Critical Design Review (CDR)
Of
ULTRA VIOLET IMAGING TELESCOPE (UVIT)
(June 17th -18th 2011, ISAC, Bengaluru)

Contamination Control

UVIT-CDR-00-011

Indian Institute of Astrophysics
Bangalore-560034

Contamination Control

for

Ultra Violet Imaging Telescope (UVIT)

Version 1.0

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By

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The absorption cross-sections in ultraviolet are very large, and great care needs to be taken to avoid any contamination of the optical surfaces of the UVIT, on which the radiation falls, during any stage of fabrication/testing/assembly or packing/transport etc. This section describes the possible ways to minimize the chances of contamination.

Possible Sources of Contamination

The contamination of an optical surface can be either due to deposition of the particles or due to deposition of the molecules. Contamination due to particles can be minimized by insisting that the optical surfaces are only opened in areas with clean air; for the purpose of the window of CPUs, Mirrors, etc., it is best that these are only opened in Class 100 air, and this exposure is minimized. The control of molecular contamination is far more difficult to achieve. In this note we are primarily concerned with control and monitoring of contamination of all the UVIT critical components.

Declared Material List& Declared Process List:

All materials and process used in any part of the UVIT instrument are subjected to a screening process and based on contamination clearance the material or process are added in to the approved DML/DPL list.

Special attention was paid to materials selection and only those with low or no outgassing characteristics were used for UVIT. The criteria for selection is TML(Total Mass Loss) and CVCM(Collected Volatile Condensable Mass) values.

It should be TML<1% & CVCM <0.1%

TML & CVCM are the criteria to screen the materials, and only those materials which pass these are tested further for qualification by "UVIT Contamination Test" of materials.

UVIT Contamination Test:

For UVIT contamination test the witness sample windows have been used. Witness samples are smaller models of actual optical components or the smaller optical windows. The material of the optical window used as witness sample is magnesium fluoride (MgF2). These windows are exposed to the material. As the contamination is very sensitive to UV photons, the degradation in transmission measured on optical windows quantifies the possible contamination of the material or the environment where the window is exposed.

In MGKML 20mm x 2mm Mgf2 optical windows are used as witness sample for measuring possible contamination of material/equipments used for UVIT. The window is exposed to the material, which can degauss contaminating molecules or particles for certain period under certain condition like under vacuum or vacuum & baking for long period(80-120 deg C & 24 -72 hrs). The material degaussed from contaminant deposits over the witness sample which is kept at lower temperature(~30 deg C). The transmission of the window in UV range (120nm to 180nm) is measured and compared with its original transmission. The degradation in transmission gives the measure of potential of contamination of the particular material.

The approved material list and process list for UVIT are given in the following table.

List Of Declared NON-METALS

Declared Non-metal list

GROUP 2 :
Non Metals

1	2	3	4	5	6	7			8	9						9.2	9.3	10
										9.1								
Item No.	Commercial	Chemical Nature and	Procurement,	Summary of Processing Parameters	Use and	Environmental Codes			Size Code	Corr	SCC	Flamm	Offg	Outg		Justification for Approval	Ast App.	Cust. App.
						R	A	T										
UVIT-NM-001	Cables	Polyimide (Kapton) And Wire Insulation	Done by IIA, Sanghavi Aerospace (P) Ltd. Ahmedabad/ MIL-DTL-81381		Signal and Data transfer UVIT Payload (Inside & Outside)	L									CVCM-0.0% TML- 0.75%		Heritage use in ISAC for the same wires from the Same Manufacturer		
UVIT-NM-002	Cable Ties	Ethylene-Tetrafluoroethylene (Tefzel) And Wire Anchoring Hardware	Done by IIA, Panduit/ NASA Test #GSC19998		Cables Anchoring And UVIT Payload (Inside & Outside)	L						UL 94V-0			TML: 0.22% CVCM: 0.01%		Heritage use in ISAC for the same Cable Ties NASA-GPL-AS23190-3		
UVIT-NM-003	Glue for Heaters	Polymide w/966PSA and Adhesive	3M		Thermal Control and UVIT Payload (Inside & Outside)	L									TML: 0.93% CVCM: 0.01%		Heritage use in ISAC for the same Glue		
UVIT-NM-004	Thermal Sensors	Epoxy Encapsulated and Thermistor	Done by ISAC, YSI,USA/YS144900		Thermal Control and UVIT Payload (Inside &	L									TML: 0.69% CVCM: 0.01%		Heritage use in ISAC for the same thermistor and GSFC Qualified		

