0019	Methyl Ethyl Ketone	17.6	0.08%	
			Total	**21329.0**	100.0%	**6.14%**

Process: *Machining: 1,1,1-Trichloroethane or Tetrachloroethylene*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
NN	Boeing PGOC	HK0009	Solvent contaminated debris	**171.6**	100.0%	**0.05%**

Process: *Sealings/ Adhesives: 1,1,1-Trichloroethane*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA Ground Operations		Negligible amount of hazardous waste	**0**	0.00%	**0.00%**

Process: *Sealings/ Adhesives: PR-1422*

Directorate	Contractor	KSC Waste Code	Waste Description	Amount (lbs)	Process %	
PH	USA-SRB	HK0011	Polysulfide sealant (contains chromates)	**215.6**	100.0%	**0.06%**

TOTAL: 347393.2 lbs 100.0%

* Percentage of waste generated from identified P2 opportunities

Table 8: Disposal Impact Worksheet

Identified Processes With Waste Volume, Total Percentage and Score

Process	Volume (lbs)	Total Percentage	Score
Metal Finishing: Hand Application of Alodine® and Pasa-jell	3238.4	0.93	**2**
Metal Finishing: Dip Application of Alodine®	5434.0	1.56	**3**
Metal Finishing: Spray Application of Alodine®	105622.0	30.40	**10**
Precision Cleaning: Isopropanol	10432.4	3.00	**6**
Precision Cleaning: CFC-113	866.8	0.25	**0**
Precision Cleaning: Trichloroethylene	0.0	0.00	**0**
Foam Application: HCFC-141b	0.0	0.00	**0**
Fueling: Monomethylhydrazine	17404.2	5.01	**10**
Testing: Monomethylhydrazine	14495.8	4.17	**9**
Cable Fabrication: 1,2-Dimethoxyethane	171.6	0.05	**0**
Surface Preparation: TCLP Metal-Based Coatings	646.8	0.19	**0**
Surface Preparation: TCLP Metal-Based Coatings	95717.6	27.55	**10**
Surface Preparation: 1,1,1-Trichloroethane	0.0	0.00	**0**
Surface Preparation: Dichloromethane	171.6	0.05	**0**
Surface Preparation: TCLP Metal-Based Coatings	12254.0	3.53	**7**
Surface Preparation: TCLP Metal-Based Coatings	5596.8	1.61	**3**
Surface Preparation: TCLP Metal-Based Coatings	12254.0	3.53	**7**
Coating Application: Waste solvents (xylene, toluene, MEK or mineral spirits)	6091.8	1.75	**3**
Coating Application: Waste solvents (xylene, toluene, MEK or mineral spirits)	6091.8	1.75	**3**
Coating Application: Coatings and Paints	11041.8	3.18	**7**
Coating Application: Coatings and Paints	4950.0	1.42	**3**
Coating Application: Hypalon®	4037.0	1.16	**2**
Coating Application: Lube-Lock	250.8	0.07	**0**
Coating Removal: Hypalon®	2534.4	0.73	**1**
Coating Removal: TCLP Metal-Based Coatings	6373.4	1.83	**4**
General Cleaning: MEK	21329.0	6.14	**10**
Machining: 1,1,1-Trichloroethane or Tetrachloroethylene	171.6	0.05	**0**
Sealings/ Adhesives: 1,1,1-Trichloroethane	0.0	0.00	**0**
Sealings/ Adhesives: PR-1422	215.6	0.06	**0**
TOTAL	**347393.2**	**100.0**	

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Metal Finishing

Pollution Prevention Opportunity	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	TOTAL
Hand Application						
Pollution Prevention Opportunity	**Organization Element**					
Material Substitution of Alodine ® and Pasa-jell	PH, LO, NN	Chromic Acid	11	13	2	**26**
Dip Application						
Pollution Prevention Opportunity						
Material Substitution of Alodine ®	PH, LO	Chromic Acid	11	13	3	**27**
Spray Application						
Pollution Prevention Opportunity						
Material Substitution of Alodine ®	PH	Chromic Acid	11	13	10	**34**
Precision Cleaning						
Pollution Prevention Opportunities						
Recycling/Reuse of Isopropanol	PH	Isopropanol	3	7	6	**16**
Material Substitution of CFC-113	PH, LO	CFC-113	3	12	0	**Note***
Material Substitution of Trichloroethylene	NN	Trichloroethylene	6	12	0	**Note***
Foam Application						
Pollution Prevention Opportunity						
Material Substitution of HCFC-141b	PH, LO	HCFC-141b	3	14	0	**Note***

Note*: See Page 129

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Pollution Prevention Opportunity	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	TOTAL
Fueling						
Material Substitution of Monomethylhydrazine	PH, NN	Monomethylhydrazine	10	15	10	**35**
Testing						
Material Substitution of Hydrazine	PH	Monomethylhydrazine	10	15	9	**34**
Cable Fabrication						
Material Substitution of Tetra-etch®	LO, NN	1,2-Dimethoxyethane	4	18	0	**22**
Surface Preparation						
Substitution of TCLP metal-based coatings	NN	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
			9.3	**13.3**	**0**	**22.7**
Implementation of supplemental coating removal process	LO, JP	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
			8.5	**13**	**10**	**31.5**
Material Substitution of 1,1,1-Trichloroethane	PH	1,1,1-Trichloroethane	4	19	0	**23**
Product Substitution of Miller Stevenson-171 and CEEBE 228-D	LO	Dichloromethane	6	8	0	**14**

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Pollution Prevention Opportunity	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	TOTAL
Material Substitution of TCLP metal-based coatings	LO	Chromium	7	12		
		Lead	10	14		
			8.5	**13**	**7**	**28.5**
Coating Application						
Pollution Prevention Opportunities						
Material Substitution of TCLP metal-based coatings	NN, JP	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
			9.3	**13.3**	**3**	**25.7**
Material Substitution of TCLP metal-based coatings	LO	Chromium	7	12	7	**26**
Installation of paint gun washers	JP	MEK	3	13		
		Xylene	4	11		
		Toluene	4	16		
			3.7	**13.3**	**3**	**20.0**
Solvent reclamation	JP	MEK	3	13		
		Xylene	4	11		
		Toluene	4	16		
			3.7	**13.3**	**3**	**20.0**

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Pollution Prevention Opportunities	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	TOTAL
Installation of HVLP paint guns	JP	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
		1,2-dichloroethane	6	10		
		1,1-dichloroethylene	4	7		
		MEK	3	13		
		Tetrachloroethylene	6	14		
		Trichloroethylene	6	12		
		Xylene	4	11		
		Toluene	4	16		
			6.1	**12.3**	**7**	**25.4**
Installation of Computerized paint mixing system	JP	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
		1,2-dichloroethane	6	10		
		1,1-dichloroethylene	4	7		
		MEK	3	13		
		Tetrachloroethylene	6	14		
		Trichloroethylene	6	12		
		Xylene	4	11		
		Toluene	4	16		
			6.1	**12.3**	**3**	**21.4**
Material Substitution of Hypalon®	PH	Tetrachloroethylene	6	14	2	**22**
Material Substitution of Lube-lock	PH	Cadmium	11	14		
		Lead	10	14		
			10.5	**14**	**0**	**24.5**

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Coating Removal

Pollution Prevention Opportunities	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	
Material Substitution of Hypalon®	PH	Tetrachloroethylene	6	14	1	**21**
Material Substitution TCLP metal-based coatings	PH	Cadmium	11	14		
		Chromium	7	12		
		Lead	10	14		
			9.3	**13.3**	**4**	**26.7**

General Cleaning

Pollution Prevention Opportunity	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	
Material Substitution of MEK	PH, LO, NN	MEK	3	13	10	**26**

Machining

Pollution Prevention Opportunity	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	
Material Substitution of hazardous chemicals: 1,1,1-Trichloroethane and Tetrachloroethylene	NN	1,1,1-Trichloroethane	4	19		
		Tetrachloroethylene	6	14		
			5	**16.5**	**0**	**21.5**

Sealing/Adhesives

Pollution Prevention Opportunities	Organization Element	Hazardous Constituent	Health	Environmental	Disposal	
Material Substitution of 1,1,1-Trichloroethane	PH	1,1,1-Trichloroethane	4	19	0	**23**
Material Substitution of PR-1422	PH	Chromium	7	12	0	**19**

Table 9: KSC Pollution Prevention Opportunity Prioritization Worksheet

Pollution Prevention Opportunities Not Prioritized

Pollution Prevention Opportunity	Organization Element
• Material Substitution of Deft IS-248	PH
• Laundering of Solvent Contaminated Rags	PH, LO, NN
• Creation of a Hazardous Material Pharmacy	NN
• Material Substitution of Adhesives and Epoxies	NN
• Laundering of Oily Rags	NN
• Elimination of Printed Circuit Board Manufacturing	NN
• Material Substitution of Teflon® -Coated Cables	LO, NN

5.2 KSC Pollution Prevention Opportunity Prioritization

Table 10: Identified Pollution Prevention Opportunities

Rank	Process and Identified P2 Opportunity	Organization Element	Total Score
1	**Fueling** Material Substitution of Monomethylhydrazine	PH, NN	**35**
2	**Metal Finishing** *Spray Application* Material Substitution of Alodine ®	PH	**34**
2	**Testing** Material Substitution of Hydrazine	PH	**34**
4	**Surface Preparation** Implementation of supplemental coating removal process	LO, JP	**31.5**
5	**Surface Preparation** Material Substitution of TCLP Metal-Based Coatings	LO	**28.5**
6	**Metal Finishing** *Dip Application* Material Substitution of Alodine ®	PH, LO	**27**
7	**Coating Removal** Material Substitution of TCLP Metal-Based Coatings	PH	**26.7**
8	**Coating Application** Material Substitution of TCLP Metal-Based Coatings	LO	**26**
8	**Metal Finishing** *Hand Application* Material Substitution of Alodine ® and Pasa-Jell	PH, LO, NN	**26**
8	**General Cleaning** Material Substitution of MEK	PH, LO, NN	**26**
11	**Coating Application** Material Substitution of TCLP Metal-Based Coatings	NN, JP	**25.7**
12	**Coating Application** Installation of HVLP paint guns	JP	**25.4**
13	**Coating Application** Material Substitution of Lube-lock	PH	**24.5**

5.2 KSC Pollution Prevention Opportunity Prioritization

Table 10: Identified Pollution Prevention Opportunities

Rank	Process and Identified P2 Opportunity	Organization Element	Total Score
14	**Surface Preparation** Material Substitution of 1,1,1-Trichloroethane	PH	**23**
15	**Surface Preparation** Substitution of TCLP metal-based coatings	NN	**22.7**
16	**Coating Application** Material Substitution of Hypalon®	PH	**22**
16	**Cable Fabrication** Material Substitution of Tetra-etch®	LO, NN	**22**
18	**Machining** Material Substitution of hazardous chemicals: 1,1,1-Trichloroethane and Tetrachloroethylene	NN	**21.5**
19	**Coating Application** Installation of Computerized paint mixing system	JP	**21.4**
20	**Coating Removal** Material Substitution of Hypalon®	PH	**21**
21	**Coating Application** Installation of paint gun washers	JP	**20**
21	**Coating Application** Solvent reclamation	JP	**20**
23	**Sealing/Adhesives** Material Substitution of 1,1,1-Trichloroethane	PH	**19**
24	**Precision Cleaning** Recycling/Reuse of Isopropanol	PH	**16**
25	**Surface Preparation** Product Substitution of Miller Stevenson-171: CEEBE 228-D used for chemical stripping	LO	**14**
26	**Sealing/Adhesives** Material Substitution of PR-1422	PH	**12**

5.2 KSC Pollution Prevention Opportunity Prioritization

Table 11: Opportunities of Significant Importance

Rank	Process and Identified P2 Opportunity	Organization Element	Total Score
Note *	**Precision Cleaning** Material Substitution of Trichloroethylene	NN	18
Note *	**Foam Application** Material Substitution of HCFC-141b	PH, LO	17
Note *	**Precision Cleaning** Material Substitution of CFC-113	PH, LO	15

Note*: No rank assigned. Process generates no or negligible amounts of hazardous waste.

