



NASA-STD-6001 Test 7, Assembled Article Offgas Testing Exemption Criteria – Response To SSPCB Action 139404



**Sponsoring Org/Office: OZ/Research
& Integration**

Forum: SSPCB

Date: July 12, 2016

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Purpose & Agenda

◆ Purpose:

- ***Respond to Action from SSPCB to Justify Proposed Exemption Level.***
- Obtain SSPCB concurrence on expansion of assembled article exemption requirements for NASA-STD-6001 Test 7 Offgas Products toxicity

◆ Agenda:

- Give context for discussion on exemptions.
- Provide rationale for revised approach
- Seek ISS approval of revised approach

◆ Prior forums presented:

- Joint VCB/ RICB for original presentation.
- SSPCB on June 7, 2016. Original presentation had concurrence received from JSC M&P (ES4), Toxicology (SK4), Research and Integration Management Office (OZ6), MSFC Materials Test Branch (EM10), MFSC Materials and Processes Laboratory (EM01)



Value Assessment Key Discussion Points



◆ Current exemptions

- COTS <5lbs. testing exemption (SSP50835)
 - Exclusions to exemption: uncured adhesives, lubricants, cleaning wipes, marker pens, and other items containing liquids or gels
 - Applicability to COTS Payloads items via SSP50986 (09/15)
 - Current exemption based on evaluation of limited data set
- Existing exemption has been in place since 2012
- Overwhelmingly majority of articles pass the off-gas testing! (Good news!...It means we are doing a good job educating folks on materials selection and process.)
- T-value (toxicity index) of 0.5 is used to judge acceptability for individual articles.
- ISS acceptability limit is T-value of 1 when assessing monitoring data (ie, no individual article can account for more than half the acceptable ISS T-value)

◆ Could assembled article exemption criteria be further expanded?

- At June 7 SSPCB, the team proposed raising the exemption from <5 lbs to <15 lbs.
- ISS Program managers were generally supportive of the presentation and efforts. They did request that Toxicology re-evaluate why the exemption limit couldn't be even higher.
- An SSPCB Action (139404) was issued to T. McCoy to bring back this story by July 12th, 2016.



Top 10 Reported T Values



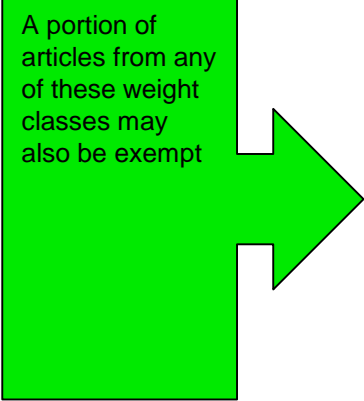
Test Rpt. No.	Weight (lbs)	T Value (ISS 118 m3)	Pre-conditioning	Precond. Rational	Comments
M108820-A	248.11	41.0515	72hrs, 120F	Initial HLA, Failure	PAYLOAD: (major contributors: Unidentified Chlorofluorocarbon 35,4545 ug @0.1 SMAC, perfluoro-1-heptene 4,273 ug @0.1 SMAC, Unidentified component 12,0566 @0.1 SMAC) Fluid leak in hardware, Liquids included in exemption exclusions
W-38605	68.01	0.774			PAYLOAD: Retest Passed, Major Contributor was AK225G which if assigned a non-default SMAC would have passed initially
M107823-A	79.00	0.3945			PUMP/SEPARATOR FILTER: (Major contributors are unidentified fluorinated hydrocarbon(285 ug @0.1 SMAC) and unidentified component (4,274 ug @0.1 SMAC)
W38301-A	99.40	0.3624	72hrs, 120° F Purge	Good measure (purge)	INCUBATOR: (Major contributor C10 Aromatic hydrocarbon 4,200ug @0.1 SMAC)
W-40501-A	13.62	0.253 (0.244 of value PFBs)	93.25hrs, 120° F Purge	Good measure (purge)	FLOW METER ASSEMBLY (Major Contributors Perfluorobutenes 23ug @ 0.0008 SMAC, various ethers @ 0.1 SMAC) Consisted of Various Articles: 1. Flow Display Computer, 2. Transducer, 3. 15' Transducer Cable, 4. LiMnO2 AA Battery Cable main culprit, Retest w/o cable (40501-B) T value 0.008 with no perfluorobutenes. (1.5lbs, 15ft cable)
M108545-A	14.00	0.2387			PAYLOAD
M108695-A	20.94	0.2256			PAYLOAD, Largest contributor to T-value2,359ug of Formaldehyde (SMAC 0.12)
M108806-A	53.90	0.2047	72hrs, 120F	Initial HLA/ Good measure?	PAYLOAD: (Major contributors Camphene 224ug @ 0.1 SMAC, Formaldehyde 181ug @ 0.12 SMAC, Unidentified Fluoroaliphatic hydrocarbons 857 ug @ 0.1 SMAC, Unidentified siloxanes 1062 @ 0.1 SMAC)
M108622-A	13.29	0.201 (likely similar wo cond.) (0.16 of value organic acids)	3hrs, 118F (iphone & cord) 4hrs, 118F (lab cubes)	Minor conditioning (good measure?)	PAYLOAD, SMARTPHONE, AND CABLE (Major contributors Formaldehyde 133ug @0.12 SMAC, Methylene chloride 107,229ug @ 49 SMAC, Organic acids 1927 @ 0.1 SMAC , Unidentified siloxane 61ug @ 0.1 SMAC) Organic acids could likely be further examined and specified wo default
W38605-A	68.01	0.1850	120° F, 72 hrs	Initial Failure	RETEST-FLUIDS AND COMBUSTION FACILITY HARDWARE