UVIT-NM-005	Kapton tapes	Polyimide (Kapton) and Insulation tape	Done by IIA 3M, USA/ and part Num 1218		To hold the leads of Thermistors and heaters and UVIT payload (Inside&Outside)									TML:0.75% CVCM: 0.00%	Heritage use in ISAC for the same Tape and ASTM Test Method E595		
UVIT-NM-006	Potting Material of Detectors	Arthane and Scotchweld 1838 and Potting Compound	Done by CSA		Inside UVIT Detectors									Checked at IIA (TBM)*			
UVIT-NM-007	Potting material for FWM	Arthane	Done by IISU		Potting on Connectors and Inside Back Focal Volume of UVIT	L								Checked at IIA (TBM)*			
UVIT-NM-008	Heat Shrink Sleeves	PolyVinylidene Fluoride (PVDF) (Kynar) and heat Shrink Tubes	Done by IIA, Pep Charles Limpens Pvt Ltd, Bangalore/ And AMS-DTL-23053/8		Sleeves for Thermistors and Heaters Crimp Contacts And UVIT Payload (Inside &	L								TML: 0.14% CVCM: 0.02%	Heritage use in ISAC for the same HT Sleeve		
UVIT-NM-009	Heaters	Kapton + Electrical Lead	Minco		UVIT Thermal Control Heates	L								TBM	Heritage use in ISAC		
UVIT-NM-010	Mirror Glue	Scotch Weld Epoxy Adhesive 2216B/A	3M		UVIT Mirror bonding	L								TML:0.77% ; CVCM:0.4 %	Heritage use in LEOS		
UVIT-NM-011	HVU	Scotchweld 2216 Uralene												TBM			

List Of Declared Metals

Declared Materials List

GROUP 1 : Metals

DOC. No : DML-UVIT-0.01
ISSUE/REV.: 1 DATE: Nov-09

1	2	3	4	5	6	7			8	9						9.2	9.3	10
										9.1								
Item No.	Commercial Identification	Chemical Nature and Product Type	Procurement, Manufacturer/ Supplier, Specification and Issue.	Summary of Processing Parameters	Use and Location	Environmental Codes R	A	T	Size Code	Corr	SCC	Flamm	Offg	Outg		Justification for Approval	Ast App.	Cust. App.
UVIT-M-001	Invar36	Ni 36.35%, Al 0.003% C 0.025%	Specification ASTM F1684-9 and	100 micron Ni coated, further black anodised.	UVIT telescope, metering structure and focal plane elements.	L			Code (parameter) 4(area) 3(vol.)	B								
UVIT-M-002	AL6061 T6	Si 0.81% Fe 0.3% Cu 0.17% Mn 0.05%	Specification AA-AMS4150L; AMS-QQ-A200/8, ASTMB221-06	Black anodised.	UVIT telescope baffles and back focal elements.	L			Code (parameter) 4(area) 3(vol.) 2(mass	B								
UVIT-M-003	Titanium, T6Al4V Gr F23	Al 6% Fe 0.3% O 0.25% Ti 90% V 4%	Specification ASTM B381 Rev. 08A ASTM E9-89a (2000) Supplier Weber metals 16706, Grafield Avenue CA 90723	No surface treatment.	UVIT satellite adapter	L			Code (parameter) 3(area) 3(vol.) 2(mass)	A								
UVIT-M-004	Titanium Gr 5	Al 5.5-6.75% C<0.1% Fe <0.4% V 3.5-4.5 % O < 0.2% H <0.01% Residuals <0.4%	Specification ASTM B348 Supplier Lee Hydraulics and fasteners (p) ltd.	No surface treatment	Fasteners (bolts nuts and washers	L			Code (parameter) 3(area) 3(vol.) 1(mass)	A								
UVIT-M-005	High tensile steel bolts	High tensile carbon steel	supplier UNBREAKO	Oxidised	Fasteners (bolts nuts and washers	L			Code (parameter) 2(area) 2(Vol) 1 (Mass)	B								