6.0 Appendix

6.1 Flow Diagrams

Shuttle Processing (PH)

USA Ground Operations

Baseline Pretreatment - Alodine® 1200
Dip Application of Small Aluminum Parts

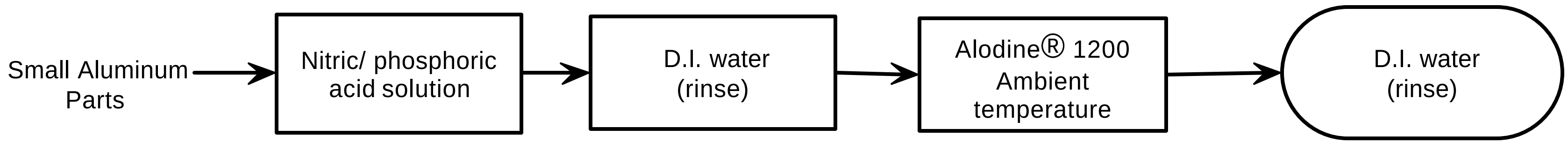


Figure 1 **132**

USA Ground Operations

The Mechanical Bench Machine Repair Shop

Cleaning of Orbiter Tire Rims

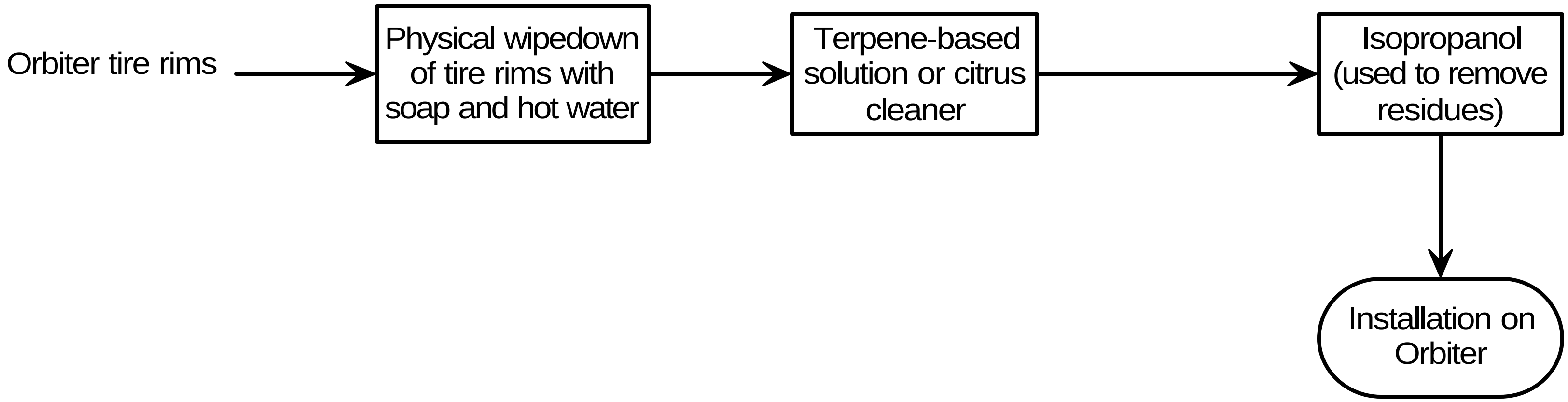
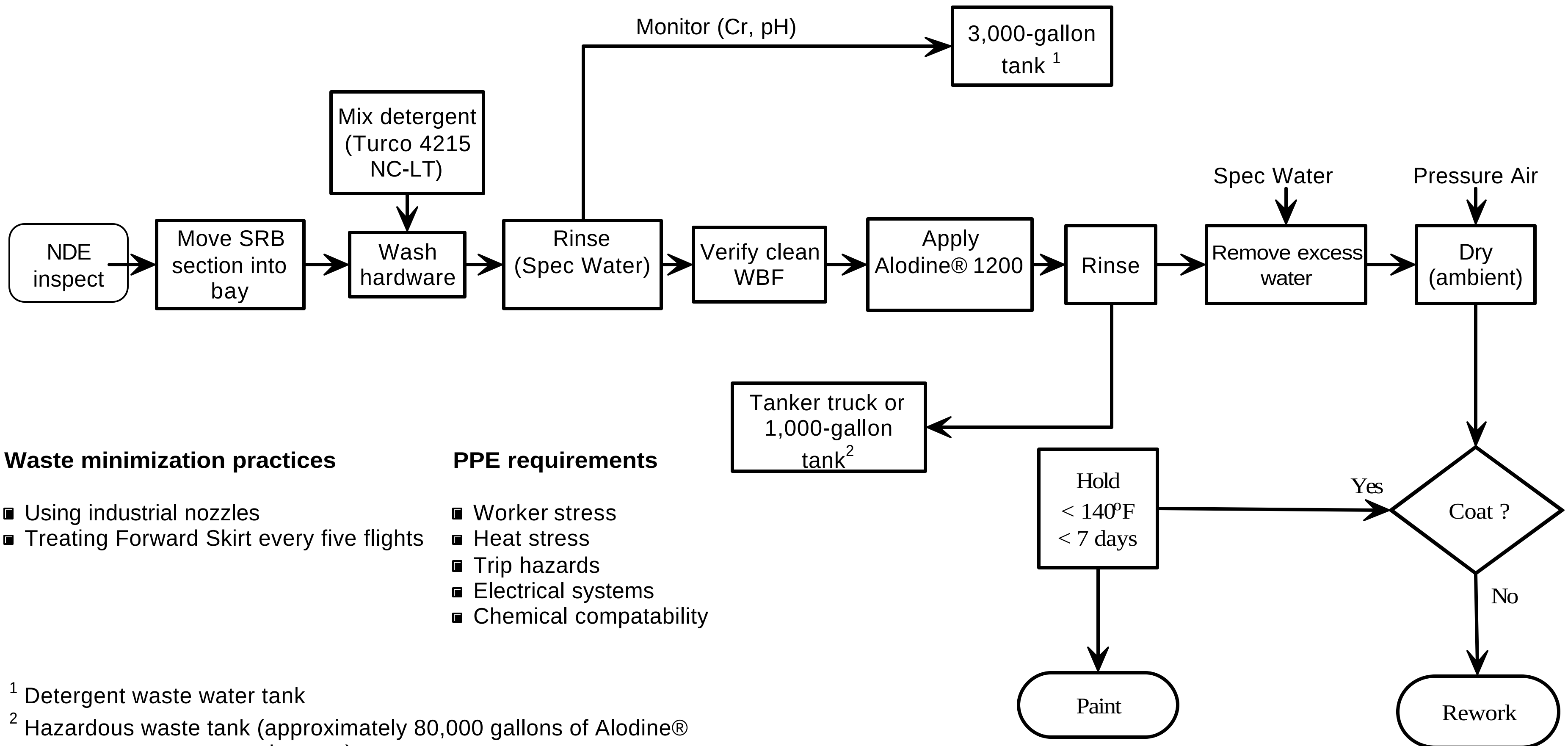


Figure 2 **133**

Baseline Pretreatment - Alodine® 1200
Spray Application



Waste minimization practices

- Using industrial nozzles
- Treating Forward Skirt every five flights

PPE requirements

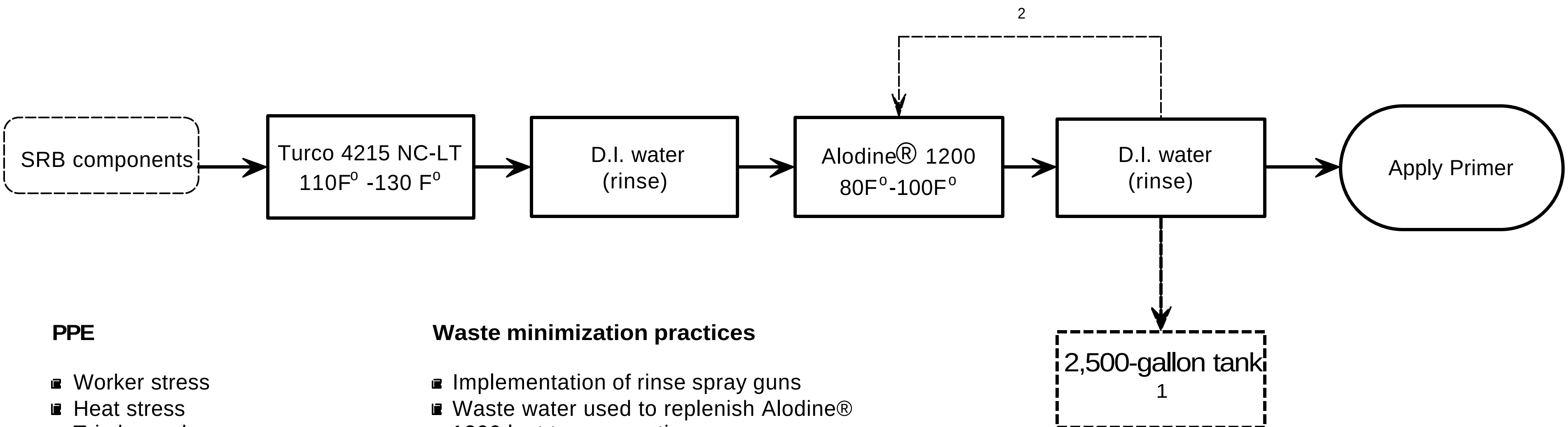
- Worker stress
- Heat stress
- Trip hazards
- Electrical systems
- Chemical compatability

[1] Detergent waste water tank

[2] Hazardous waste tank (approximately 80,000 gallons of Alodine® waste water generated a year)

Figure 3 **134**

Baseline Pretreatment - Alodine® 1200
Alodine® Treatment of Small SRB Components



PPE

- Worker stress
- Heat stress
- Trip hazards
- Chemical compatibility

Waste minimization practices

- Implementation of rinse spray guns
- Waste water used to replenish Alodine® 1200 lost to evaporation

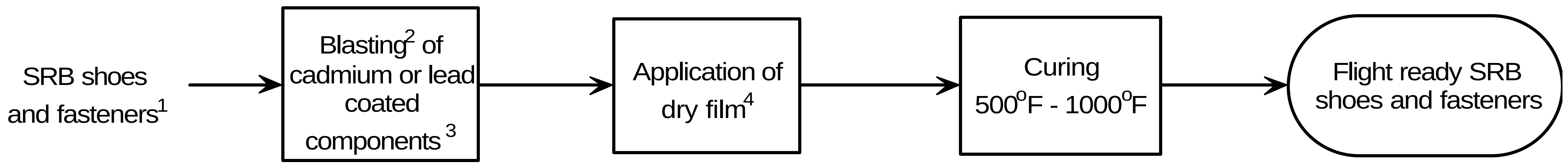
[1] Hazardous waste tank (approximately 20,000 gallons of alodine waste water generated each year)

[2] Waste water used to replenish Alodine® 1200

Figure 4 **135**

USA-SRB

Blasting and Coating of SRB Shoes and Fasteners



[1] Fasteners include spherical nuts, spherical bearings, washers, ball fittings, spacers and nuts

[2] Aluminum oxide is used as blast media

[3] 5,100 pounds of spent bead blast media generated in 1998, (characteristically hazardous for barium, cadmium, chromium and lead)

[4] Lead based Lube-Lock replaced with Booster-Lube

Waste minimization practices

- USA-SRB has ceased purchasing cadmium-plated fasteners

Figure 5 **136**

Preparation and Application of SRB Coating System Prior to Flight

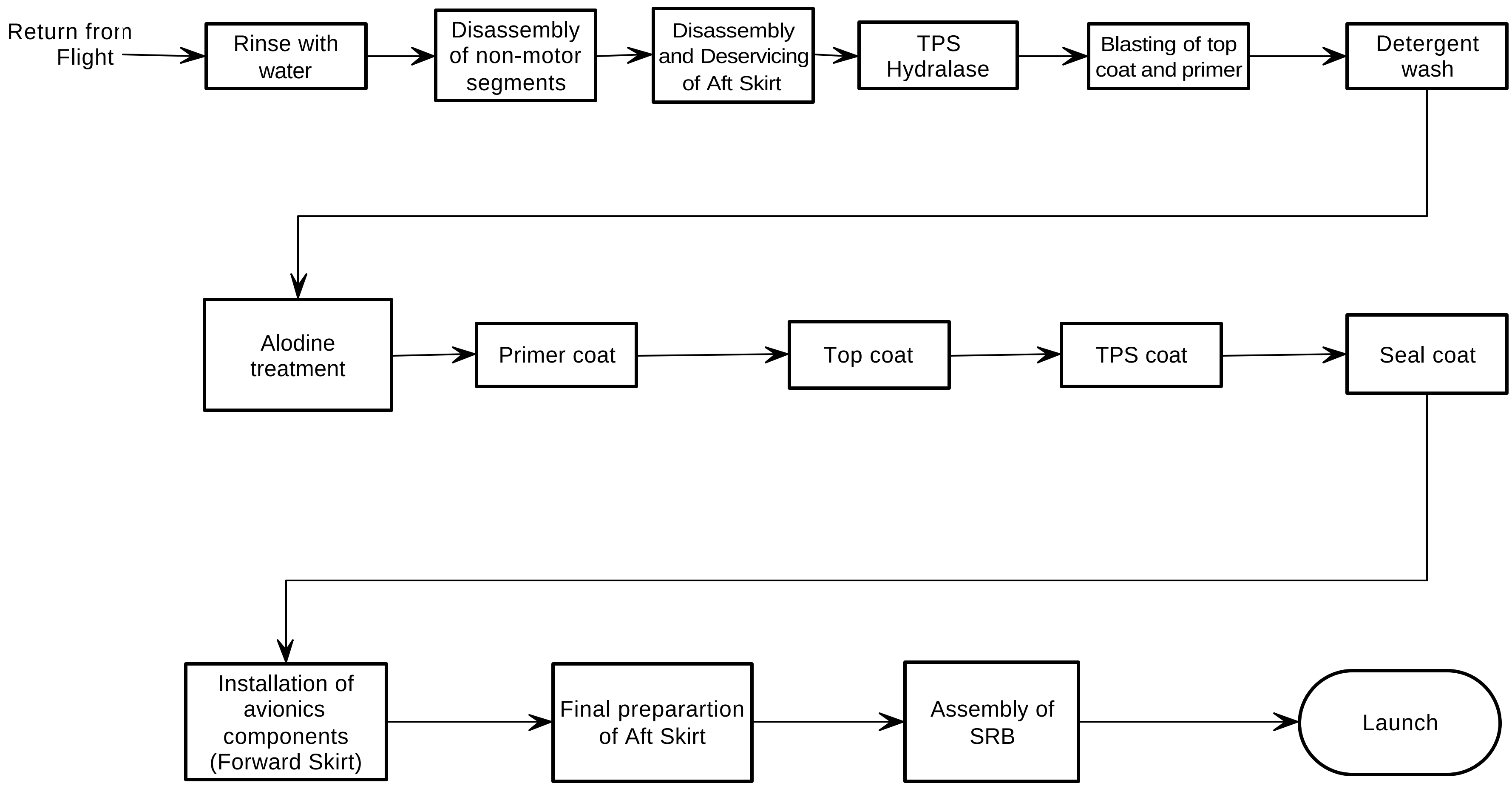
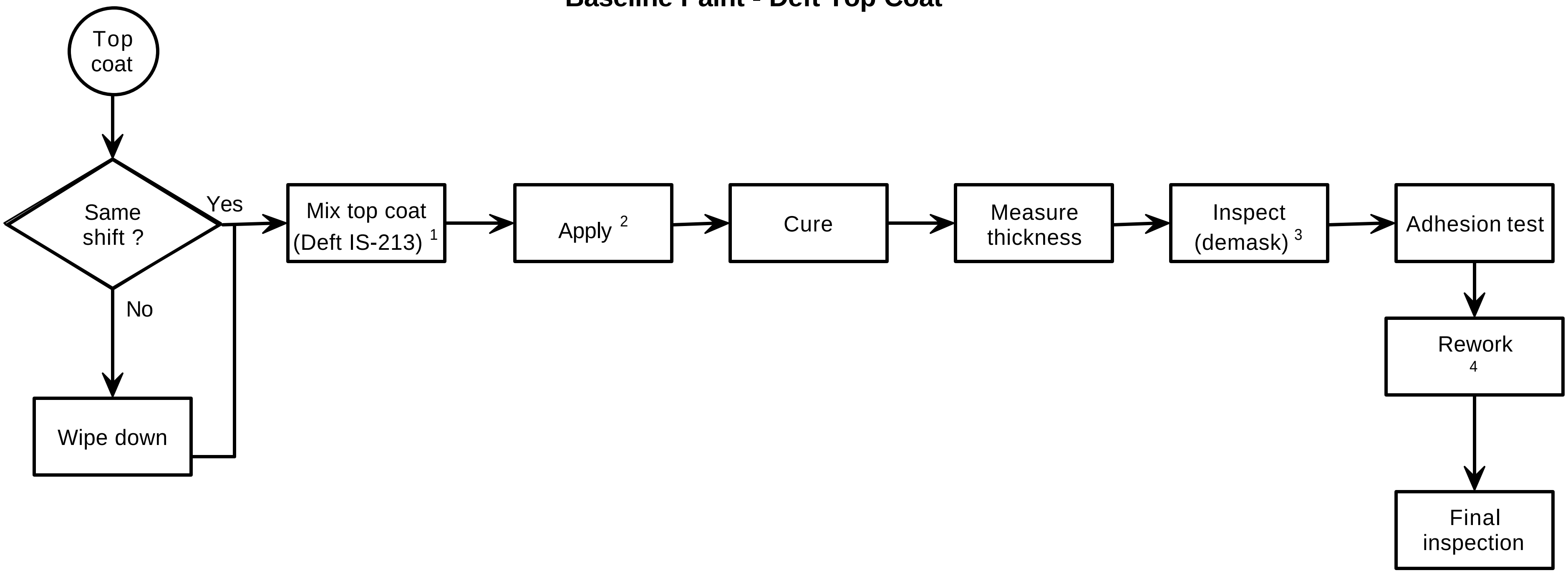


