






TITLE Process Specification for, <i>AdLIGO Seismic Isolation System In-Vacuum Mechanical Elements Fabrication</i>	DOCUMENT NUMBER 20008225	REV B	 ALLIANCE SPACESYSTEMS, INC. 1250 LINCOLN AVE., SUITE 100 PASADENA, CA 91103 www.asi-space.com
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Warnings, Cautions and Notes

Information contained within this specification that is especially important to note is identified by one of the following labels:

Warnings

The paragraphs listed within this specification having descriptions or practices that could cause harm to personnel and/or hardware are identified with the following symbol:



Cautions

The paragraphs listed within this specification having descriptions or practices that could result in an adverse result or compromise personnel safety are identified with the following symbol:



Notes

The paragraphs listed within this specification having descriptions or practices that are important to the successful completion of that operation, without compromising personnel safety, are identified with the following symbol:



1. SCOPE

This document establishes general requirements for fabrication of metallic hardware for the AdLIGO Seismic Isolation System In-Vacuum Mechanical components.

1.1. Purpose

This specification is intended to provide the necessary controls to minimize surface contamination of fabricated parts. The requirements specified herein are intended to support the Vacuum Compatibility requirements of the AdLIGO Seismic Isolation System In-Vacuum Mechanical components contract.

1.2. Waivers or Deviations

If it is apparent that the requirements of this specification cannot be complied with, the responsible technical organization shall initiate a waiver or deviation and submit it in sufficient time to allow for proper evaluation and disposition. Submit requests by memorandum to ASI's cognizant Contract Technical Manager.

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue used shall be the one in effect on the date of contract negotiation. Conflicts between the documents referred herein and the contents of this specification shall be brought to the attention of the cognizant ASI Contract Technical Manager for resolution.

Document #	Document Title
Specifications	
<i>ASI</i>	
20006034	Hardware Cleaning
20006638	General Packaging Requirements
20007440	Quality Assurance Process Control
<i>Non-ASI</i>	
AWS A5.9	Bare Stainless Steel Welding Electrodes And Rods, Specification For
AWS A5.10	Bare Aluminum Welding Electrodes And Rods, Specification For
Standards	
<i>Non-ASI</i>	
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes
ASME B46.1	Surface Texture, Surface Roughness, Waviness, And Lay
ANSI Z540-1	Calibration Laboratories and Measuring and Test Equipment, General Requirements for
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel
MIL-STD-1246	Product Cleanliness Levels and Contamination Control Program

3. REQUIREMENTS

3.1. End Item Requirements

3.1.1. Workmanship

Fabricated components shall be uniform in quality and shall be visibly free from contaminants, chips and foreign materials that are not associated with the composition of materials specified on the engineering drawing. Unless otherwise specified or where required by function or contractual obligations, all sides of the raw materials shall be machined.

3.2. Materials of Construction

3.2.1. Approved Materials

All materials of construction shall be in accordance with the engineering drawings.

3.3. Process Control

3.3.1. Travelers

All fabricated components shall be supported by a shop traveler. Shop travelers shall include all pertinent support and process information identified by the engineering. Travelers shall be maintained (as required) by the manufacturing activity and shall accompany all aspects of the parts process traceability.

3.3.1.1. Inspection

Unless otherwise specified components shall be inspected in accordance with 20007440, Level 3.

3.3.1.1.1. Calibration

All equipment required to measure parameters during inspection processes shall be calibrated and maintained in accordance with ANSI/NCSS Z540-1.

3.3.1.2. Material Certification

Unless otherwise specified, all vendor supplied materials of construction shall be in accordance with 20007440, Type 2.

3.3.1.3. Cleaning

All components and materials of construction shall be cleaned in accordance with 20007440, Class 1 (Special Cleaning; See 6.3.1).

3.3.1.4. In-Process Protection

In-process components shall be packaged in accordance with 20006638 Type III, Grade B, Style optional.



Delicate surfaces, including the knife edges of high vacuum flanges shall be kept covered during in-process operations to mitigate damage that would affect its end functionality.



Bagging materials shall not be re-used on components that have been cleaned per 3.3.1.3.

3.4. Manufacturing Practices

3.4.1. Machining

3.4.1.1. Surface Texture

Unless otherwise specified, machined surfaces shall be finished to a minimum 64 RMS in accordance with ASME B 46.1.