Data Analysis and Recommended Exemptions



- 362 assembled articles (MSFC & WSTF, Non-preconditioned, Modern analysis 2004-2016)

Range	Count	Avg lbs	Avg T Value	% Total	Σ% Testing Reduction	
>100lbs (wo #1)	14	176	0.0615	4%	100%	
65-100lbs	13	80	0.0616	4%	96%	
55-65lbs	5	60	0.0396	1%	93%	
45-55lbs	4	50.67	0.0100	1%	91%	
35-45lbs	8	40	0.0220	2%	90%	
25-35lbs	8	30.17	0.0569	2%	88%	
20-25lbs	8	22.27	0.0477	2%	86%	
15-20lbs	18	16.8	0.0080	5%	83%+	Revised Recommendation
10-15lbs	15	11.74	0.0251	4%	78%	Initially Proposed
5-10lbs	46	7.14	0.0083	13%	74%	
<5lbs	223	0.827	0.0020	62%		Existing Exemption

Revised proposal to exempt articles <20 lbs of non-metallic weight, regardless of total weight (i.e., only focus on weight of materials that off-gas). This will result in excluding additional articles from heavier size classes (>83% excluded from testing)



Why Test, Even if Most Pass?



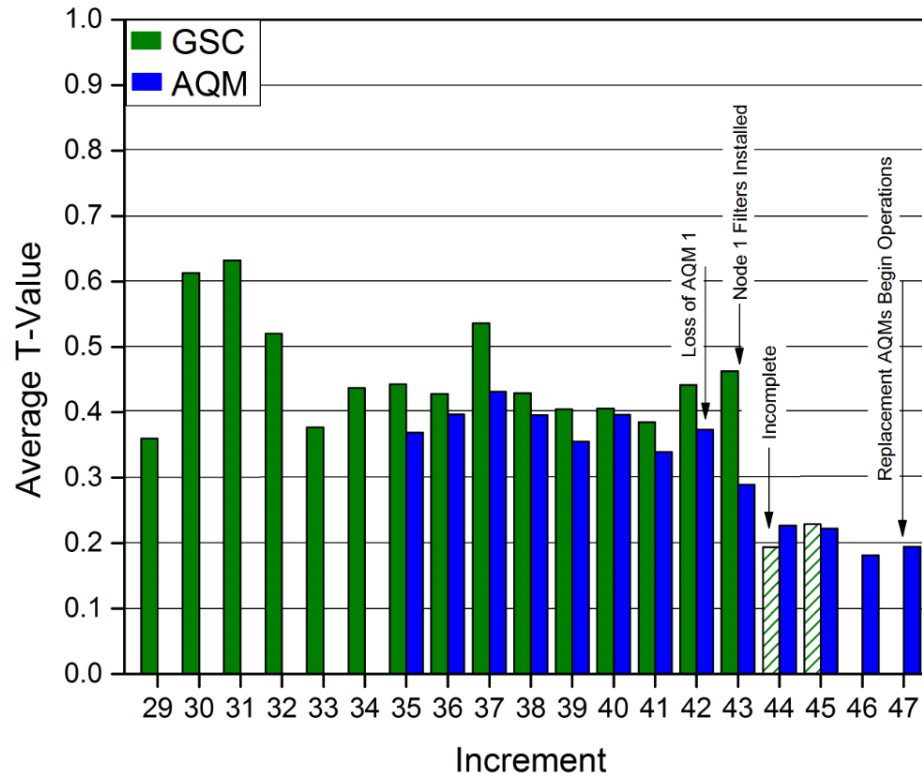
- ◆ **Testing promotes accountability**
- ◆ **You don't know what you don't know**
 - Preconditioning
 - Kynar bag fluorinated off-gas products
- ◆ **Worst-case T-value isn't the whole story!**