Figure 6

137

Baseline Paint - Deft Top Coat



[1] Short pot life (0.75 to 1 gallon of waste paint generated every paint job)

[2] Air emissions and chemical exposure

[3] Mask waste

[4] Particulate and rework waste

PPE requirements

- Worker exposure
- Heat stress
- Nozzle efficiency
- Process flexibility

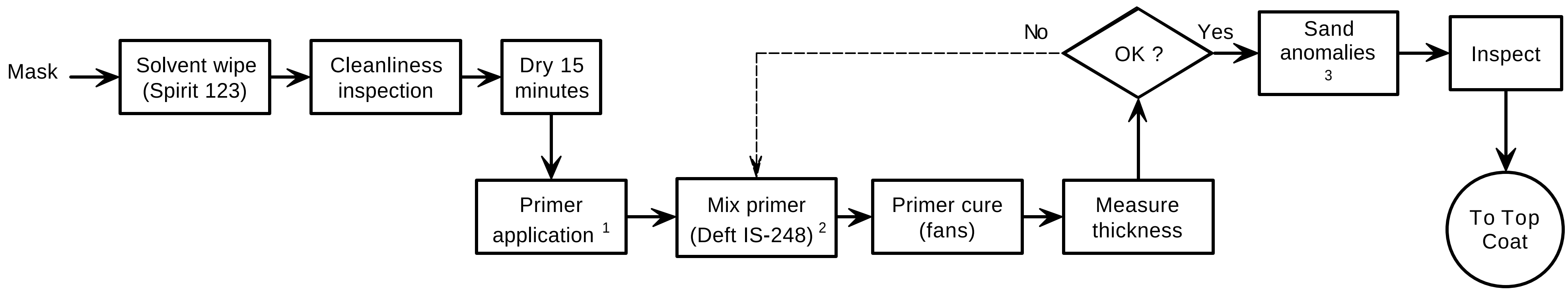
Waste generation

- 5 gallons of organic solvent (xylene, toluene and MEK) waste generated every 10 paint jobs
- Spent air filters are disposed of in dumpster as solid waste

Figure 7

USA-SRB

Baseline Paint - Deft Primer



[1] Air emissions and Chemical exposure

[2] Short pot life, 0.75 to 1 gallon of waste generated evey paint job

[3] Particulate and Rework waste

PPE requirements

- Worker exposure
- Heat stress
- Nozzle efficiency
- Process flexibility

Waste generation

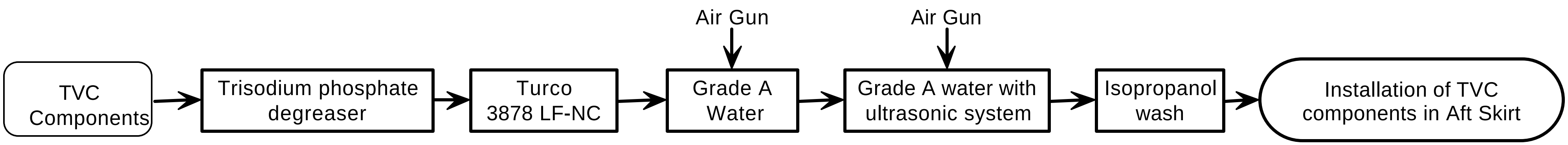
- 5 gallons of organic solvent (xylene, toluene and MEK) waste generated every 10 paint jobs

Figure 8

139

USA-SRB

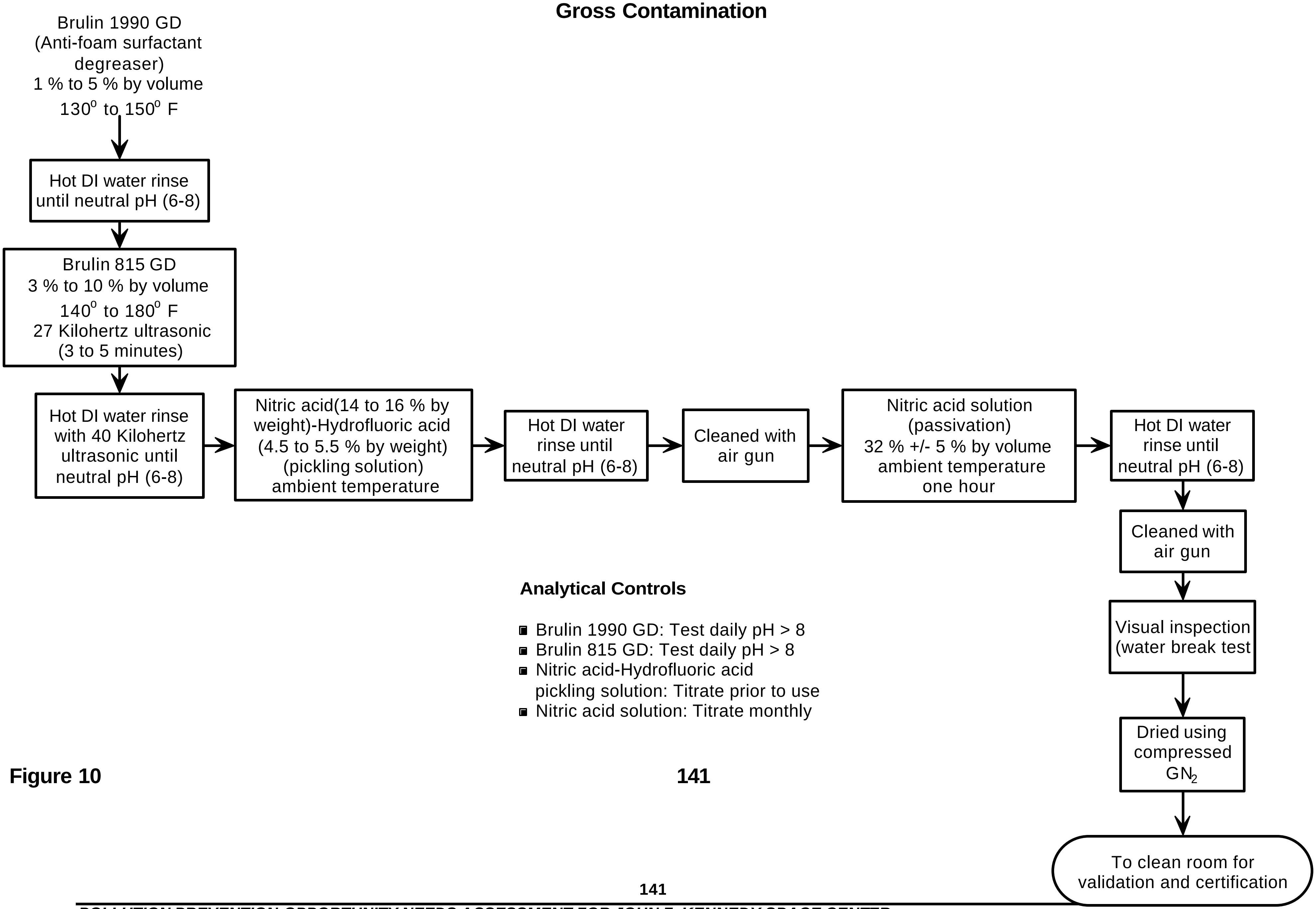
Precision Cleaning of Thrust Vector Control (TVC) Components



3,750 pounds of waste isopropanol generated in the first 9 months of 1999

Figure 9

Aqueous Cleaning of 300 Series Stainless Steel
Gross Contamination



Analytical Controls

- Brulin 1990 GD: Test daily pH > 8
- Brulin 815 GD: Test daily pH > 8
- Nitric acid-Hydrofluoric acid pickling solution: Titrate prior to use
- Nitric acid solution: Titrate monthly

