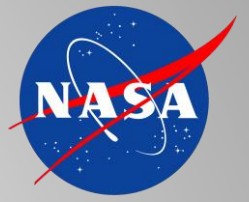


Workmanship Lab Management at Goddard Space Flight Center

Bo Yang, CQE
Terry James, PMP
Alvin Boutte

GSFC Workmanship and ESD Program

Acknowledgement

- Malinda Hammond, Code 585 Associate Branch Head
- Gregory Wood, Code 585 LQMS Developer
- Alexander Durkin, Code 585 System Engineer
- Dann Brown, Code 500 Lab Manager
- Becky Pike, Code 373 Branch Head
- Jeannette Plante, Quality Engineering Technical Fellow

Agenda

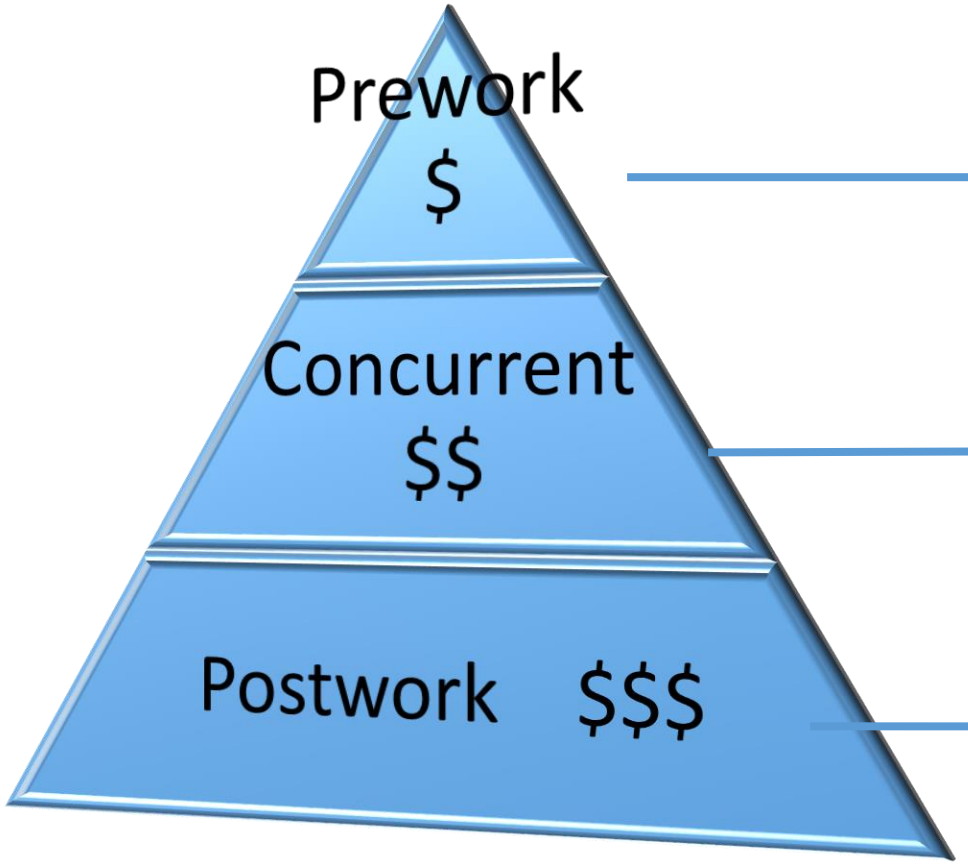
- Overview
- Lab Quality Management System Workmanship Module
- Deployment and Result
- Future Work

Overview:
NPD 8730.5: NASA Quality Assurance Program Policy

- Prework Assurance Measures:
  - Provide increased confidence for meeting prescribed requirements (e.g., pre-award surveys, qualified source selection, training).
- Concurrent Assurance Measures:
  - Ensure that work is being performed in accordance with requirements (e.g., process control, process witnessing).
- Postwork Assurance Measures:
  - Ensure that work was properly performed

  (e.g., inspections, tests, record review, configuration control).