Declared Process List

GROUP : Process List for UVIT

DOC. No : UVIT-DPL-0.01
ISSUE/REV. : 1 DATE: 1st Jan-10

1	2	3	4	5	6	7	8	9	9.2	10
Item No.	Process Identification	Specification	Process Description	Use and Location	Manufacturers Name	Materials List No.	Criticality of Process		Justification for Approval	Aot Approval	Customer Approval
UVIT-DPL-001	Stripping	NASA-STD-8739.4 ESA-PSS-01-726	Stripping Tools are used to remove the insulation of correct size.	Wires Stripping And Cables between CPU, HVU to EU Thermal Control cables to BMU	Sanag Corporation, USA IIA	UV-NM-001	NO		CSA heritage ISAC		
UVIT-DPL-002	Separation of Shield Strands	NASA-STD-8739.4	Separate the Strands of Shield to form a wire	Shielded Wires And Cables between CPU, HVU to EU	Sanag Corporation, USA				CSA heritage		
UVIT-DPL-003	Soldering	NASA-STD-8739.4	Shield Termination Wiring	Shielded Wires And Cables between CPU, HVU to EU	Sanag Corporation, USA				CSA heritage		
UVIT-DPL-004	Crimping	NASA-STD-8739.4 ESA-PSS-01-726	Crimp Contact Terminals Crimp Contact Terminals	Shielded Wires And Cables between CPU, HVU to EU Thermal Control cables to BMU	Sanag Corporation, USA IIA				CSA heritage ISAC		
UVIT-DPL-005	Installation of Heat Shrink Tubes	NASA-STD-8739.4 ESA-PSS-01-726	Wire Formation for Crimping	Shielded Wires And Cables between CPU, HVU to EU Thermal Control cables to BMU	Sanag Corporation, USA IIA	UV-NM-008			ISAC Heritage ISAC		
UVIT-DPL-006	Wire Wrapping	NASA-STD-8739.4	Wrapping the Wires with EMI Braid	Shielded Wires And Cables between CPU, HVU to EU	Sanag Corporation, USA				CSA Heritage		
UVIT-DPL-007	Wire Wrapping	NASA-STD-8739.4	Wrapping the Wires with Insulation Braid	Shielded Wires And Cables between CPU, HVU to EU		UV-NM-014			ISA Heritage		
UVIT-DPL-00	Special Fabrication		The satellite adapter is forged from a billet and later heat treated and machined The satellite adapter is forged from a billet and later heat treated and machined.	Satellite Adapter will be used as a interface between UVIT and satellite	IT Globe,USA	UVIT-M-003			ISAC Heritage		
UVIT-DPL-00	Heat Treatment		All the invar components have under gone 2 stage of heat treatment a) after rough machining,in Vacuum furnace at 315deg.C/600deg.F for 3hrs, and b) after final machining,Accelerated Ageing Process, in vacuum furnace, at 100C (212DF) 24 hours,followed by slow cooling.	UVIT payload components	M/s BATL Tirwindrum	UVIT-M-001			ISAC Heritage		

Cleaning of the components:

Various methods are employed to remove particulate and molecular contamination like Vacuum Cleaning (HEPA Filter Clean room vacuum Cleaner), Solvent Wiping (Soap solution &Acetone), Ultrasonic cleaning with soap water, Ultrasonic Cleaning with Acetone & IPA Wiping with clean tissues.

After drying the parts have been sent to secondary process like black anodizing.

After Black coating all the UVIT mechanical parts are cleaned with Acetone in ultrasonic bath and given two dips in de-ionised water to remove traces of the surfactant. Next, Drying is done in class 100 clean air on a CLEAN table . After the final cleaning/drying, the part is examined in bright and in black-light.(UV) to check for any leftover deposits etc. If any contamination found process need to be repeated till it is certified as clean.

After cleaning all components are baked for 24 hrs at 100° C in high vacuum (< 10^-4 mbar). After the bake, degassing is checked, with TCQM kept at – 10 C, to be less than 1 x 10^-8 g/sq cm/hr. After baking the component is tagged as precision cleaned and after this very great care is taken to avoid all contact with NOT-CLEAN surface of any kind.

Cleaning Aids:

1. Clean room optical grade wipes.
2. Lint free clean room tissue
3. Edgeless polyester clean room wipe

4. Spectroscopic grade IPA
5. Commercial grade Acetone
6. Soap solution (Teepol)

Storage:

Packing of parts and equipment requires some extra precautions to preserve cleanliness after any precision cleaning operation.

For small metal parts and assemblies, it is recommended that clean vacuum grade aluminium foil be used as the primary packing material. The wrapped item is then sealed inside a suitable non out-gassing poly bags.

Additionally the temperature and humidity of the work environment shall be controlled. To minimize water absorption and moisture-induced degradation, humidity is controlled to 40-50% range.

During downtimes when PAYLOAD is not actively being worked on, or for weekends and other non-operational times, It shall be kept covered with black removable poly cover. The use of removable covers for these devices will provide protection during storage and transportation and 'waiting for work' periods.

Purging

The aim of the purging is to avoid external contaminants being deposited on sensitive equipment, such as optics, by injecting a high-purity 99.999 grade dry gas inside the optical cavity .

Purging using grade 5 nitrogen is used whenever required during the PAYLOAD integration phase. Purging pipe is flushed/rinsed with Sp. grade IPA before use.

If an instrument or hardware is removed for testing, or some other reason, it must re-verified to a cleanliness level PRECISION clean standard level before it can reenter the assembly area.