Figure 10

141

Aqueous Cleaning and Verification

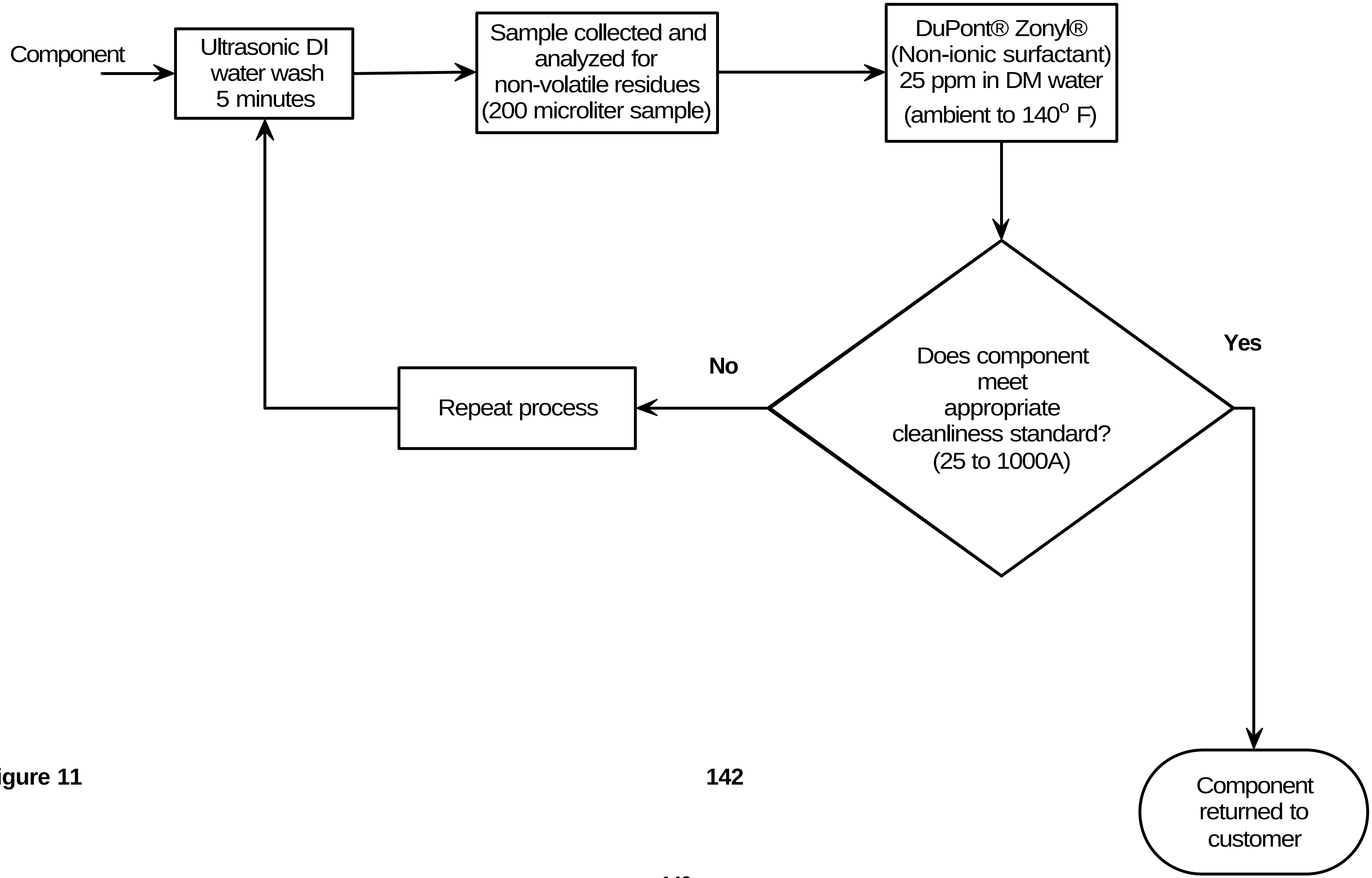


Figure 11

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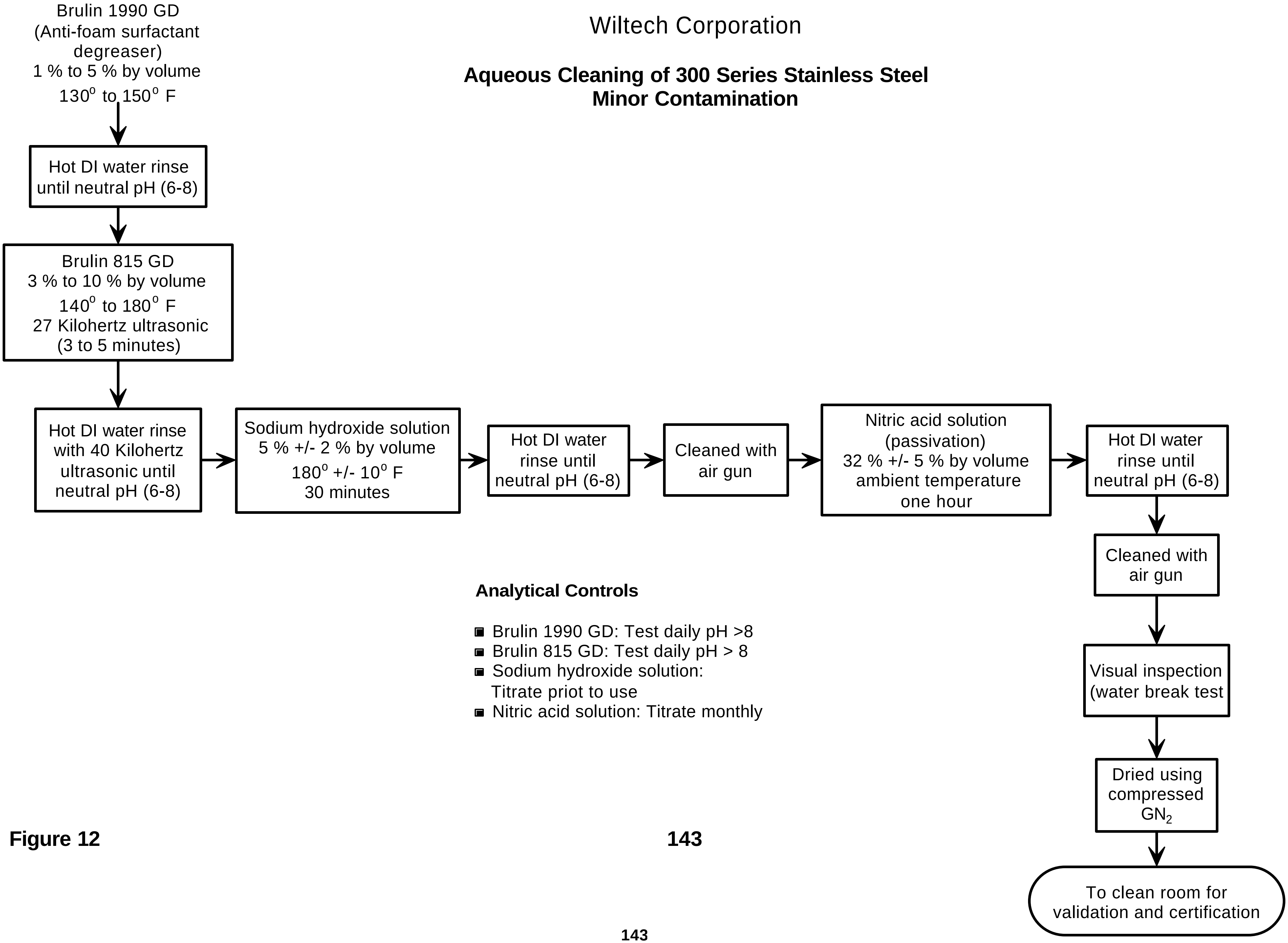
Wiltech Corporation

Aqueous Cleaning of 300 Series Stainless Steel
Minor Contamination



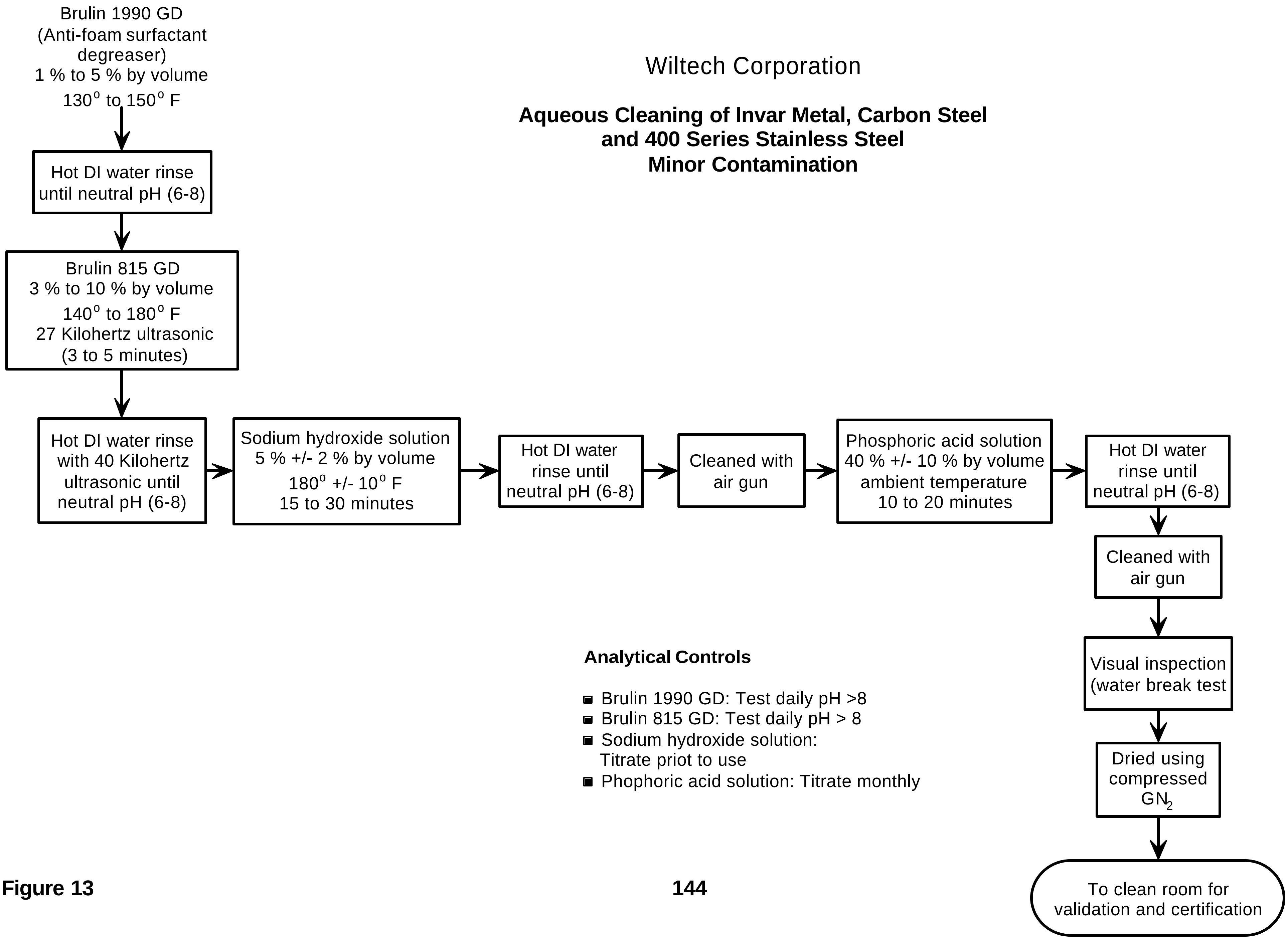
Analytical Controls

- Brulin 1990 GD: Test daily pH >8
- Brulin 815 GD: Test daily pH > 8
- Sodium hydroxide solution: Titrate priot to use
- Nitric acid solution: Titrate monthly

Figure 12

Wiltech Corporation

Aqueous Cleaning of Invar Metal, Carbon Steel and 400 Series Stainless Steel Minor Contamination



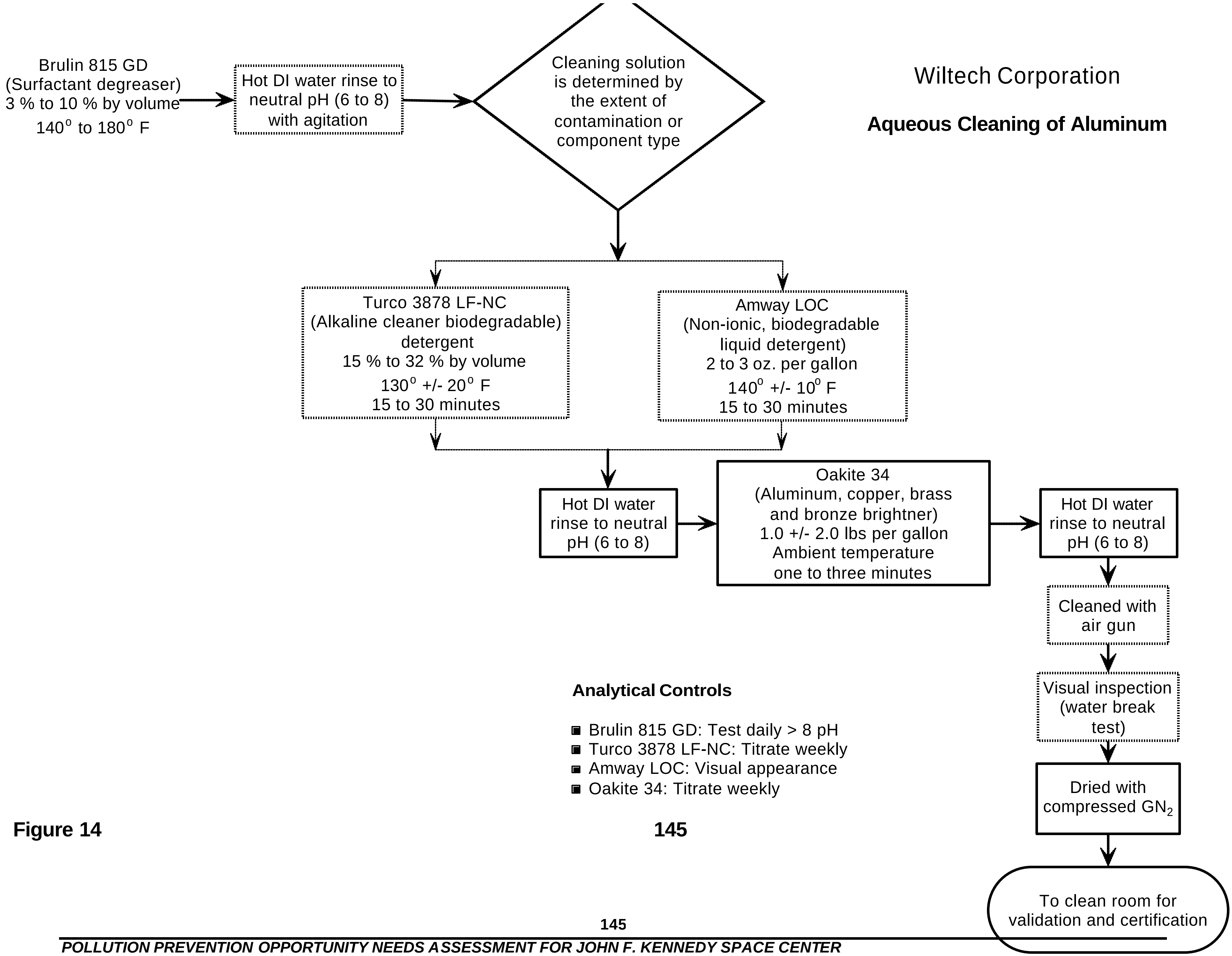
Analytical Controls

- Brulin 1990 GD: Test daily pH >8
- Brulin 815 GD: Test daily pH > 8
- Sodium hydroxide solution: Titrate priot to use
- Phophoric acid solution: Titrate monthly

Figure 13

Wiltech Corporation

Aqueous Cleaning of Aluminum



Analytical Controls

- Brulin 815 GD: Test daily > 8 pH
- Turco 3878 LF-NC: Titrate weekly
- Amway LOC: Visual appearance
- Oakite 34: Titrate weekly