Cost of Quality



Prework $	Lab survey, training, pre-award selection	LQMS Workmanship Module
Concurrent $$	Process control and witness for Lab Work	WOA, Traveler, Process Control Plan
Postwork $$$	Inspection for works done by labs	Product Inspection Tool

Tools Used for Pre-award Need to Answer:

- How many labs are there at GSFC?
- What do those labs do? (harness? solder? polymeric? etc..)
- Which lab is capable of assembling flight hardware?
- Which lab is capable of performing rework/repair for flight hardware?
- What are the quality of the work from a lab?
- ……

Lab Self Assessment $

Audit $$$

Quality Data History $

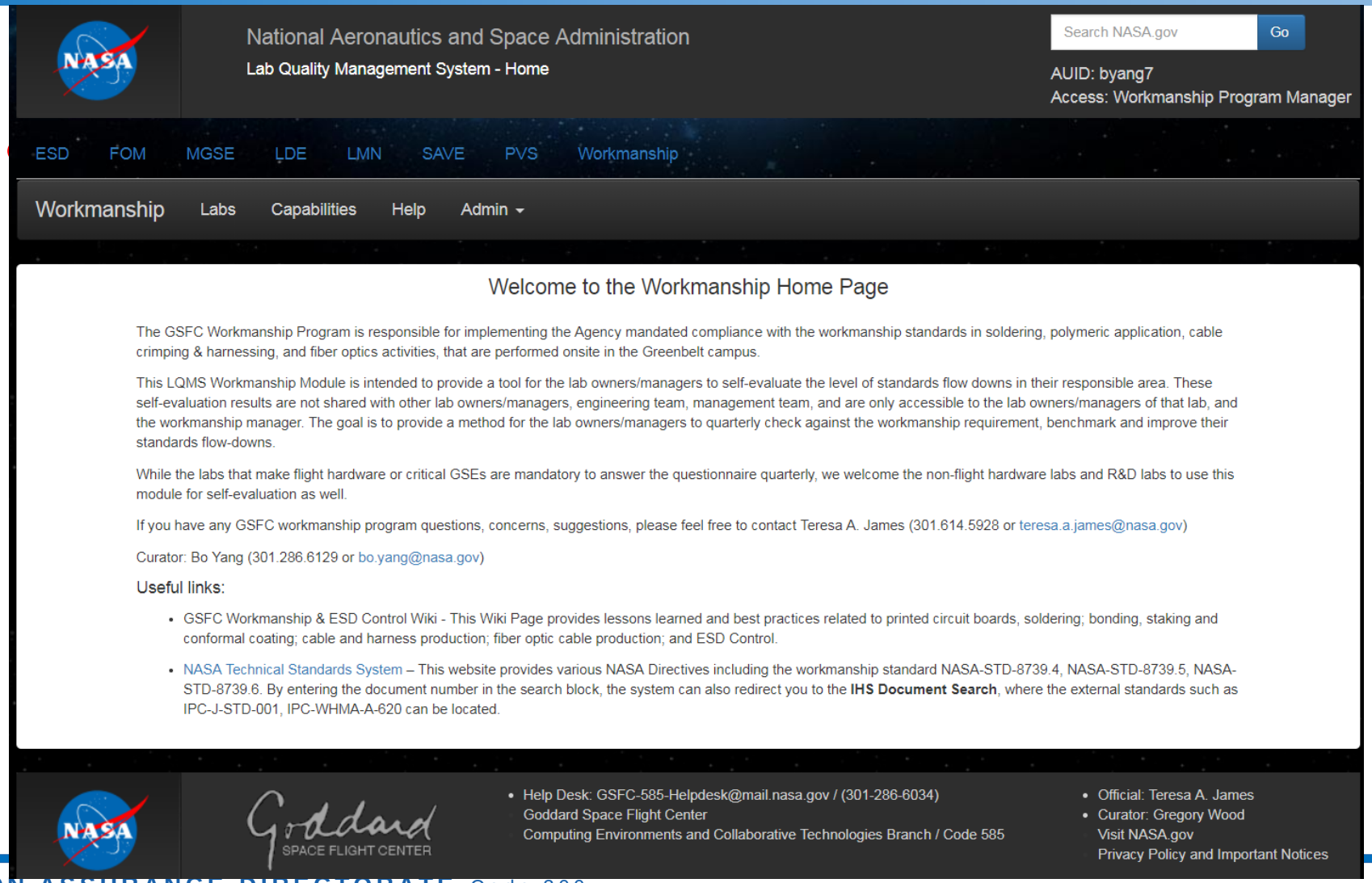
GSFC Lab Quality Management System (LQMS) Workmanship Module

- No center-wide tool or system exists to this date to aid in the tracking of the workmanship performance of the labs.
- The GSFC Workmanship Program is in need of a system to help the center comply with the requirements of NPD 8730.5, NASA Quality Assurance Program Policy with regards to Workmanship.
- Lab Quality Management System (LQMS) Workmanship Module is our choice.