3.4.1.2. Coolants and Lubricants

Coolants and lubricants used for machining shall be water soluble and shall not contain sulfur, chlorine, or silicone. The coolants and lubricants identified in Section 7 are approved for the fabrication processes identified herein.

3.4.2. Welding

3.4.2.1. Aluminum

All aluminum welds shall be in accordance with AWS D1.2 as full penetration welds using gas tungsten arc welding (GTAW) process.

3.4.2.2. Austenitic Stainless Steel

All austenitic stainless steel welds shall be in accordance with AWS D1.6 as full penetration welds using gas tungsten arc welding (GTAW) process.

3.4.2.3. Welding Cleanliness

All faying surfaces to be welded shall be shall be cleaned in accordance with 3.5.1.1. prior to the welding process.

3.4.2.4. Consumables

3.4.2.4.1. Filler Material

1. All welding on aluminum alloys shall use ER4043 filler material per AWS A5.10
2. All welding on austenitic stainless steel shall use ER308L filler material per AWS A5.9.

3.4.2.4.2. Electrodes

Electrodes shall be 2% thoriated tungsten.

3.4.3. Abrasives

The use of free-abrasives (including free abrasive grinding and honing) or polishing compounds is prohibited. Abrasives used in grinding and finishing operations shall be limited to aluminum oxide, aluminum silicate, silicon carbide and diamond-based abrasive materials. Coated abrasive papers and cloths manufactured with silicone are prohibited.

3.4.3.1. Grinding

Stainless and maraging steels shall be ground using block or wheel grinding techniques where the abrasive used is permitted under 3.4.3.



Grinding aluminum is prohibited to mitigate the embedment of abrasive particles

3.4.3.2. Polishing

Surface textures that do not meet the requirements of 3.3.2.1 may be polished where the abrasive used is permitted under 3.4.3. It is recommended that all welds and weld zones be polished with 3M™ Scotch-Brite™.

3.4.3.3. Finishing and Deburring

Processed hardware shall be deburred using a process that does not violate the requirements of 3.4.3.

3.5. Sub-Assemblies

3.5.1. Ancillary Hardware Installation

3.5.1.1. Pre-Cleaning

Machined components requiring ancillary hardware installation (e.g., threaded inserts and fastening devices) shall be cleaned in accordance with 20007440, Class 1 (Special Cleaning; See 6.3.1) prior to the installation process.



Ancillary hardware shall also be pre-cleaned per 3.5.1.1 prior to sub-assembly operations

4. QUALITY ASSURANCE PROVISIONS**4.1. Quality Conformance Inspection**

Quality conformance inspection consists of all the tests and examinations necessary to determine compliance with Sections 3 and 5 of this specification.

4.1.1. Sampling for Quality Conformance Inspection

Unless otherwise instructed, all items shall be inspected for characteristics specified below using a sampling plan in accordance with ANSI/ASQC Z1.4 as determined by the Manufacturing Activity.

4.1.2. Compliance

Inspection performed to determine compliance with the characteristics specified in Table I shall be conducted in accordance with the corresponding test and inspection paragraph.

TABLE I. Inspection and Test Matrix

Characteristic	Requirement Paragraph	Test/Inspection Paragraph
Workmanship	3.1.1	4.2.1
Approved Materials	3.2.1	4.2.2
Travelers	3.3.1	4.2.3
Packing	5.1.1	4.2.4
Marking	5.2.1	4.2.5

4.2. Inspection and Tests**4.2.1. Workmanship**

Fabricated components shall be inspected for conformance to the requirements of paragraph 3.1.1.

4.2.2. Approved Materials

Material certifications shall be inspected for conformance to the requirements of paragraph 3.2.1.

4.2.3. Travelers

Travelers shall be inspected for conformance to the requirements of paragraph 3.3.1.

4.2.4. Packing

Packaged parts shall be inspected for conformance to the requirements of paragraph 5.1.1.

4.2.5. Marking

Packaged parts shall be inspected for conformance to the requirements of paragraph 5.2.1.

5. PREPARATION FOR DELIVERY

5.1. Preservation and Packing

Preservation and packing requirements specified herein shall take precedence over those imposed in Section 3 of this specification through the requirements of 20007440 (Ref: Section 5 of 20006034).