Figure 14

145

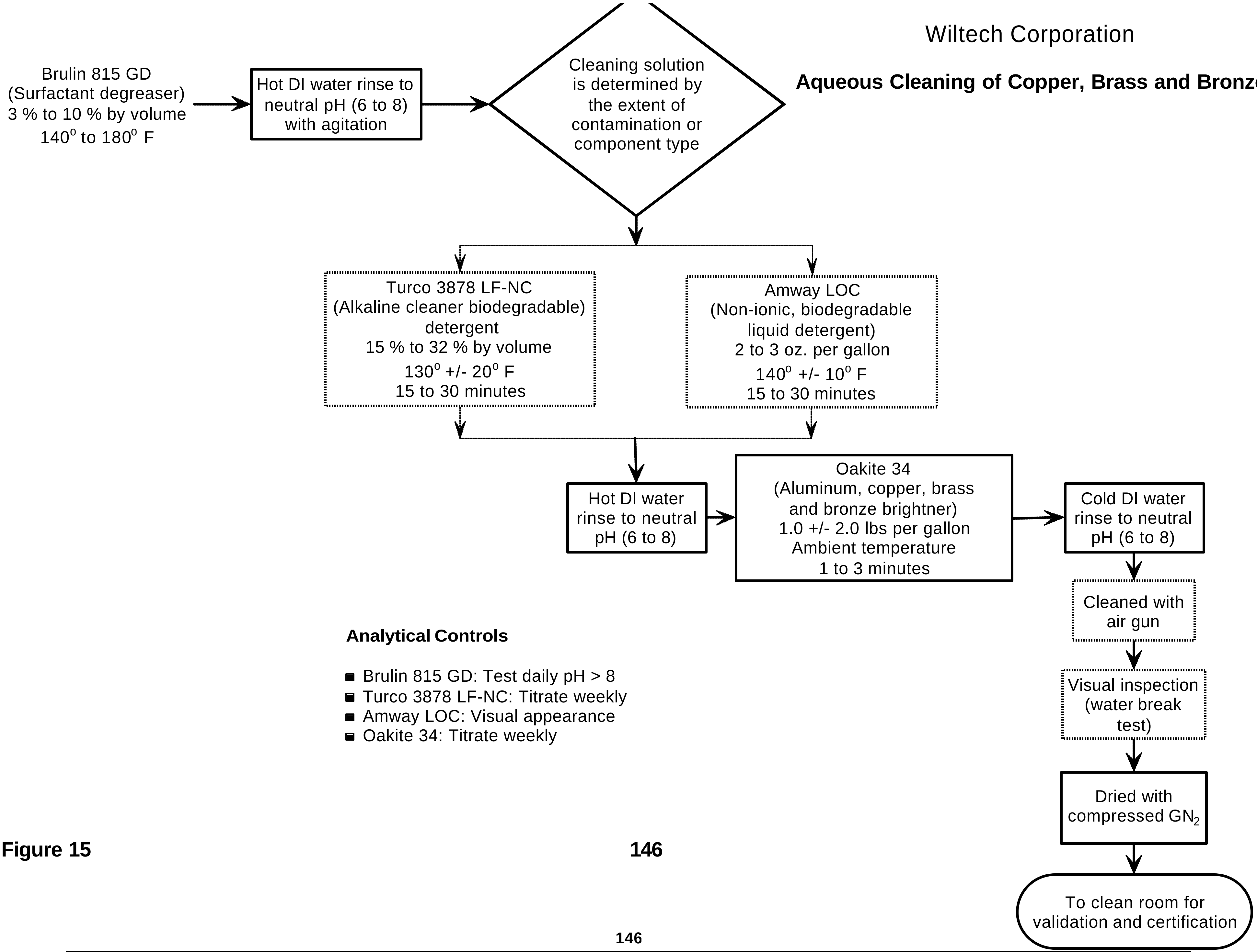
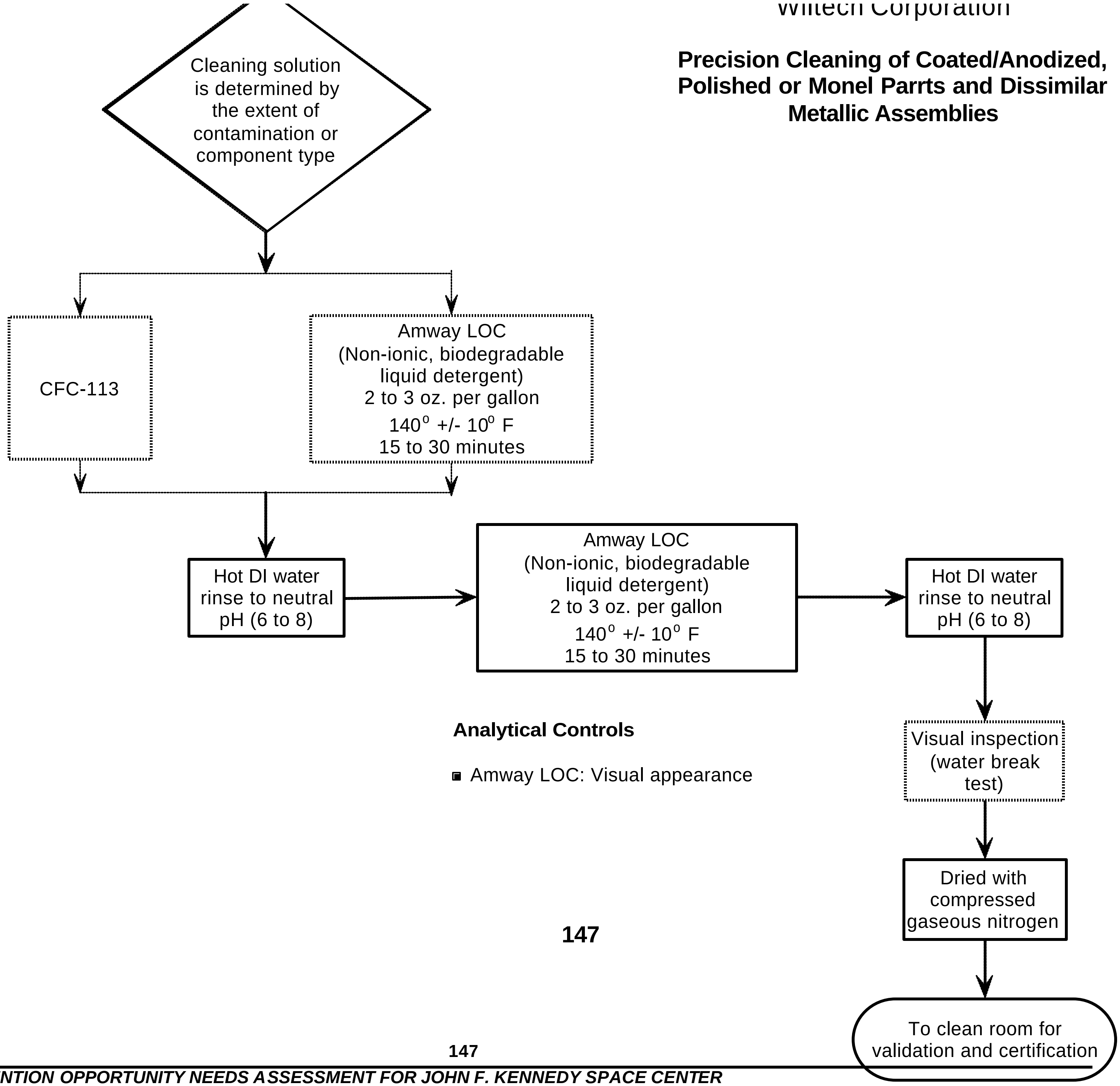

Wiltech Corporation
Aqueous Cleaning of Copper, Brass and Bronze
Brulin 815 GD (Surfactant degreaser) 3 % to 10 % by volume 140° to 180° F
Hot DI water rinse to neutral pH (6 to 8) with agitation
Cleaning solution is determined by the extent of contamination or component type
Turco 3878 LF-NC (Alkaline cleaner biodegradable) detergent 15 % to 32 % by volume 130° +/- 20° F 15 to 30 minutes
Amway LOC (Non-ionic, biodegradable liquid detergent) 2 to 3 oz. per gallon 140° +/- 10° F 15 to 30 minutes
Hot DI water rinse to neutral pH (6 to 8)
Oakite 34 (Aluminum, copper, brass and bronze brightner) 1.0 +/- 2.0 lbs per gallon Ambient temperature 1 to 3 minutes
Cold DI water rinse to neutral pH (6 to 8)
Cleaned with air gun
Visual inspection (water break test)
Dried with compressed GN2
To clean room for validation and certification
Analytical Controls
Brulin 815 GD: Test daily pH > 8
Turco 3878 LF-NC: Titrate weekly
Amway LOC: Visual appearance
Oakite 34: Titrate weekly

Figure 15

Precision Cleaning of Coated/Anodized, Polished or Monel Parrts and Dissimilar Metallic Assemblies



Analytical Controls

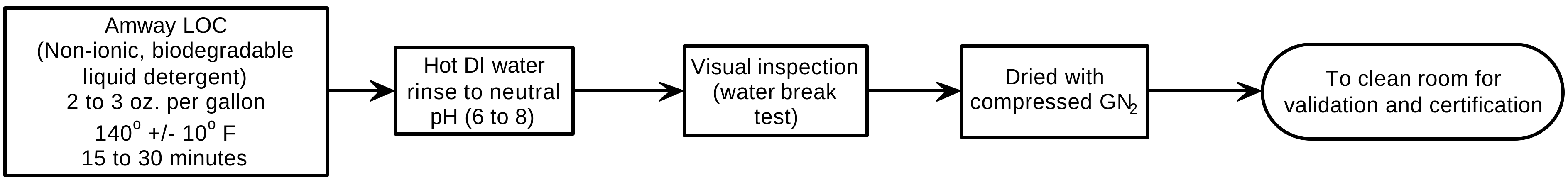
- Amway LOC: Visual appearance

Figure 16

147

Wiltech Corporation

Aqueous Cleaning of Coated/Non-Coated Metallic, Non-Metallic and Bi-Metallic Assemblies and/or Parts



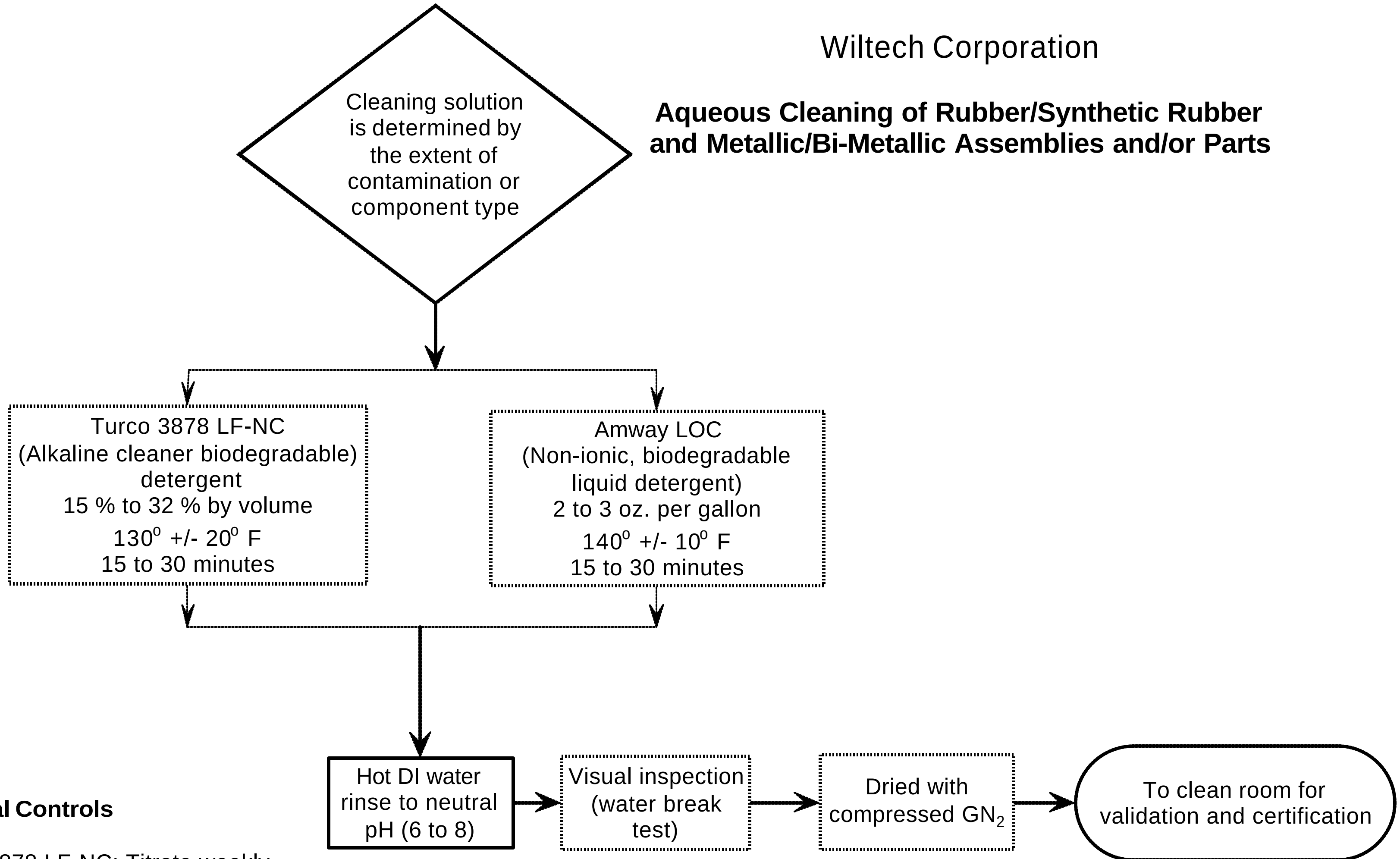
Analytical Controls

- Amway LOC: Visual appearance

Figure 17 **148**

Wiltech Corporation

Aqueous Cleaning of Rubber/Synthetic Rubber and Metallic/Bi-Metallic Assemblies and/or Parts