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.
- Allow workmanship group and branch to effective tracking of lab performance regarding workmanship.
- Allow workmanship group and branch to identify lab capabilities (e.g. hand soldering, SMT assembly, cable and harness manufacturing).

GSFC Lab Quality Management System (LQMS)



One Page for Each Lab

Workmanship Overview

Lab Name	Cryogenics Facility
Status	Submitted and Valid
Next Due	04/23/2019
Site	Greenbelt
Building / Room	007/055A
Lab Owner	Silk, Eric
Lab Manager	Hait, Tom
Alt. Lab Manager	

Lab Capabilities

ESD Class:	Yes	**Soldering:**		**Harness/Connector Assembly:**	
Polymeric Applications:		Machine Soldering	No	Crimping	No
Conformal Coating	No	Hand Soldering	Yes	Electrical Test	Yes
Bonding	No	Surface Mount	No	Fiber/Optics	No
Encapsulation/Potting	No	Printed Wiring Assemblies	No	Connector Assembly	No
Staking	No	Tinning	Yes	Splicing	No
Rework	No	Rework	No	Soldering	Yes
Repair	No	Repair	No	Rework	No
				Repair	No

+ Add Note

2018	Workmanship capabilities changed.	UVWX

Questionnaire History

+ Add Questionnaire

Creation Date	Due Date	Submit Date	Updated by	Status
10/25/2018	11/24/2018	10/25/2018	UVWX	Submitted and Valid

Questionnaire Tailored to Each Lab

Question MasterSheet

	Question	Phrase	Ma-chine Solde ring	Hand Solde ring	PWA	SMT	Tinn ing	Stak ing	Con for mal Coa ting	Bon ding	Enc aps ulat ion	Splici ng	Crimp ing	Conn ector Asse mbly	Electri cal Testin g	Fiber Optic s	ESD	
1a-Training 1	8739.1B Polymerics	trained to 8739.1B						1	1	1	1							Edit
1a-Training 2	8739.4A Crimp Cable and Harness	trained to 8739.4A										1	1	1	1			Edit
1a-Training 3	IPC/WHMA-A-620CS Crimp Cable and Harness	trained to IPC/WHMA										1	1	1	1			Edit
1a-Training 4	8739.5A Fiber Optics	trained to 8739.5A														1		Edit

Questionnaire Detail

Lab Name	Cryogenics Facility
Status	Submitted and Valid
Creation Date	10/25/2018
Due Date	11/24/2018
Last Update By	UVWX
Submit Date	10/25/2018
Last Update Date	10/25/2018
Lab Type	Flight Work (Flight Hardware, Critical GSE) Non-Flight Work

Lab Capabilities

ESD Class:	No
Polymeric Applications:	
Conformal Coating	No
Bonding	No
Encapsulation/Potting	No
Staking	No
Rework	No
Repair	No

Soldering:	
Machine Soldering	No
Hand Soldering	Yes
Surface Mount	No
Printed Wiring Assemblies	No
Tinning	Yes
Rework	No
Repair	No

Harness/Connector Assembly:	
Crimping	No
Electrical Test	Yes
Fiber/Optics	No
Connector Assembly	No
Splicing	No
Soldering	Yes
Rework	No
Repair	No

The questionnaire form has been completed and submitted. Thank you!