5.1.1. Packing

Components that have been subjected to the special cleaning processes specified in 3.3.1.3 shall be immediately packaged in new polyethylene film in accordance with ASI 20006638, Type III, Grade B, Style 2. Closures shall be made by folding excess barrier material into a lap seam and securing with staples.



The use of adhesive tape is prohibited as a method for securing a closure.

5.2. Marking

5.2.1. General Markings

Components that have been packaged shall be clearly marked with the following information securely attached to the exterior of the package:

1. Part Number
2. Serial Number (if applicable)
3. Traveler Number
4. Date of Packaging

6. NOTES

6.1. Intended use

This specification is intended for use in establishing fabrication protocols and precautions to reduce surface contamination of manufactured hardware in advance of Ultra High Vacuum (UHV) cleaning operations.

6.2. Definitions

6.2.1. Materials of construction

Materials of construction identify all raw materials and purchased parts used in the manufacturing process of AdLIGO components.

6.3. Cleaning Considerations

6.3.1. Special Cleaning

All materials of construction will be subjected to the *Special Cleaning* methods identified in Appendix A of this specification, which will be used to achieve visibly clean parts ahead of UHV cleaning operations. The aforementioned cleaning process is intended to remove residues generated in the fabrication processes. The cleanliness level achieved by gross cleaning will not require verification beyond visual inspection.



Machined parts should be cleaned as soon as practical to prevent set-up or cross-linking of the fabrication residues, which will make UHV cleaning more problematic

7. APPROVED PRODUCTS

Approved products used in the processes specified herein maybe facilitated by the following companies:

7.1. Coolants and Lubricants

Product Nomenclature

Manufactures Address

Blasocut 2000CF, Art. 875
Blasocut Universal, Art. 870
Blasocut 4000 Strong, Art. 872
Blasocut Kombi, Art. 872

Blaser Swisslube;
31 Hartford Lane
Goshen, New York 10924
845-294-3200

Hangsterfer's S-500 CF

Hangsterfer's Laboratories Inc.

Arrow 9050

Chem Arrow
13643 Live Oak Lane
Irwindale, CA 91704
626-358-225

APPENDIX – A (SPECIAL CLEANING)



Although much effort was taken to make cleaning processes less hazardous, the techniques and materials described herein may have health, safety and environmental impacts. Consult the appropriate Material Safety Data Sheets (MSDS's) of the products to be used before performing any process specified herein.

Good industrial hygiene and safety practices shall be employed at all times. The use of the following personal safety equipment is recommended:



A.1. Background

The cleaning procedures identified herein were developed to accomplish the gross cleaning of hardware as defined in the Appendix of MIL-STD-1246 with an emphasis on using low-hazard (biodegradable) critical cleaning detergents.

This process is not intended to provide guidance for passivation or phosphate-based acid cleaning of austenitic stainless steels.

A.2. Cleaning Processes

The recommended cleaning processes for selected materials and surface conditions are identified in Table A.1. Cleaning processes will normally be accomplished in consecutive order from left to right.

Material	Surface Condition	Gross Cleaning Processes							
		MEC	ORG	ACD	TW	DET	TW	DIW	DRY
Aluminum	Machined		X		X	X	X	X	X
	Weld Scale, Corrosion or Heat Oxidation	X	X	X	X	X	X	X	X
Copper/Brass	Machined		X			X	X	X	X
	Corrosion or Heat Oxidation		X			X	X	X	X
Stainless Steel	Machined		X		X	X	X	X	X
	Weld Scale, Corrosion or Heat Oxidation	X	X	X	X	X	X	X	X
	Electro Polished		X			X	X	X	X
Maraging Steel	Machined		X			X	X	X	X
	Corrosion or Heat Oxidation		X	X	X	X	X	X	X

TABLE A.1. Recommended Gross Cleaning Processes

A.2.1. Processes Defined

MEC = Mechanical Clean

ORG = Organic solvent degrease

ACD = (Phosphate free) Acidic cleaning

TW = Tap water rinse

DET = Detergent cleaning

DIW = Deionized water rinse

DRY = Drying

A.2.2. Gross Cleaning Types

The following types of cleaners or their equivalents, maybe used for performing the processes identified herein.