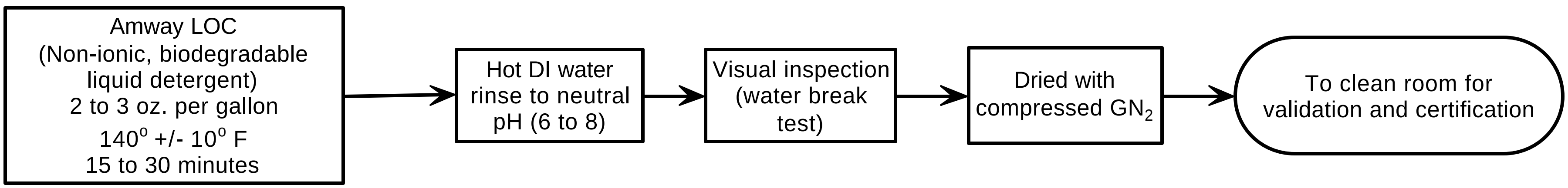
Analytical Controls

- Turco 3878 LF-NC: Titrate weekly
- Amway LOC: Visual appearance

Figure 18 **149**

Wiltech Corporation

Aqueous Cleaning of Tygon Tubing and Tubing Kits



Analytical Controls

- Amway LOC: Visual appearance

Figure 19 **150**

Wiltech Corporation

Electropolishing of 300 Series Stainless Steel

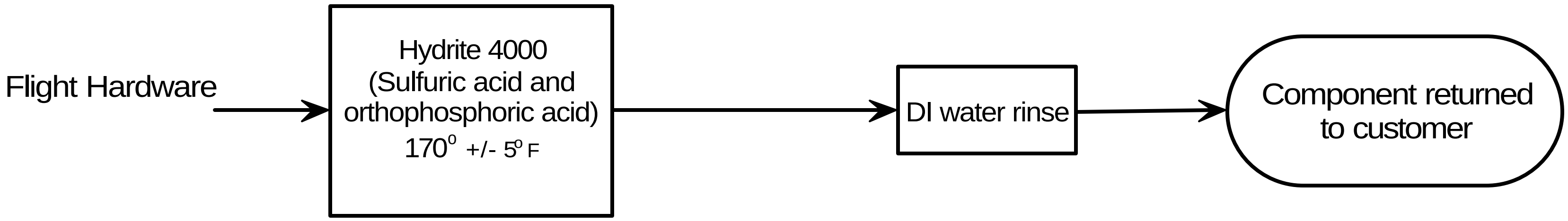


Figure 20 **151**

Solvent Cleaning and Verification

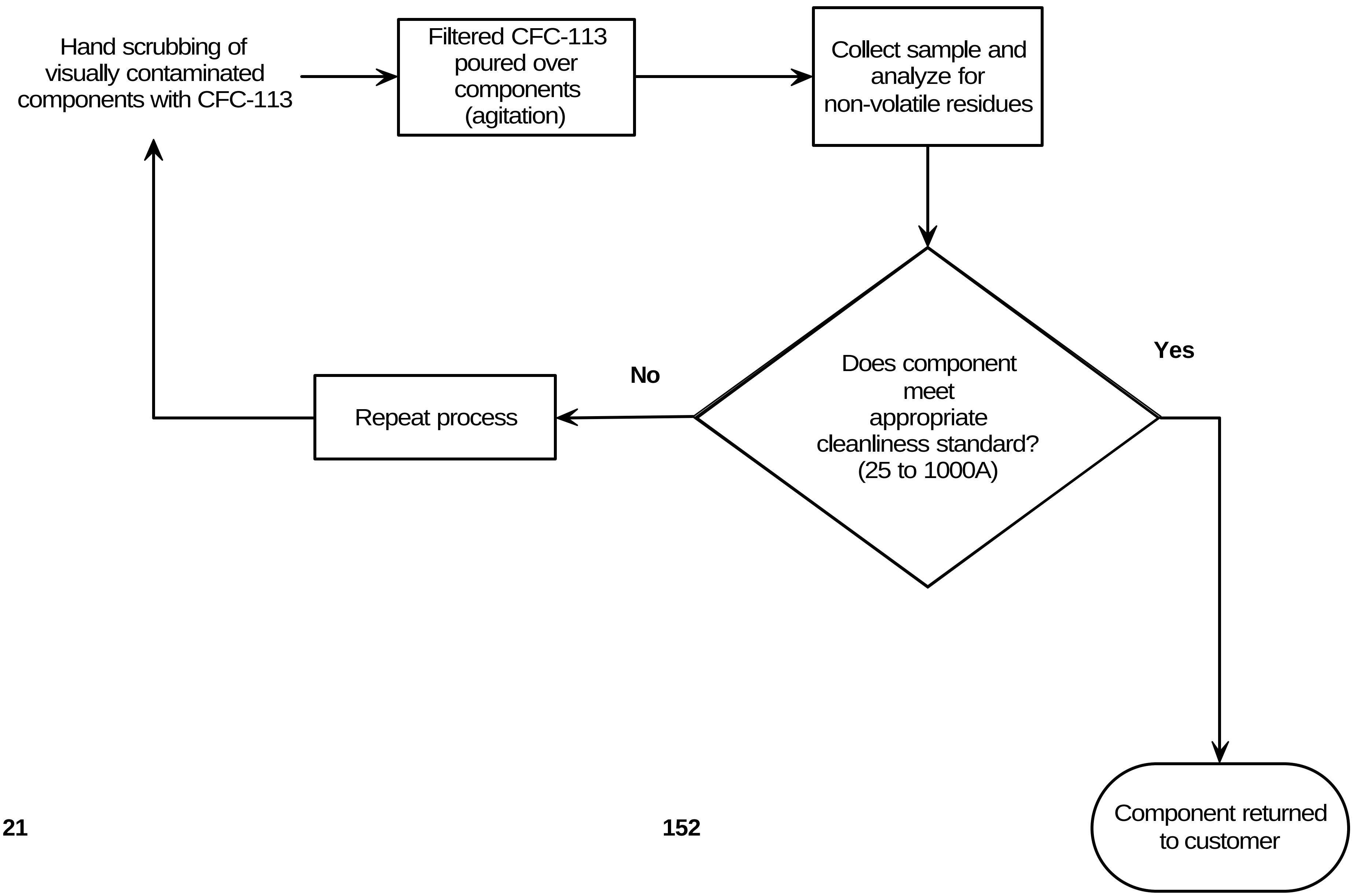


Figure 21

152

Wiltech Corporation

Solvent Cleaning of Electrical Accessories and Coils

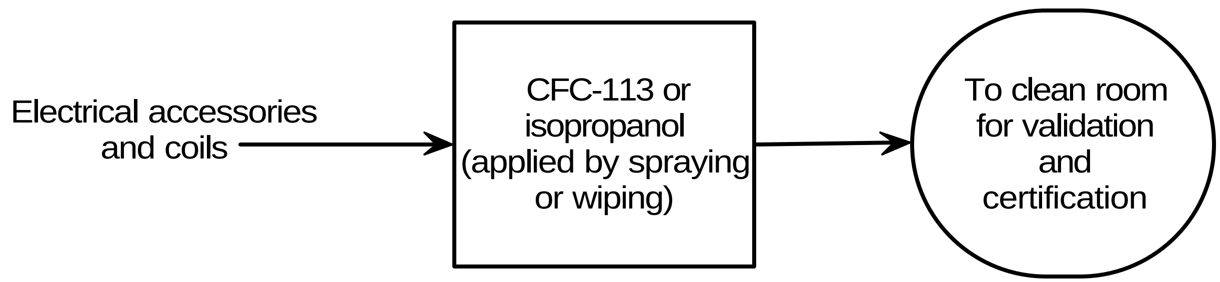


Figure 22 **153**

Wiltech Corporation

Precision Cleaning of Convoluted Hoses
Jet-mole Process

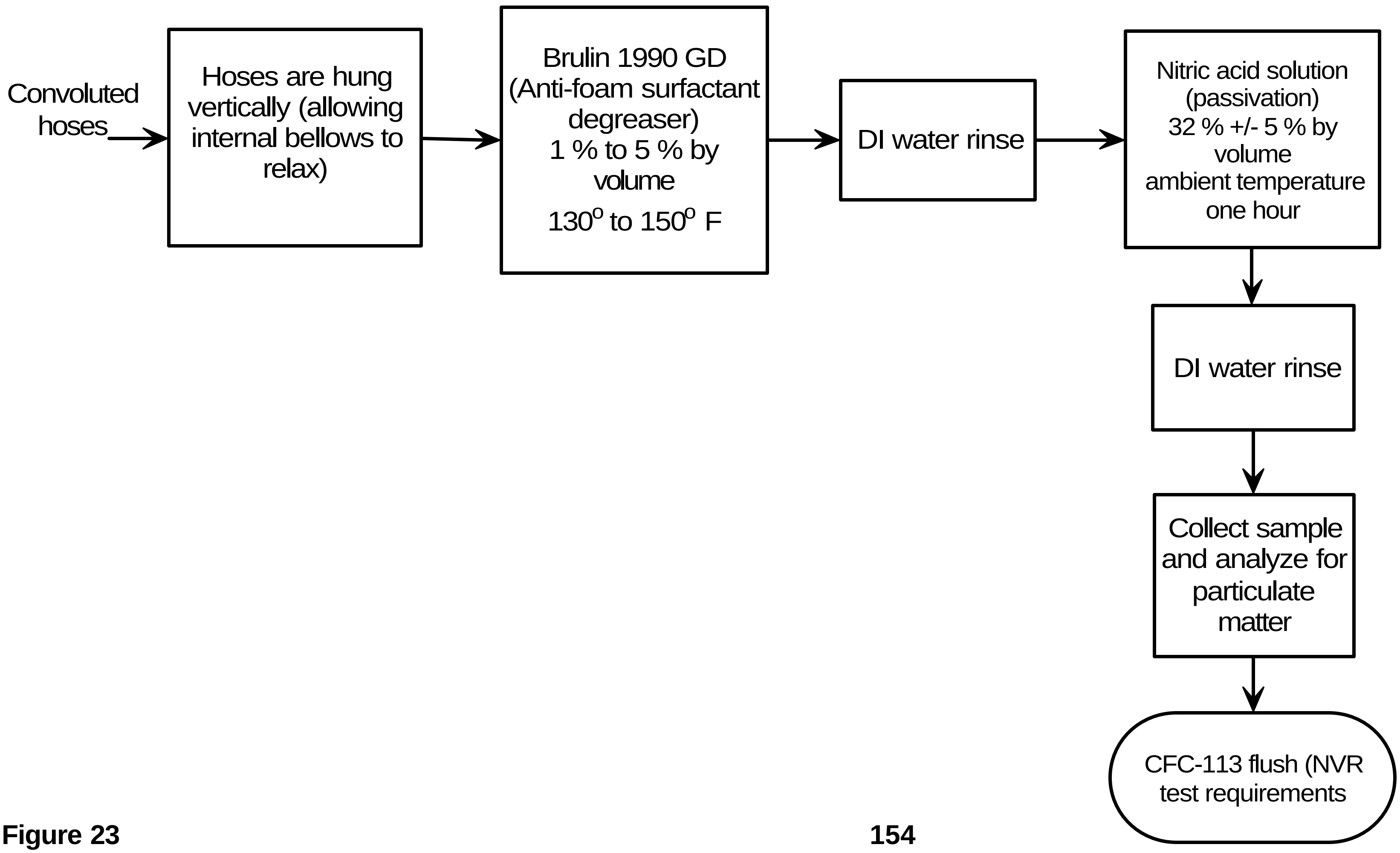


Figure 23 **154**

Logistics Operations (LO)