0 - Background [100% Completion, 11 out of 11 Questions]

The following standard apply to your area (select all that apply):	
8739.6A Workmanship Standard	Yes
J-STD-001FS WAM1	Yes
GSFC-STD-8001 Water Soluble Flux	No
GSFC-STD-6001 CCGA	No
300-PG-8730.6.1A ESD	Yes
Solder pot is used for tinning in your area.	No
Tinning or gold removal is performed by soldering iron only. No solder pot is used.	Yes
All personnel in the lab are contractors.	No
Assembly includes heat sensitive parts	No
Razor blade is used to removing cable outer jacket.	No
Assembly includes moisture sensitive parts	No

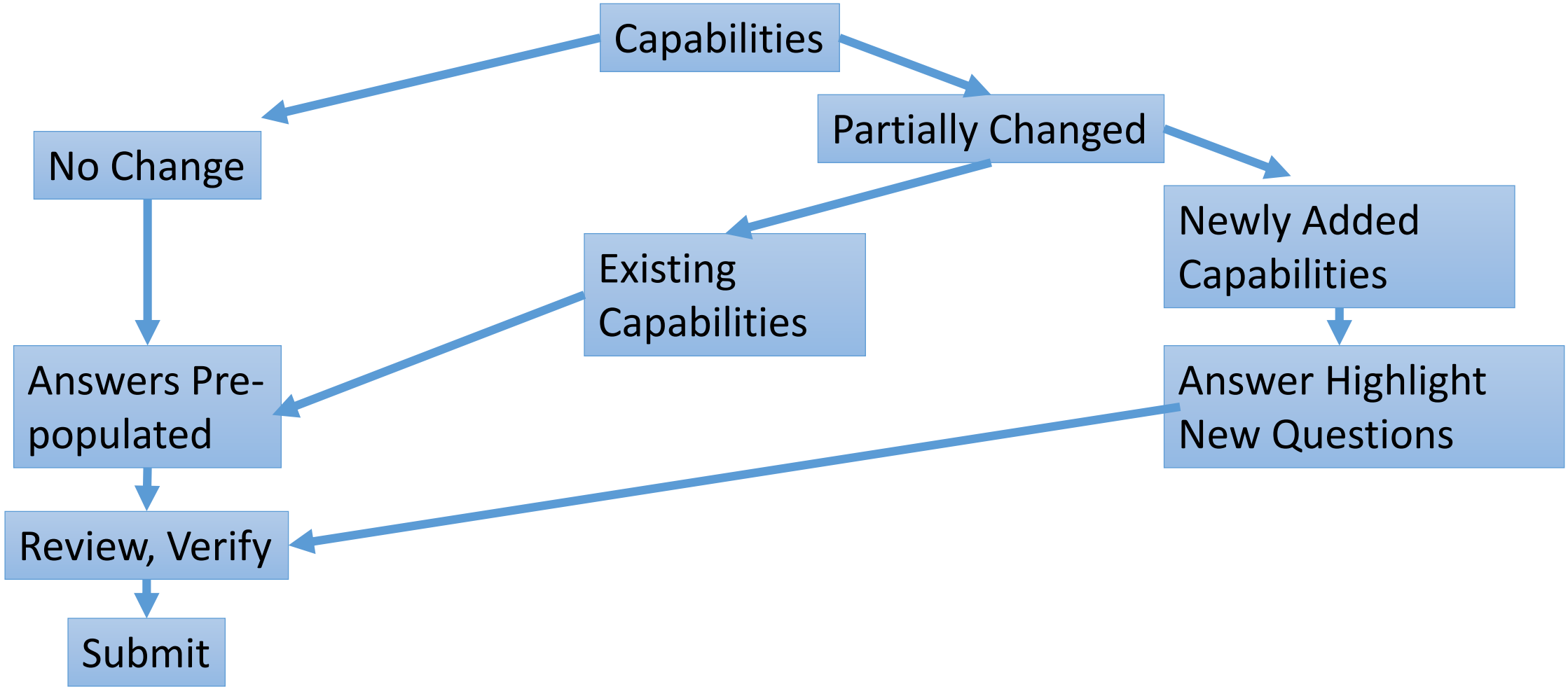
1 - Training [100% Completion, 9 out of 9 Questions]

Employees are trained to the following (select all that apply):

9d - Workload [100% Completion, 12 out of 12 Questions]	
Workload for the past 6 months has been:	
increasing	No
decreasing	Yes
steady	No
flucating	Yes
The 6 months forecast of the workload is:	
increasing	Yes
decreasing	No
steady	No
fluctuating	Yes
There has been continuous work over the past:	
3 months	Yes
6 months	Yes
12 months	Yes
18 months or more	Yes