 - Off-gas testing exemptions/acceptability criteria ultimately impacts the "Cumulative" off-gas load to the ISS
 - This load (and other non-off gas contributions) is evidenced by our air monitoring data. This is the data that you use to determine if you can alter your exemption criteria.
 - What is the cumulative impact of your paradigm?





Average T-Values by Increment based on GSC and AQM Data

(guideline: T-Value < 1; GSC sample frequency: every 45-days (recently decreased from every 30-days))



Note: Average T-values do not include contributions from CO2 and first ingress samples.



Proposed Exemption Conclusions (To be reevaluated in 2 years)



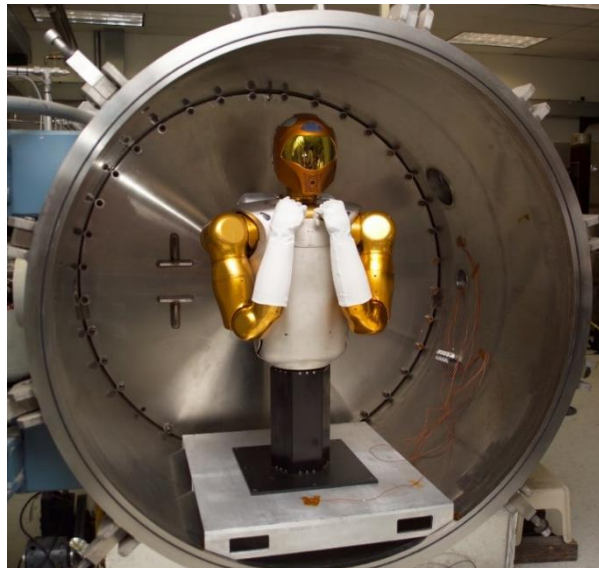
◆ Exempt Assembled Articles of Any Weight which have <20 lbs of non-metallics.

- Exemption limited to cumulative of all assembled units of a single payload assembly flown to ISS



◆ Exempt Assembled Articles of Any Weight which have >20lbs of non-metallics, via materials assessment

- Exempt by Analysis via application form, materials data requested
- Non-metallic materials used shall be previously tested and proven to be safe at the use weight