Baseline Pretreatment - Alodine® 1200S
Dip Application of Small Aluminum Parts

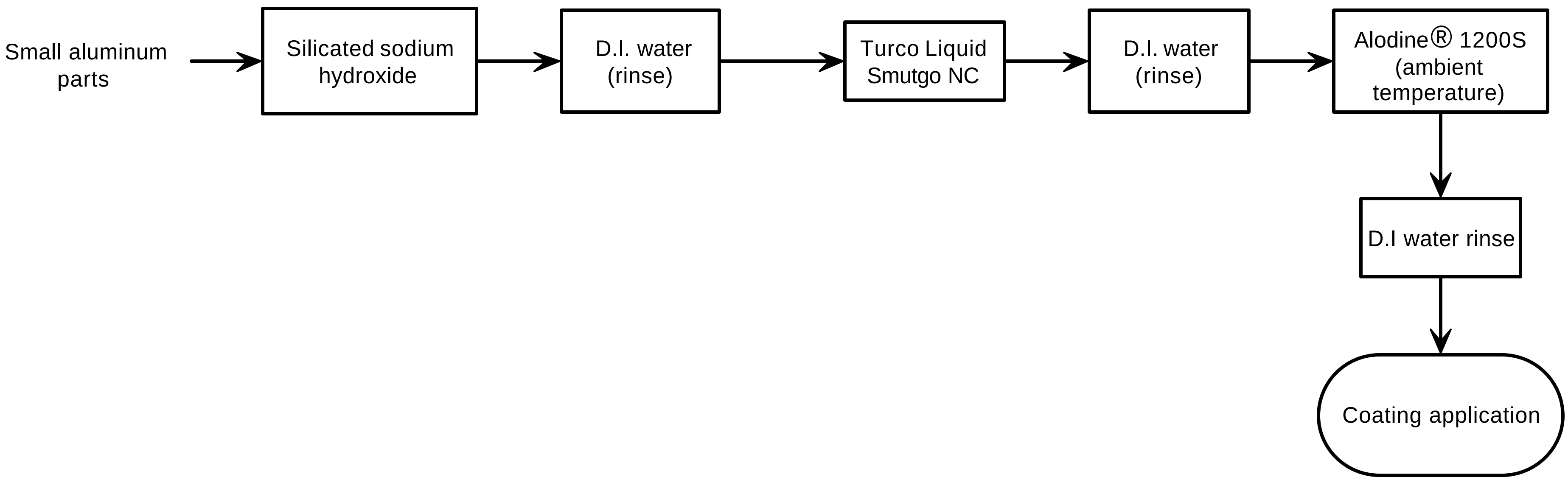


Figure 24 **156**

USA-NSLD

Aluminum Etching

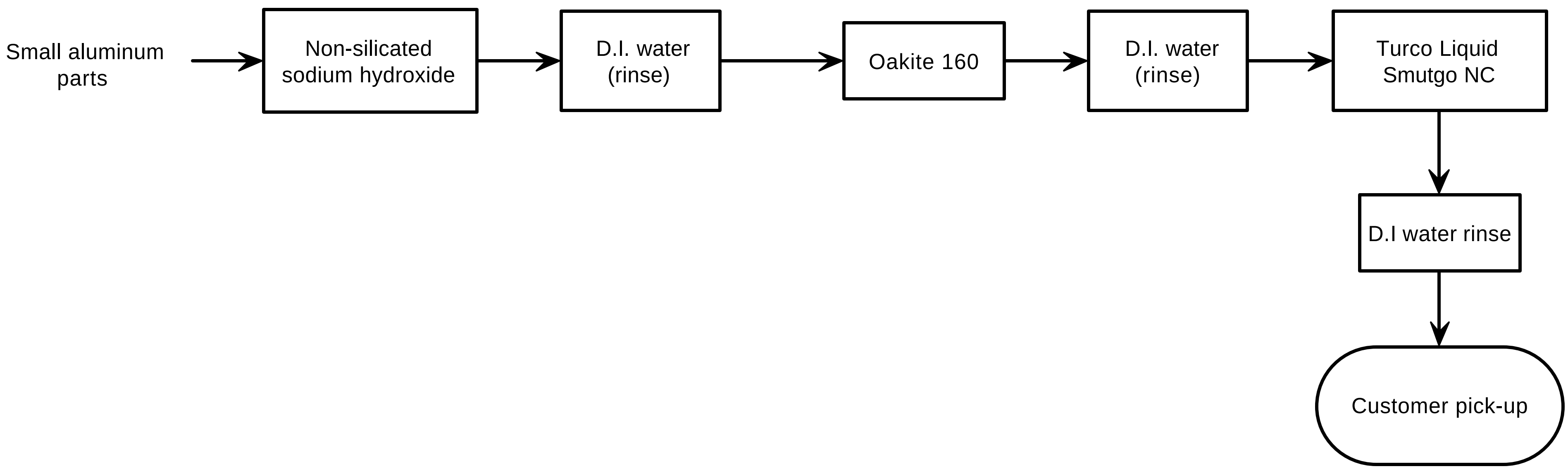


Figure 25 **157**

USA-NSLD

Precision Cleaning

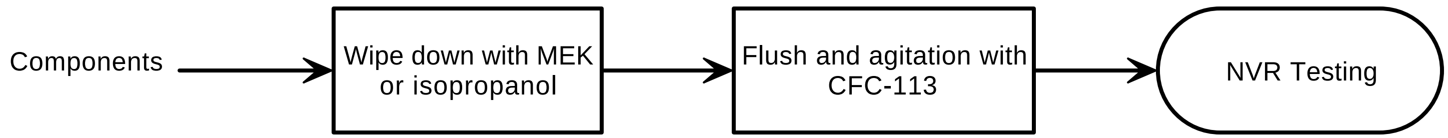


Figure 26

158

Coating Application

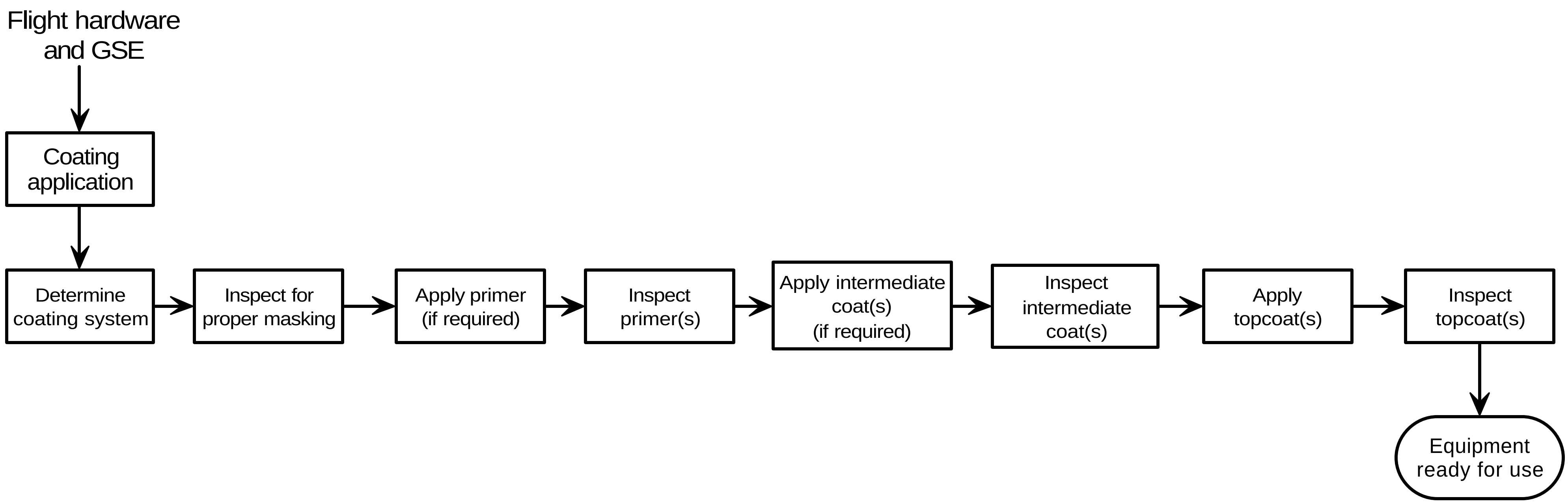


Figure 27

159

USA-NSLD

Surface Preparation of Flight Hardware
Aluminum, Stainless Steel and Plastic

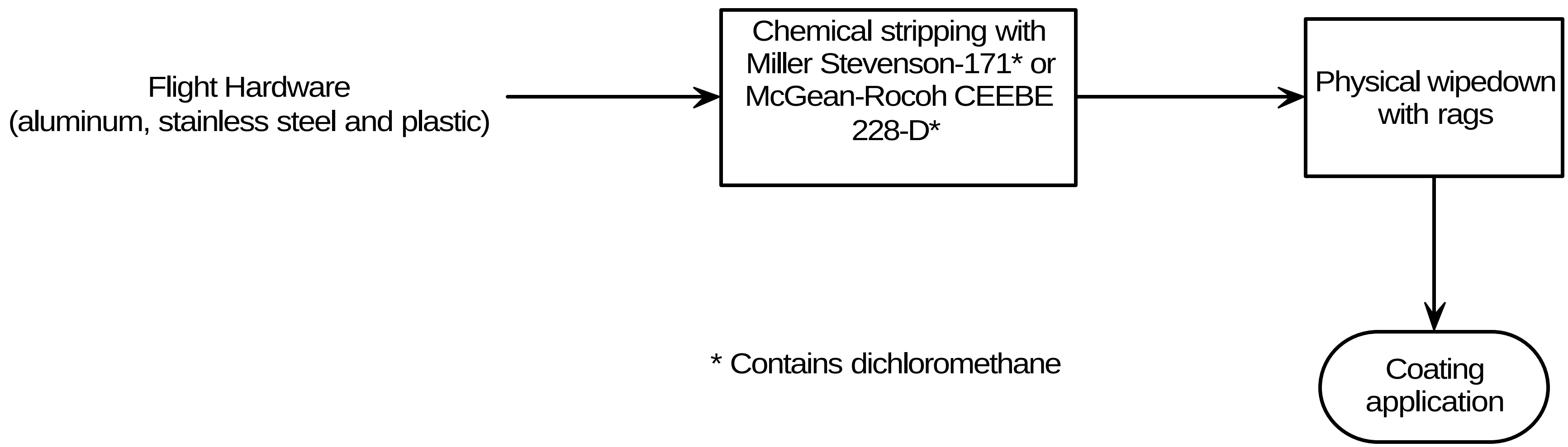
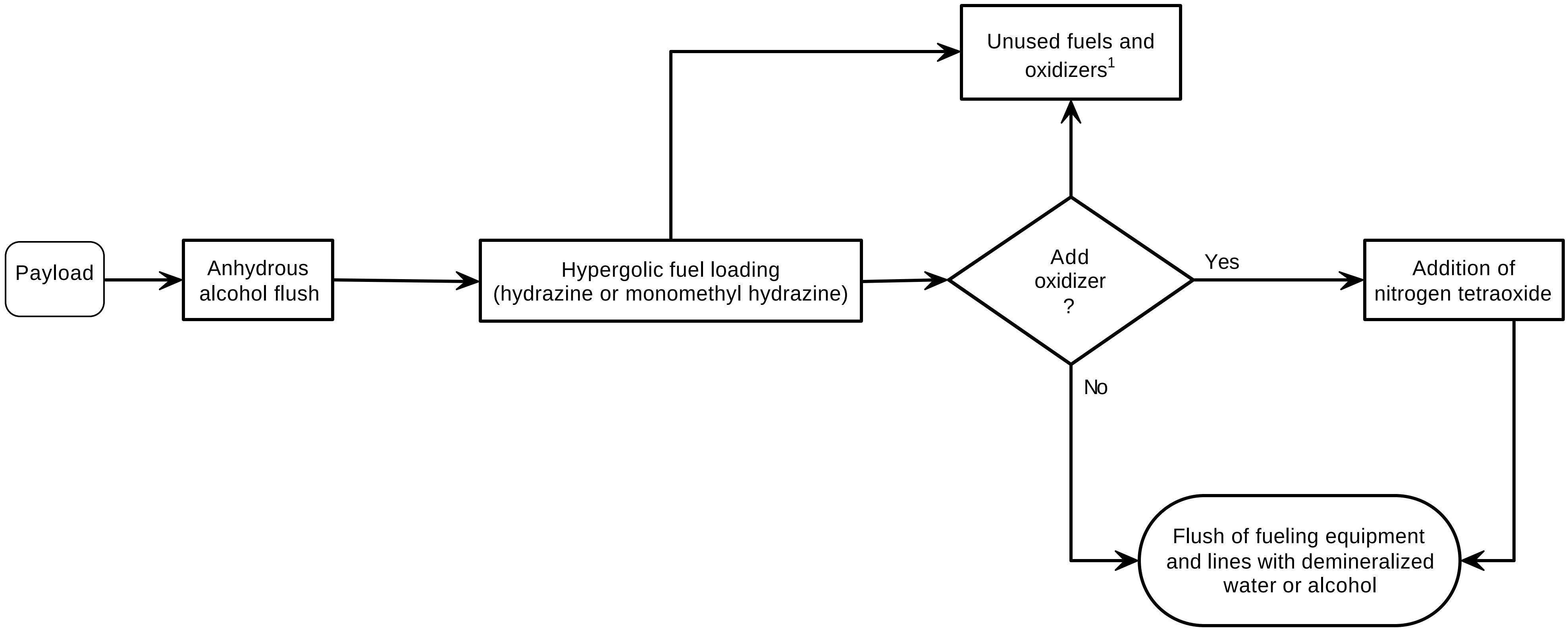


Figure 28 **160**

Space Station and Shuttle Payloads (NN)

Boeing PGOC

Payload Fueling



[1] Unused fuels and oxidizers are reused by SGS

PPE

- Full body encapsulating suite (PHE, Propellant Handlers Ensemble)

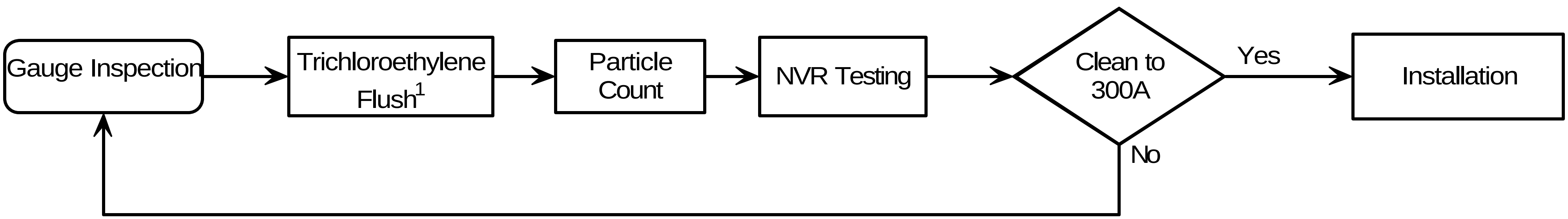
Waste generation

- 550 gallons of rinsates (hydrazine, alcohol and oxidizer) generated in 1998
- Hazardous waste generated from hydrazine solids, contaminated absorbent materials, tyvek suits and oxidizer solids

Figure 29 **162**

Boeing PGOC

Precision Cleaning



[1] TCE reclaimed and reused for future cleanings (closed loop filtration system)

PPE

- Latex rubber gloves
- Splash goggles
- Respirator

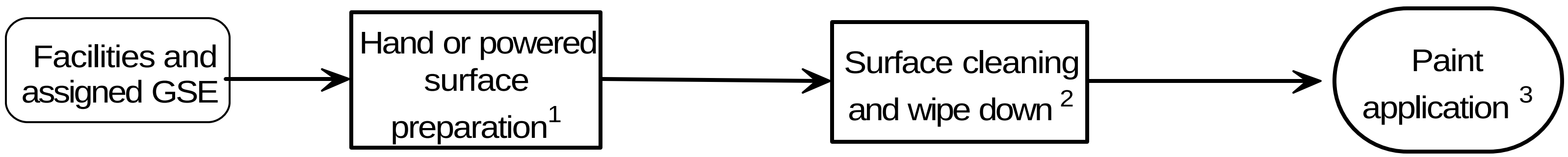
Waste minimization practices

- TCE replaced with HFE-7100

Figure 30 **163**

Boeing PGOC

Facility/ GSE Maintenance Painting



[1] Sanding, needle gun or blasting
[2] Alcohol, solvent or water
[3] Hand, roller or aerosol spraying