During Assembly & Integration:

It is generally observed that biggest sources of contamination arise from human being. All the clean room personnel working inside the clean room shall enter through air showers. Proper gowning of the personnel (full size garments covering the head, beard), clean room footwear etc. must be ensured. Use of cosmetics, comb, pencils, papers and eatables shall be strictly avoided.

Handling:

After baking, handling the components with bare hands is prohibited. Precision cleaned items shall only be handled with gloved hands and with proper tools.

Assembly activities shall be performed only by specifically trained personnel. Critical and sensitive elements should only be exposed during essential operations and returned to their dedicated containers when not

in work. Dedicated procedures are established for critical item assembly like mirror assembly, CPU assembly, etc.,

The number of staff members in the clean rooms was controlled based on experience gathered during build of the UVIT engineering model (EM). To maintain class 100 conditions maximum 2 people shall be allowed in class 100 and one activity at one time shall be planned to minimise the number of occupants.

Visual inspections shall be performed frequently during the assembly process to ensure that cleanliness has not been degraded. Parts and components shall be rejected if visible contaminants are detected during the assembly process.

Purges shall be used in all possible instances to prevent the entry of contaminants into precision-cleaned items. Gloves should not be allowed to touch any item or surface that has not been thoroughly cleaned.

Every time before starting assembly make sure that the tools used for assembly are cleaned with Spectroscopic grade IPA. Spectroscopic Grade IPL is often used to wipe tools, gloves, etc.

Before assembly operation all the fixtures shall be wiped with Sp. grade IPA and checked for any contamination using white bright light

Precision Cleaned items shall be assembled only in class 100.Precision Cleaned items shall never be placed on clean room floor. Precision cleaned

parts shall be protected from recontamination by interim packaging or other protection methods before and during assembly operation.

A set of assembly tools and equipment for assembly and integration shall be used and maintained in clean conditions. It is generally not good practice for personnel to touch clean room surfaces. Although clean room surfaces are very much cleaner than those outside the clean room, its surfaces, and that of the equipments in the room, will have particles and fibres on them. If personnel touch their garments or mask or phones, they also will pick up CONTAMINATION ON THEIR GLOVES, which may be transferred to the PAYLOAD.

Contamination Monitoring in MGKML:

Verification of cleanliness will be aided by inspection with UV light, which shows organic contamination by fluorescence and by a strong beam of white light arranged to graze the ostensibly clean surfaces. The white light is best for inorganic materials and so is complementary to the UV.

A standard way of checking for any possible molecular contamination of the hardware is to place witness plates/windows in close proximity of the optical surfaces and check these plates/windows for any signs of contamination.

For the UVIT project, we have found that MgF2 windows of ~ 25 mm dia. make very convenient witness samples, as any reduction in UV transmission of these is easily measured with a sensitivity < 5%. Therefore, all the

processes would involve use of 2- witness windows. These windows are always kept in as close proximity of the critical hardware as possible. The witness windows are cleaned and measured for their transmission, in 120 – 180 nm range, before being placed with critical hardware. One of the two windows can be checked periodically for its transmission, to infer any contamination occurring during certain steps. The other window is used to check total/integrated contamination occurring during all the stages of process. It is expected that any reduction in the transmission, in range 120 -180 nm, of > 5% can be detected.

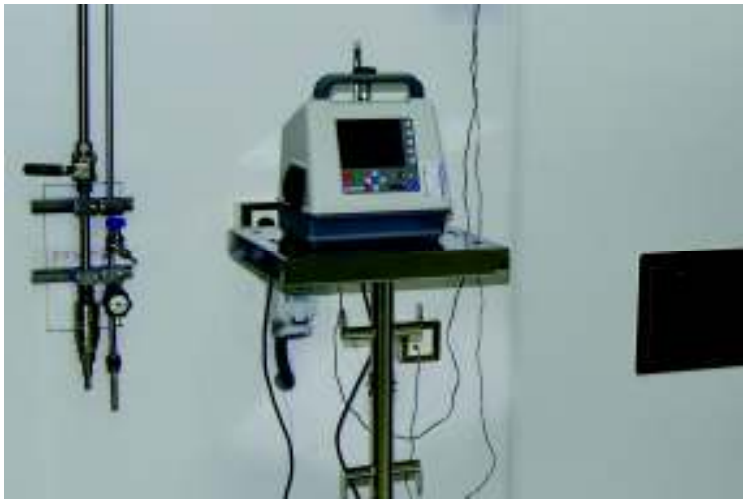
Particulate contamination monitoring:

Particulate monitoring in clean room is done by various methods like Visual inspection of surfaces i.e Surfaces are examined with the naked eye, White light inspection, Ultra-violet lamp (370-390 nm) inspection, laser particle counter, PFO meter etc.,

Laser Particle Counter:

Clean room airborne particle counters, work on a Light Scattering principle. Essentially, this means the particle counters utilise a very bright laser source to illuminate the particles. As entrained particles in the air pass through the laser beam, the laser light interacts with the particles and is scattered. The term "scattering' means that the light undergoes a directional change. This change occurs in all directions:

forwards, backwards and sideways. As the light scatters, it is picked up by these mirrors, which focus the scattered light on to one or more photo-detectors. The photo-detector converts the burst of light energy from each particle into a pulse of electrical energy. By measuring the height of the signal and referencing it to the calibration curve we can determine the size of the particle, and by counting the number of pulses we can determine quantity. So it is relatively straight forward from that point to allocate particle numbers into size channels.