Chemical cleaning agents must be compatible to prevent excessive material attack or latent degradation, check material compatibility before proceeding with this procedure

A.2.2.1. Mechanical Cleaning

This process is used to remove scale and heavy oxide by abrasive action and should only be used when physical damage to the items being cleaned would not be a concern.

A.2.2.2. Organic Solvent Cleaning

This process is used to remove forms of organic contamination such as oils, grease and hydrocarbon fuels.

A.2.2.3. Acidic Cleaning (Phosphate free)

This process is used for the removal of inorganic contamination, trace metals and oxides such as scale, (calcium and magnesium) salts and where general metal brightening is required.

A.2.2.4. Anionic Detergent Cleaning

This process is used for the removal of organic contamination such as oils, fats, shop soil and grease.

A.2.2.5. Water Rinsing

This process is used to remove the residue material left by the cleaning processes. Tap water is appropriate for inter-process rinsing; however, deionized water should be used for final rinsing as it is particularly low in ionic or inorganic contaminants.

A.2.2.6. Drying

This process is used to minimize the impurities from rinse water that can be deposited on the part during evaporation.

A.3. Gross Cleaning Procedures

A.3.1. Cleaning Materials

Cleaning materials used in the processes identified herein, shall be as specified in Table A.2.

A.3.2. Part Preparation

All parts subjected to Gross Cleaning shall be free from all visible tape, inks, and other residues not identified in the engineering drawing. All residues shall be removed using an organic solvent and a low-lint task wiper such as a **Kimwipes®** EX-L.

A.3.3. Contamination Control

A.3.3.1. Cleaning Facility

Unless otherwise specified, Gross Cleaning shall be performed in a facility (building or room) that is isolated from general shop practices (e.g. machine operations, welding or aerosol applications). Isolation should also include separate air handlers to minimize re-contamination. When an isolated facility is not available, suitable isolation may be accomplished using a temporary soft wall partition or clean bench. Parts that have been gross cleaned and dried shall be packaged and identified per Section 5 of this document before removing them from the isolated facility.

Process	Recommended Material	Source
ORG	Methyl ethyl ketone – ACS (# 9319) or Reagent Alcohol – ACS (# 9401)	Mallinckrodt Baker, Inc. 222 Red School Lane Phillipsburg NJ 08865 CAGE: 70829
DET	Alconox® or Alcojet®	Alconox, Inc. 30 Glenn Street White Plains, NY 10603 UPC: 660483
ACD	Citranox® or Citrajet®	Alconox, Inc. 30 Glenn Street White Plains, NY 10603 UPC: 660483

TABLE A.2. Cleaning Materials

A.3.4. Essential Equipment

The following equipment is required to support the procedures specified herein. All equipment used to perform the cleaning procedures identified herein shall be pre-cleaned using the cleaning materials and procedures identified herein.

1. Stainless Steel Tanks, Containers and/or Pails
2. Stainless Steel Brushes with ABS ^[1] handles
 - a) Scouring Brushes
 - b) Finishing Brushes (for soft metals)
 - c) Tube Cleaning Brushes (for holes)
3. Stainless Steel Metal Wool or Gauze
4. Polyester Clean Room Wipers

A.3.4.1: Special Fixtures

Tools or fixtures used in the cleaning processes, which are not specified herein, shall be designated and approved by the cognizant Engineering activity.

^[1] ABS: Any class of plastics based upon acrylonitrile-butadiene-styrene copolymers

A.3.4.2. Special Equipment

Certain safety equipment shall be worn by personnel during the processes specified herein to minimize exposure risk to chemicals, which maybe hazardous. This equipment shall include, but is not limited to: Safety glasses, aprons, and gloves.

A.3.5. Cleaning Solutions

Cleaning solutions should be prepared fresh per Table A3 before each lot of cleaning. Cleaning solutions prepared for manual and ultrasonic processes should be discarded following each lot of cleaning. Solution life extension maybe accomplished as directed by the manufacturer, as required.

A.3.6. Cleaning Approach

Parts subjected to gross cleaning should be processed in manageable lots of identical materials (i.e., aluminum with aluminum).