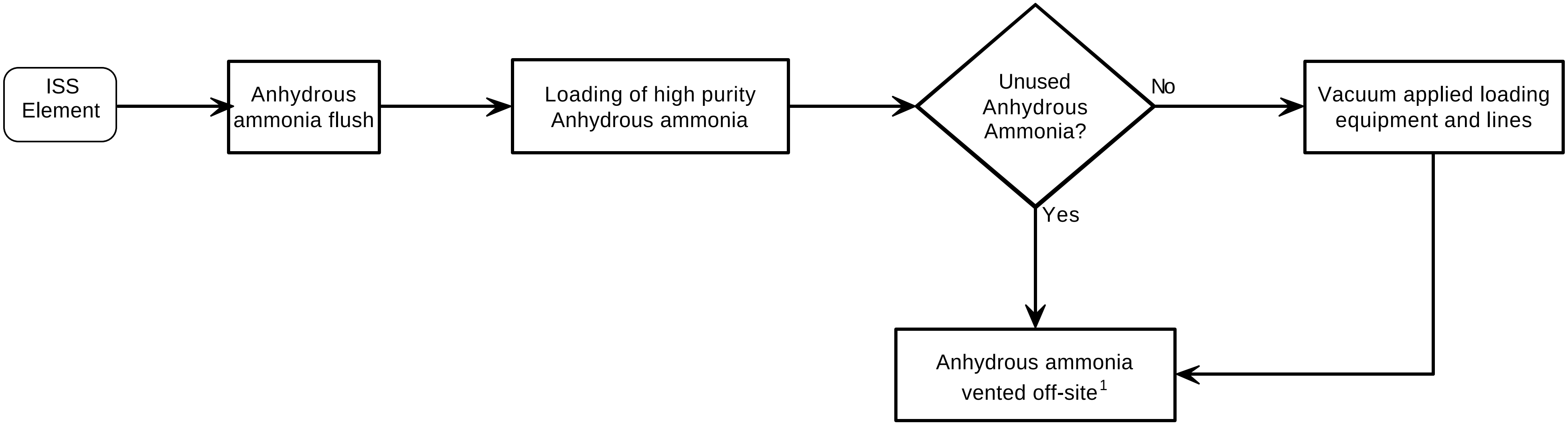
PPE
- Tyvek suit
- Latex rubber gloves
- Respirator

Waste generation
- 530 pounds of solid debris contaiminated with TCLP metals generated in 1998
- 134 gallons of hazardous solvent rags contaminated with MEK generated in 1998

Figure 31 **164**

Boeing PGOC

Ammonia Servicing



[1] Approximately 60 pounds of anhydrous ammonia vented a year

PPE

- Splash goggles
- Respirator
- Butyl gloves
- Chemical sleeve apron

Figure 32 **165**

Joint Performance Management Office (JP)

SGS Corrosion Control Facility

Work Flow Process

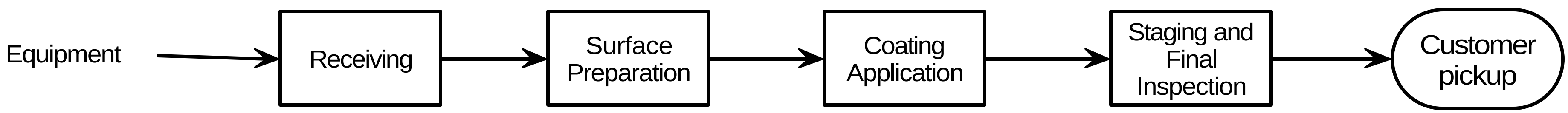


Figure 33 **167**

SGS Corrosion Control Facility

Receiving

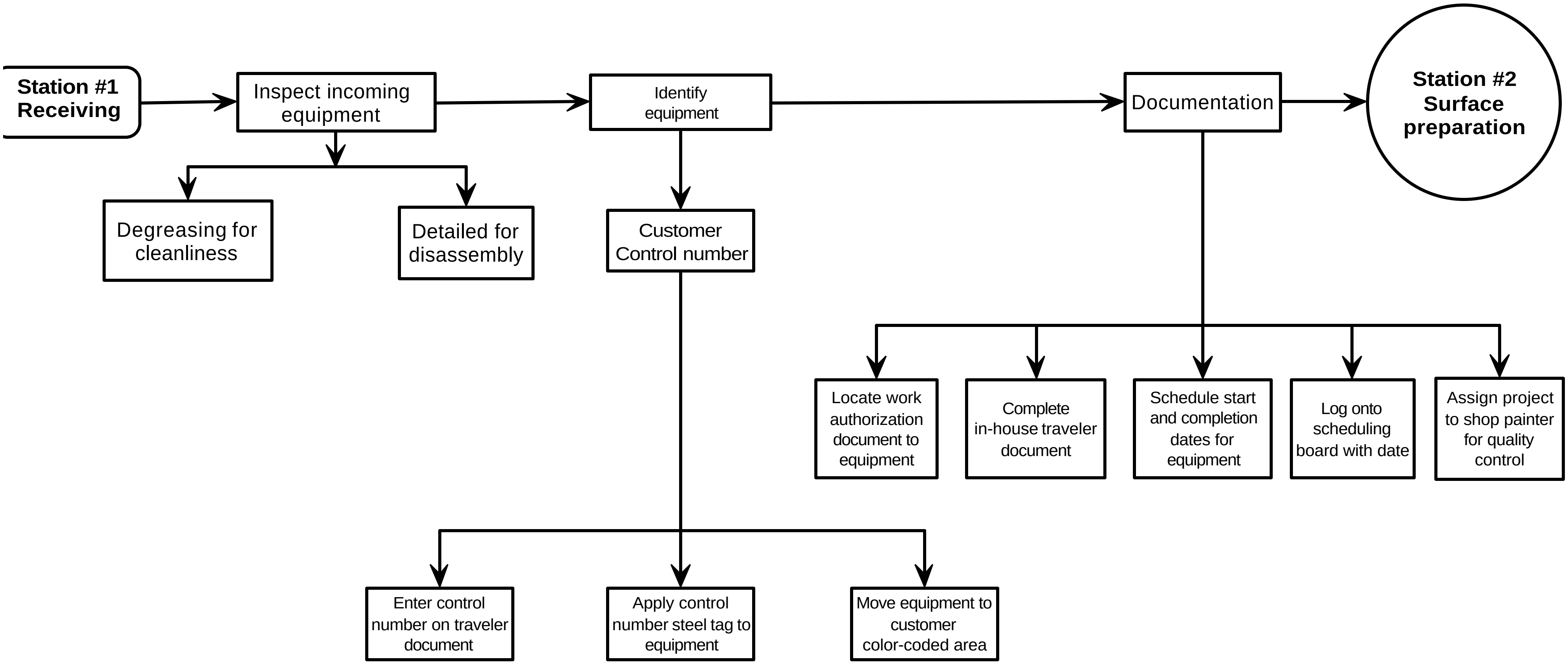


Figure 34 **168**

SGS Corrosion Control Facility

Surface Preparation

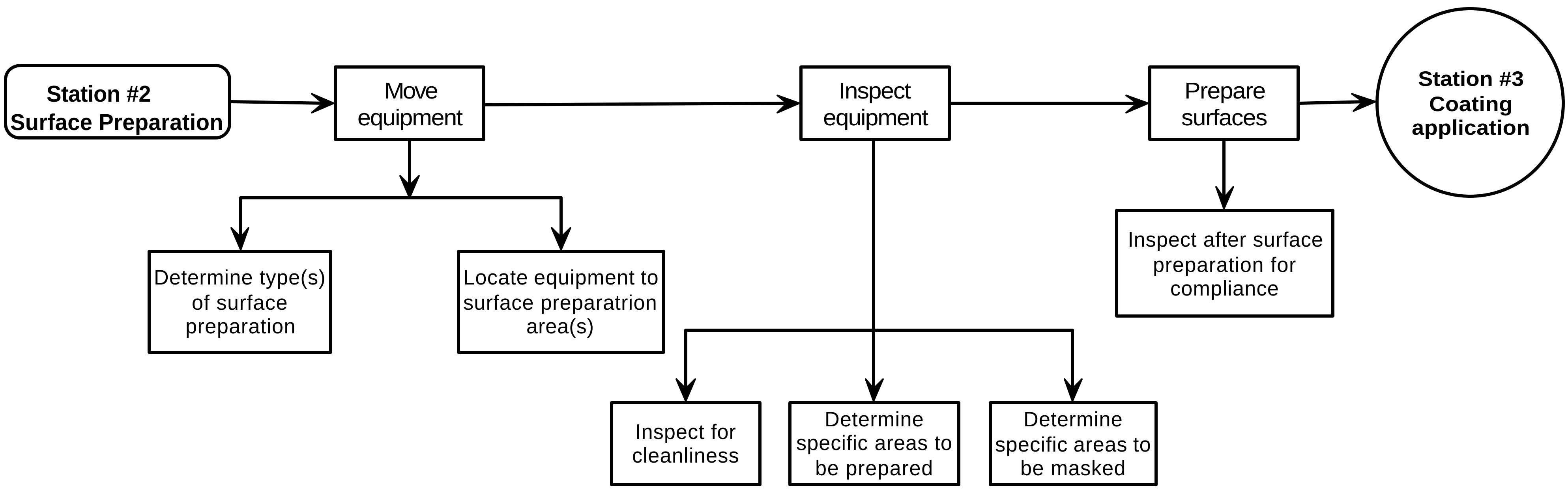


Figure 35 **169**

SGS Corrosion Control Facility

Coating Application

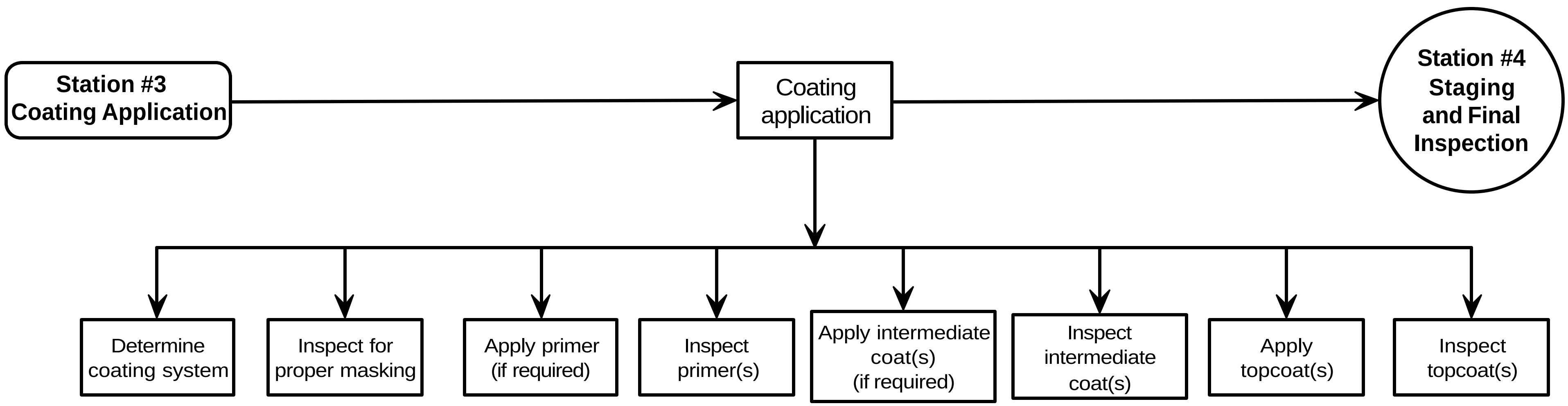


Figure 36 **170**

SGS Corrosion Control Facility

Staging and Final Inspection

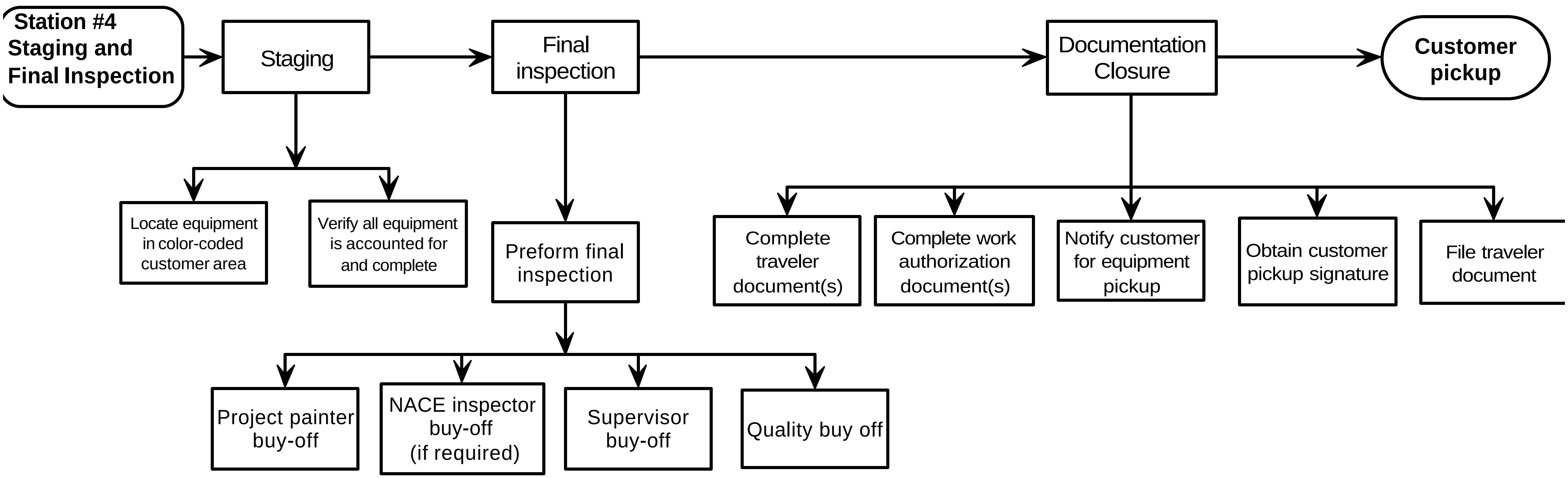


Figure 37 171

6.2 References

1 International Agency for Research on Cancer: *Monographs on the Evaluation of the Carcinogen Risk of Chemicals to Man*.

2 United States Environmental Protection Agency: *Integrated Risk Information System*.

3 National Fire Protection Association Chemical Hazard Labels.

4 Genium Publishing Corporation: *Chemical Container Label Database*.

5 United States Department of Labor. Occupational Safety and Health Administration: *29 CFR 1910.1000*.

6 National Aeronautics and Space Administration.