Back up slides



All Preconditioned Assembled Articles in 5-15lbs Range



Test Rpt. No.	Weight (lbs)	T Value (ISS 118 m3)	NASA Lab Pre-conditioning	Precond. Rational	Designation/ Comments
W-40501-A	13.62	0.253 (0.244 of # perfluorobutenes)	93.25hrs, 120° F Purge	Good measure (purge)	FLOW METER ASSEMBLY (Major Contributors Perfluorobutenes 23ug @ 0.0008 SMAC, various ethers @ 0.1 SMAC) Consisted of Various Articles: 1. Flow Display Computer, 2. Transducer, 3. 15' Transducer Cable, 4. LiMnO2 AA Battery Cable main culprit, Retest w/o cable (40501-B) T value 0.008 with no perfluorobutenes. (1.5lbs, 15ft cable)
M108622-A	13.29	0.201 (likely similar wo cond) (0.16 of # organic acids)	3hrs, 118F (iphone & cord) 4hrs, 118F (lab cubes)	Minor conditioning, Good Measure?	PAYLOAD, SMARTPHONE, AND CABLE (Major contributors Formaldehyde 133ug @0.12 SMAC, Methylene chloride 107,229ug @ 49 SMAC, Organic acids 1927 @ 0.1 SMAC, Unidentified siloxane 61ug @ 0.1 SMAC) Organic acids could likely be further examined and specified wo default
W43026-A (W42733 tested WO precondition)	6.61 (6.61)	0.017 (0.021)	48hrs, 120F, purge without battery, test w battery	Preconditioning per PRC-9010, Goal to increase # of allowable units	LAPTOP COMPUTER Todd Sullivan United Space Alliance, 2008 for Station Test request specifies: Bake out in accordance to PRC-9010. (conditioned without battery) Various boards conformal coated DC3140. Polycarbonate standoffs adhered w/ Hysol 608 epoxy. Higher number approved for flight using 602m3 volume justification.
M108218-A	7.50	0.013	24hrs, 120F	Goal to increase number of allowable units	LIGHTING MODULE Believed to be and engineering unit, marked as flight on the test request. Follow up test on M108328 to increase # allowable units.
W-40501-B (Retest of W40501-A WO cable)	12.12	0.008	(93.25hrs, 120F Purge)(72hrs, 120F test w cable)	Good measure (purge), initial test	FLOWMETER ASSEMBLY WITHOUT CABLE - Retest of 40501-A - Various Articles: 1. Flow Display Computer, 2. Transducer, 3. LiMnO2 AA Battery Cable found to be main culprit, no perfluorobutenes (1.5lbs, 15ft cable)
M108328-A (Retest M108218)	8.00	0.000	Customer Cond.: (72hrs, 140F) (168hrs, 120F) (432hrs,140F) (72hrs, 120F)X3	Goal to increase number of allowable units	Follow up test to 108218 (T value 0.013) - LIGHTING MODULE - Believed to be Flight, marked as such on the test request. Goal to increase number of allowable units (Desire unlimited units?)



All Preconditioned Assembled Articles in 15-20lbs Range



Test Rpt. No.	Weight (lbs)	T Value (ISS 118 m3)	NASA Lab Pre-conditioning	Precond. Rational	Designation/ Comments
M108693-A	24.70	0.0080	72hrs, 120F	Good Measure, requested by customer pre-test	GAS CHROMATOGRAPH 67212MFAM30000 Would have likely performed well even without preconditioning
M108613-A	19.69	0.0344	72hrs, 120F by customer @ University of North Dakota	Good Measure, preconditioned before sent in for test	INTERNATIONAL SPACE STATION AGRICULTURAL CAMERA (ISSAC) COMPONENTS AS FOLLOWS: ACAM-014-303-0 SENSOR OPTICS ACAM-014-306-0 SENSOR ENCLOSURE ACAM-014-302-0 SENSOR BACK PLATE ACAM-006-301-0 GREEN CABLE ACAM-006-302-0 RED CABLE ACAM-006-303-0 INFRARED CABLE ACAM-006-307-0 TRIGGER CABLE ACAM-104-310-0 SENSOR CAP ACAM-104-307-0 ISSAC LENS ACAM-104-303-0 ISSAC LENS CAP ACAM-104-309-0 ISSAC LENS BACK CAP ACAM-001-306-0 SENSOR FRAME ACAM-006-304-0 SENSOR FIREWIRE CABLE ACAM-006-305-0 SENSOR POWER CABLE ACAM-006-306-0 SENSOR USB CABLE Would have likely performed well even without preconditioning