No. of particles allowed at MGKML as per Federal Standard.

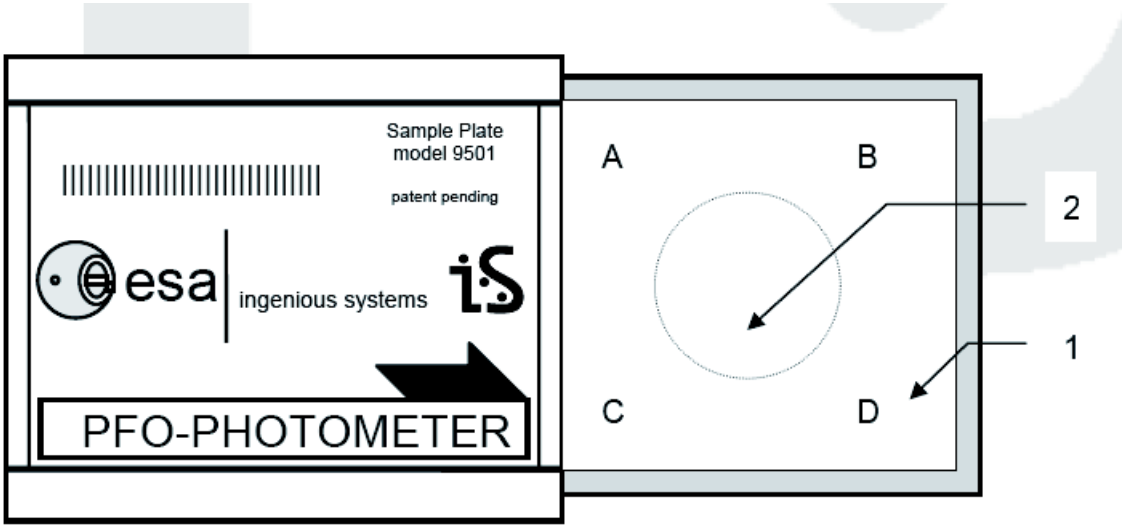
Maximum Number of Particles in Air (particles per cubic foot air)					
Class	Particle Size				
	0.1 µm	*0.2 µm*	*0.3 µm*	*0.5 µm*	*5.0 µm*
1	35	7.5	3	**1**	
10	350	75	30	**10**	
100		750	300	**100**	
1,000				**1,000**	7
10,000				**10,000**	70
100,000				**100,000**	700

On daily basis particle counts have been taken and verified in all the areas and noted down for record purpose. Along with particle count other vital clean room parameters like temperature, Relative humidity and positive pressure are also verified and recorded.

Particle fall out Meter (PFO):

Particulate fall out (PFO) plates are also used to monitor the clean room environment. PFO plates have been used to monitor periodically and the surface coverage of the monitor plates can be evaluated by a PFO-meter. It is a photometric measuring instrument that is able to detect small particles present near the critical areas in clean room environments, to monitor the surface contamination.

A small sample plate which could laid out o different locations of the clean room. After a fixed time (24 Hrs) the sample plates were collected and analysed by PFO meter. The measurement method is based on the scattering of light beams caused by particles on the sample plate. In general the levels shall be expressed in parts per million (mm2/m2).



1.45x45 mm glass plate 2. 15mm circular area used for contamination measurement.

Correlation airborne and PFO for clean rooms

Fed class	PFO (mm2/m2/24 h)
100	2,0
1000	10
10000	52
100000	275

Periodical checks confirm that all the clean areas in MGKML are within the specified limits.

Contamination monitoring in vacuum facility:

In general, the use of witness samples is the simplest and cheapest method to find out contamination in the vacuum facility. Apart from that

combination of a QCM and a mass spectrometer can also be used for the identification of different condensed species.

Spectrophotometer:

Spectrophotometer is used for measuring the transmission of optical windows (witness sample) in UV range (120nm to 180nm). Spectrophotometer consists of UV vacuum Monochromator attached with UV Source and reflectometer.