Product	Dilution	Amount	Wash Temperature	Manual Precautions		
	%	Oz/Gal	Degrees F	Hand	Eye	Clothing
Alconox ®	1	1.25	120	Yes	Yes	No
Alcojet ®	.5 to 1	0.5 to 1.25	140	Yes	Yes	No
Citranox ®	1 to 2	1 to 3	140	Yes	Yes	Yes
Citrajet ®	1 to 2	1 to 3	140	Yes	Yes	Yes

TABLE A.3. Cleaning Solution Preparation

A.3.7. Application

A.3.7.1. Mechanical Cleaning

Remove all weld splatters, slag, scale, discoloration, and carbonization using mechanical cleaning methods. During the mechanical cleaning process, ensure that the resulting surfaces are smooth and meet the workmanship requirements of Section 3. Tools used for mechanical cleaning shall be clean and previously used only on the same material being cleaned.

A.3.7.2. Organic Solvent Cleaning

Organic solvent cleaning shall be performed using controlled application methods (e.g., saturated technical wipers or swabs). Prioritizing on threads and holes, while finishing with the main surfaces. Technical wipers and swabs will be discarded when there is visible evidence of contamination. The recommended organic solvents are Methyl ethyl ketone (2-Butanone) or Reagent alcohol.

A.3.7.3. Acidic Cleaning (Phosphate free)

Acidic cleaning shall be performed using manual, ultrasonic or pressure washer methods. The recommended acidic cleaner for manual or ultrasonic applications is **Citranox®**, while the recommended acidic cleaner for pressure washer applications is **Citrajet®**.



Acid cleaning agents will cause eye and skin burns if operators do not take appropriate precautions. Eye and Hand protection are mandatory

A.3.7.4. Anionic Detergent Cleaning

Anionic detergent cleaning shall be performed using manual, ultrasonic or pressure washer methods. The recommended anionic detergent for manual or ultrasonic applications is **Alconox®**, while the recommended anionic detergent for pressure washer applications is **Alcojet®**.

A.3.8. Procedures

A.3.8.1. Manual Cleaning

Manual cleaning shall be performed in accordance with the following procedure:

1. Transfer prepared cleaning solution in a stainless tank or container (bucket).
2. Submerge the part or incremental sections until all surfaces have been exposed to cleaning solution.
3. Clean the entire part using soaked clean wipers, brushes; prioritizing on blind and through holes, while finishing with the main surfaces.



Cleaning solution should not be allowed to dry on part during cleaning operations.

4. Rinse entire part as identified in A.3.8.4.

A.3.8.2. Ultrasonic Cleaning

Ultrasonic cleaning shall be performed in accordance with the following procedure:

1. Prepare cleaning solution in a separate stainless container
2. Transfer prepared solution into ultrasonic machine
3. Activate machine to manufacturers recommendations to degas cleaning solution and allow bath temperature to rise to desired wash temperature.
4. Using clean racks or baskets, immerse parts for 10 minutes minimum.
5. Rinse entire part as identified in A.3.8.4.

A.3.8.3. Pressure Washer

Pressure washer cleaning shall be performed in accordance with the following procedure:

1. Prepare cleaning solution in a stainless tank or container.
2. Transfer prepared solution into pressure washer.
3. Clean entire part prioritizing on blind and through holes, while finishing with the main surfaces (changing nozzles as necessary to facilitate).



Cleaning solution should not be allowed to dry on part during cleaning operations.

4. Rinse entire part as identified in A.3.8.4.

A.3.8.4. Tap Water Rinsing

Subject parts an initial running water rinse with ambient or warm (120°F) tap water. The rinse water should contact all surfaces and hole details for a minimum of 20 seconds on each surface. Where a running water rinse is not practical, a series of three (3) or more agitated soak/rinse tanks or at least two (2) counter-flow cascade rinse tanks. Immediately dry parts per A.3.8.6 or proceed to subsequent operations.

A.3.8.5. Dionized Water Rinsing

Immediately following tap water rinsing, parts shall receive a final rinse in ambient or warm (120°F) deionized water. The deionized water should contact all surfaces of the part for a minimum of 20 seconds. Immediately dry parts per A.3.8.6.

A.3.8.6. Drying

Physically remove rinse water from all surfaces using clean room wipers and/or clean nitrogen gas.