Summary of Selection Rational



- ◆ **Examined data from more than 400 assembled articles (MSFC & WSTF, Non-preconditioned, Modern analysis 2004-2016)**
- ◆ **Identified Worst case weight/ T value performers and used as model for worst cases to ensure safety margin.**
 - **13-14 lbs, T values 0.2-0.25 (~1/2 of 0.5)**
 - **20 lbs similar, T values of 0.22 (~1/2 of 0.5)**
- ◆ **Preconditioning**
 - **Items in 5-15lbs assessed and found not to bring up any concerns with 15lbs criteria**
 - **Items in 20lbs assessed and found not to bring up any concerns**
- ◆ **Low average T values in 15 (0.0251) and 20lbs (0.0080) range provide added confidence**
- ◆ **Largest impact in reducing testing found up to 15lbs (~78% reduction) decrease in testing, 20lbs would be next largest increment to 83%. Further increase in exemptions have lesser impacts.**



Implementation

- ◆ **Expand Non-COTS Exclusions**
 - Uncured adhesives, lubricants, **foams, foamed fluorocarbons (cables)**, cleaning wipes, marker pens, and other items containing liquids or gels
- ◆ **Expand JSC M&P screening process per these guidelines**
- ◆ **Update documents with exemptions**
 - Payload Safety Requirement Document 51700
 - Include Exemption by Analysis Form
 - SSP50835 & SSP50986
 - Target completion date Sep30th
- ◆ **Include exemptions in RISE Data set**
- ◆ **Train PIMS and RIMS on exemption criteria**
- ◆ **Work with OZ to ensure exemption application form resides in electronic searchable database**
- ◆ **Re-evaluation for expansion of exemptions in 2 years**
 - Current IMV reconfiguration (US and Russian segment) may effect distribution of contaminants on USOS. Proposed exemptions based on US Lab volume (118m³) to ensure conservatism. With further contaminant distribution data, exemptions can be re-evaluated in ~2 yrs.



Efficiencies/ Consolidation Position



◆ Your Efficiencies Gained

- ~80-90% reduction in testing
- Cost , schedule, hardware shipment risk reduced

◆ Potential agency facilities efficiencies

- Executive Council recommended consolidation of NASA-STD-6001 testing at single center (WSTF)
- ISS payload concern due to schedule and shipment efficiencies associated with “one-stop shop” payload testing at MSFC
 - **If expanded exemptions reduced payload offgassing testing sufficiently, would efficiencies gained minimize impact related to facility consolidation?**

◆ Secondary Capability Cost

- ISS contribution for maintenance of MSFC secondary payload offgas testing capability
 - 136K (FY16 & 17), 350K (FY18-20)
- ~350K/year agency cost for maintenance of MSFC capability
- ~130K/year Realized savings if facility mothballed (Current Facility costs ~188K)
- Opportunity costs on facility repurposing to currently offsite laboratories (unknown)

◆ Payload Test Projections

- ~2-3 remaining required assemble article tests anticipated/ year with implementation of proposed exemptions
- ~1-2 payloads/year remaining from Huntsville area (Historically ~50% of articles developed at MSFC or Huntsville area)



Recommendation



- ◆ **Request SSPCB concurrence on expansion of assembled article exemption criteria for NASA-STD-6001 Test 7 Offgas Products toxicity analysis**

- ◆ **Request SSPCB position / concurrence on agency recommended consolidation of NASA-STD-6001 Test 7 Payload offgas toxicity testing at single facility (WSTF)**



Preconditioning



- ◆ **>400 Total assembled articles NASA STD6001-Test 7s performed tested since 2004**
 - 2004 formaldehyde analysis implemented
- ◆ **Of these 43 preconditioned (39 MSFC, 4 WSTF)**
- ◆ **Preconditioning performed for several reasons**
 - Good measure to ensure the article will pass
 - Often performed after an Initial high level assessment (dirty, med, clean)
 - Dirty ≠ Failure (Dirty: Abundant, Large, Co-eluted peaks)
 - If compounds detected nontoxic can still pass comfortably
 - Good measure to expedite interpretation / customer schedule
 - With goal of increasing number of allowable articles
 - Documentation of customer processing/ performance of customer requirement