The photon reaches the PMT thru open slot is measured. The ratio of the photons reaches with window and without window gives the transmission of the window. The entire measurement is done under vacuum better than 10^-4mbar.

Thermal Desiccators Setup:

Thermal desiccators are the glass vacuum chambers evacuated with vacuum pumps. This chamber is placed over heating furnace and can be heated to 120 degree. The material (sample), which can outgas the contaminant, is kept inside the chamber and the witness sample is placed inside the chamber close to the sample. The chamber is evacuated to 10^-4 mbar pressure and heated to 120degree for 24 to 48 hours depending on the out gassing of the material. The molecules come out of the sample deposits over the witness sample. The witness sample will be taken out and its transmission is measured in the spectrophotometer.

Thermal Baking Chamber:

This setup is used to bake out the UVIT mechanical components in a vacuum better than 10^{-4}mbar. The mechanical components are baked continuously for 24hours at 100°C to drive out the molecular contamination. To the two ports of the Thermal Vacuum/Baking Chamber are attached with RGA and a TQCM for measuring the out gassing of the components baked inside.

The TV chamber shall be checked for being contamination free before loading any component. The out gassing in the chamber shall be monitored before loading the instrument into the chamber. If the out gassing requirement is not met, the hardware may be subjected to a further bake out.

Contamination Control For UVIT during Test & Integration Activities

Sl. No.	Activity	Environment	Cleaning Methods	Inspection Method	UHP N2 Purging	Covers	Witness Samples
1	**Cleaning & Metrological Measurement of the Structural Components**						
1.1	Vacuum Cleaning of Container	Class 300K, 22+/-1.1 deg. C, RH 50% +/- 5%	Vacuum Cleaning	Visual Inspection	NO	NO	
1.2	Unpacking of Container	Class 100K, 22+/-1.1 deg. C, RH 50% +/- 5%	Solvent Wiping of Bag/Part	Visual Inspection, White Light & Black Light Inspection	NO	NO	
1.3	Metrological Measurement of the Structure	Class 100K, 22+/-1.1 deg. C, RH 50% +/- 5%	Solvent Wiping	Visual Inspection, White Light & Black Light Inspection	NO	NO	
1.4	Cleaning of Mechanical Components	Class 300K, 22+/-1.1 deg. C, RH 50% +/- 5%	Ultrasonic Cleaning(Teepol & Acetone)	Visual Inspection, White Light & Black Light Inspection	NO	Covers Immediately	
1.5	Baking	Class 10K, 22+/-1.1 deg. C,	Thermal Baking Chamber	**TQCM,RGA & Witness samples**			YES
1.6	Repacking	Class 10K, 22+/-1.1 deg. C, RH 40% +/- 5%			NO	YES- Vacuum sealed	
1.7	Storage	Class 10K, 22+/-1.1 deg. C, RH 40% +/- 5%			NO	Storage cabinet	YES
1.8	Reuse					Covers Immediately	
2	**Back Focal Component Tests**						
2.1	Outer container & Inner bag cleaning of Back focal components HVU, EU, GSE, FWM and optical	Class 10K, 22+/-1.1 deg. C, RH 40% +/- 5%	Solvent(IPA)Wiping	White light & Black light with magnifying glass	NO	NO	
2.2	Un packing of Back focal components HVU, EU, GSE, FWM and optical components	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5% or Vacuum Chamber	No cleaning of Optical Components. For Other components Solvent(IPA) Wiping	White light & Black light with magnifying glass	YES	Always Covered In	
2.3	CPU	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5% or Vacuum Chamber	No cleaning of Optical Components. For Other components Solvent(IPA)	White light & Black light with magnifying glass	YES	Always Covered In - ESD Cover	YES
2.4	Component level tests	Class 10K, 22+/-1.1 deg. C, RH 40% +/- 5%	No cleaning of Optical Components. For Other components Solvent(IPA)	White light & Black light with magnifying glass	YES	NO	

2.5	Storage	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5% or with Covers in class 1000/Dessicator			YES	YES-ESD Cove	YES
	Integration and Tests on Unit Telescope-1 & 2						Yes-Two Witness samples for each Telescope; One near the secondary mirror/on
3	Integration of the Telescope Structure, PMA, SMA	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NO	White light & Black light with magnifying glass	NO	NO	
3.1	Alignment with ATAC	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NO	White light & Black light with magnifying glass	NO	NO	
3.2	Alignment with Interferometer	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NO	White light & Black light with magnifying glass	NO	NO	
3.3	Integration of Back focal Components	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NO	White light & Black light with magnifying glass	NO	NO	Yes-periodical mesurement
3.4	Tests on Integrated Unit Telescope Vacuum Chamber	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NONE	White light & Black light with magnifying glass	NO	NO	Yes-Periodical mesurement before & After
3.5	Integration of Main Baffle & Door Assembly on Telescope	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NONE		YES	NO	
3.7	Put Telescope Under Cover	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%	NONE			YES- Storage Covers	Yes-Periodical mesurement
3.8	* To be repeated for Unit Telescope-2						
4	**Unpacking of Unit Telescope-1 & Unit Telescope-2**	Class 100 , 20 +/- 1 deg. C, RH 30% +/- 5%		White light & Black light with magnifying glass	YES	NO	
5	**Alignment and Integration of Payload on Optical Table**	Class 100, 20 +/- 1 deg. C, RH 30% +/- 5%		White light & Black light with magnifying glass	YES	NO	Yes -Periodical measurement
6	**Integration of Satellite Cylinder**	Class 10K , 22+/-1 deg. C, RH 40% +/- 5%		White light & Black light with magnifying glass	YES	NO	
7	**Conical Adapter Integration**			White light & Black light with magnifying glass			
7.1	Integration of Telescope-1 and Telescope-2 on Adapter	Class 1K, 22+/-1 deg. C, RH 30% +/- 5%		White light & Black light with magnifying glass	YES	NO	
8	**Coalignment Test**	Class 1K, 22+/-1 deg. C, RH 30% +/- 5%		White light & Black light with magnifying glass	YES	NO	

9	**Integration of Thermal Cover and Heaters**	Class 1K, 22+/-1 deg. C, RH 30% +/- 5%		White light & Black light with magnifying glass	NO	NO	Yes-Periodical mesurement
10	**Packing of Integrated Payload on the low level trolley**	Class 1K, 22+/-1 deg. C, RH 30% +/- 5%			YES	YES	Yes-Periodical mesurement
11	**Vibration Test on Paylod at ISAC**						
11.1	Preparation for Transportation of the payload				YES	YES	
11.2	Transportation to ISAC				YES	YES	
11.3	Unloading of Payload				YES	YES	Yes-Periodical mesurement
11.4	Mechanical and Electrical Checks on Payload at ISAC after Unloading				YES	NO	
11.5	Handing over the payload to ISAC (Vibration Test				YES	YES	
11.6	Vibration Test				NO	NO	
11.7	Necessary Mechanical and Electrical Checks on				YES	NO	
11.8	Packing of EM Payload to transport it to MGKML				YES	YES	
12	**Post Vibration Tests at MGKML**						
12.1	Unloading of Payload at IIA, Unload inner Container and bring to to class 10K.	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Vacuuming, Solvent Wiping of Inner Container, Wiping	NONE	YES	YES	Yes-Periodical mesurement
12.2	Mechanical and Electrical Checks on Payload at IIA after Unloading	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping of Cover. Remove Cover, if need be external mechanical	White light & Black light with magnifying glass	YES	NO	
12.3	Detailed Mechanical Checks & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping of Cover. Remove Cover, if need be external mechanical parts are solvent(IPA)	White light & Black light with magnifying glass	YES	NO	
12.4	Detailed Harness Checks & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
12.5	Detailed Electrical Test & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
12.6	Detailed Optical Tests and Review the performance	Class 100 (FED), 20 +/- 1 deg. C, RH 30% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
13	**Environmental Test on Payload at ISAC**						
13.1	Preparation for Transportation of the payload				YES	YES	Yes-Periodical mesurement
13.2	Transportation to ISAC				YES	YES	
13.3	Unloading of Payload				YES	YES	Yes-Periodical mesurement

13.4	Mechanical and Electrical Checks on Payload at ISAC after Unloading				YES	NO	
13.5	Handing over the payload to ISAC (Environment Test Team)				YES	NO	Yes-Periodical mesurement
13.6	Environment Test				NO	NO	
13.7	Necessary Mechanical and Electrical Checks on EM Payload				YES	NO	Yes-Periodical mesurement
13.8	Packing of EM Payload to transport it to MGKML				YES	YES	

14 Post Environmental Tests at MGKML

14.1	Unloading of Payload at IIA, Unload inner Container and bring to to class 10K.	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Vacuuming, Solvent Wiping of Inner Container, Wiping of container with	NONE	YES	YES	
14.2	Mechanical and Electrical Checks on Payload at IIA after Unloading	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping of Cover. Remove Cover, if need be external mechanical parts are solvent(IPA)	White light & Black light with magnifying glass	YES	NO	
14.3	Detailed Mechanical Checks & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping of Cover. Remove Cover, if need be external mechanical parts are solvent(IPA)	White light & Black light with magnifying glass	YES	NO	
14.4	Detailed Harness Checks & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
14.5	Detailed Electrical Test & Review the performance	Class 10K, 22+/-1 deg. C, RH 40% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
14.6	Detailed Optical Tests and Review the performance	Class 100 (FED), 20 +/- 1 deg. C, RH 30% +/- 5%	Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	Yes-Periodical mesurement

15 Handover the Payload to ISAC

15.1	Preparation for Transportation of the payload				YES	YES	Yes-Periodical mesurement
15.2	Transportation to ISAC				YES	YES	
15.3	Unloading of Payload				YES	YES	Yes-Periodical mesurement
15.4	Mechanical and Electrical Checks on Payload at ISAC after Unloading		Solvent (IPA) Wiping	White light & Black light with magnifying glass	YES	NO	
15.5	Handing over the payload to ISAC (Integration Team)				YES	YES	Yes-Periodical mesurement & Cummulative Measurement

16 Satellite Integration

16	Opening Covers for Integration Integration			White light & Black light with magnifying glass	YES	NO	Yes-Periodical measurement
16	After Satellite Integration			White light & Black light with magnifying glass	NO	NO	Yes-Periodical measurement
16	Before & After Satellite Thermo Vac test			White light & Black light with magnifying glass	NO	NO	Yes-Periodical measurement
16	If any storage in clean room			White light & Black light with magnifying glass	YES	YES	Yes-Periodical measurement
17	Before transportation to Launch			White light & Black light with magnifying glass	YES	YES	Yes-Periodical measurement
17	At Launch centre after transportation			White light & Black light with magnifying glass	YES	YES	Yes-Periodical measurement
17	Storage(If any)			White light & Black light with magnifying glass	YES	YES	Yes-Periodical measurement
17	Before launch			White light & Black light with magnifying glass	NO	NO	Yes-Periodical measurement & Cummulative Measurement

Contamination Measurement Values using Witness windows:

Contamination Window No	Place	Start Date	Frequency of Measurement	% Reduction in Transmission	Acceptance Limit
13	Mini Chamber -I	Jul-09	15 days	<2%	5%
14	Mini Chammber -II	Jul-09	15 days	<2%	5%
15	Baking Chamber	Jul-09	15 days	<2%	5%
16	Small Vacuum Chamber	Jul-09	15 days	<2%	5%
48	Pay Load Vacuum chamber	Aug-09	15 days/1 month	<2%	5%
49	N2 Gas supplyLlines	Aug-09	15 days	<2%	5%
54 & 55	Transport Container	Jul-10	Before and after every transport	<2%	5%
56 & 57	EM Thermo Vac Test	May-11	Before and after TV test	<2.5%	5%
58	FM collimator Mirror Storage Dessicator	Apr-11	15 days	<2%	5%
W 03-25mm	EM Payload-Thermal Cover	Aug-10	Every mile stone	<2%	5%
W 04-25mm	EM Payload-NUV Door	Aug-10	Every mile stone	<2%	5%

Packing, containerization, transportation and storage:

To maintain the cleanliness levels achieved at any point from initial precision cleaning to delivery to satellite integration provisions are taken for packing, containerization, transportation and storage.

For that, cleanliness protection shall be provided prior to leaving the controlled areas, or whenever a storage period is planned.

Payload :

- Covered with multilayer poly bags to minimise the contamination.
- Two levels of containerization. Clean SS inner container which envelops the payload will be placed inside the outer container which is exposed to the outer environment. The inner container is fixed on the wire ropes to take care of the shock loads during transport.
- Adequate provision for internal flushing with dry N2 during transport.
- Inlet and outlet valves to control the purging rate
- Contamination witness window in the container during transportation.
- On line Shock watch monitors to find out the impact level during transport.
- During various phases of storage, transport & testing two witness samples for periodical measurement and two witness samples for cumulative measurement shall accompany the payload to keep track of contamination. One set (one for periodical and one for cumulative) is fixed on the NUV door and the other is fixed on the thermal cover. Checks have been done during every mile stone to confirm the cleanliness.

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Small Components storage:

- Small clean parts shall be double bagged in airtight envelopes during transportation outside controlled clean areas.
- Bags for contamination sensitive items shall be flushed with dry N2 before sealing
- Only approved materials were procured as bagging material
- Resettable Shock watch monitors & Labels to find out the impact level during transport.

During Environmental tests:

The purging shall be implemented at payload level during functional and performance tests at less clean conditions, during and after vibration and TV tests, during all the phases without activities and during storage phases.

During downtimes when PAYLOAD is not actively being worked on, or for weekends and other non-operational times, It shall be kept covered with black removable poly cover.

The purity of the gas and the cleanliness of all the pipes shall be verified before the first use of the purging system. During door deployment tests clean filters have been used to minimize the particulate contamination. Recurrent wiping of the test facility floor is ensured to minimise the particle counts during testing.