9g - Equipment Capacity [100% Completion, 15 out of 15 Questions]	
There has been new equipment added to the lab in the past:	
3 months	No
4~6 months	No
7~12 months	Yes
13~18 months	Yes
No new equipment has been added in the past 1.5 years or more	No

Bring Down the Cost



Self-Assessment Data Analysis

Lab Name	Date (yymmdddd)	Machine Soldering	Hand Soldering	PWA	SMT	Tinning	Stacking	Conformal Coating	Bonding	Encapsulation	Splicing	Crimping	Connector Assembly	Electrical Test	Fiber/Optics	ES	bg1: use 8739.6 A	bg2: use J-STD-001 WAM	bg3: use GSFC-STD-8001	bg4: use GSFC-STD-6001	bg5: use 300-PG-8730.	bg6: solder pot for tinning	bg7: only iron for tinning & deoldering	bg8: lab people all contract to	bg9: Polymeric: touch ups only	bg10: Heat sensitive pa	bg11: Cleaning Applie	bg12: 8739.1-6.3.1	bg13: use prim	bg14: silicone prim	bg15: 8739.1-7.1.9-plasm	bg16: 8739.1-7.1.9-ultrasoni	bg17: Razor blade	bg18: moisture sensitive pa	bg9: rs
Cryogenics Facility	2018-10-25 14:39:25	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0		0							0	0	
Cryogenics Facility	2018-10-25 14:29:47	0	1	0	0	1	0	0	1	0	0	0	1	1	0	0	1	1	0	0	1	0	1	0		0		1	0	1	0	1	1	0	
Cryogenics Facility	2018-10-25 14:17:54	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0		0							0	0	
Cryogenics Facility	2018-10-25 14:10:47	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	1	0		1							0	1	
Cryogenics Facility	2018-10-24 17:54:29	0	1	0	0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	0		1		1	0	1	0	1	1	0	
Cryogenics Facility	2018-10-24 17:22:05	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0	1	1	0	0	0	0	1	0		1		1	0	1	0	1	0	0	
Cryogenics Facility	2018-10-25 10:55:02	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1	1	1	0	0	0	1	1	0		1		1	0	1	0	1	1	1	
Telecommunicatio	2018-08-23 15:58:45	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0		0							0	0	
Communication St	2018-07-12 19:48:54	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1			0		0							0	0	
Code 564 Develop	2018-08-22 15:08:34	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	0	1	0		1		0	0	1	0	1	1	0	

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.

Area of Risk and Improvement Focus for Each Lab: Gap Heat Map

# of Clauses not Flowed Down

# of Total Clauses Asked

		Training	Enviornment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymerics	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Hand soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	conformal coating	0%	0%	2%	0%	0%	0%	0%	3%	0%	0%	7%	3%	0%
1	Bonding	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Encapsulation/Potting	0%	0%	6%	0%	0%	0%	6%	8%	0%	0%	7%	7%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	crimping	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Electrical Test	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

		Training	Enviornment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymerics	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Hand soldering	14%	25%	14%	23%	18%	6%	13%	13%	17%	11%	17%	14%	11%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	20%	12%	20%	21%	6%	12%	19%	13%	18%	18%	11%	0%
0	conformal coating	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Bonding	0%	20%	13%	20%	21%	6%	12%	20%	13%	18%	18%	12%	0%
1	Encapsulation/Potting	0%	20%	14%	20%	21%	6%	11%	21%	13%	18%	21%	13%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	crimping	0%	20%	3%	8%	11%	6%	3%	10%	8%	11%	13%	3%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Electrical Test	0%	25%	5%	13%	14%	6%	8%	10%	9%	13%	20%	7%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Area of Risk and Improvement Focus for Each Lab: Gap Heat Map

Gap Heat Map % = # of Clauses not Flowed Down / # of Total Clauses Asked

		Training	Enviornment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymerics	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
0	Machine Soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Hand soldering	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	PWA	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	SMT	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Tinning	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Staking	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	conformal coating	0%	0%	2%	0%	0%	0%	0%	3%	0%	0%	7%	3%	0%
1	Bonding	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1	Encapsulation/Potting	0%	0%	6%	0%	0%	0%	6%	8%	0%	0%	7%	7%	0%
0	splicing	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	crimping	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	connector assembly	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Electrical Test	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	Fiber/Optics	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	ESD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Gap Heat Map: # of Clauses not Flowed Down

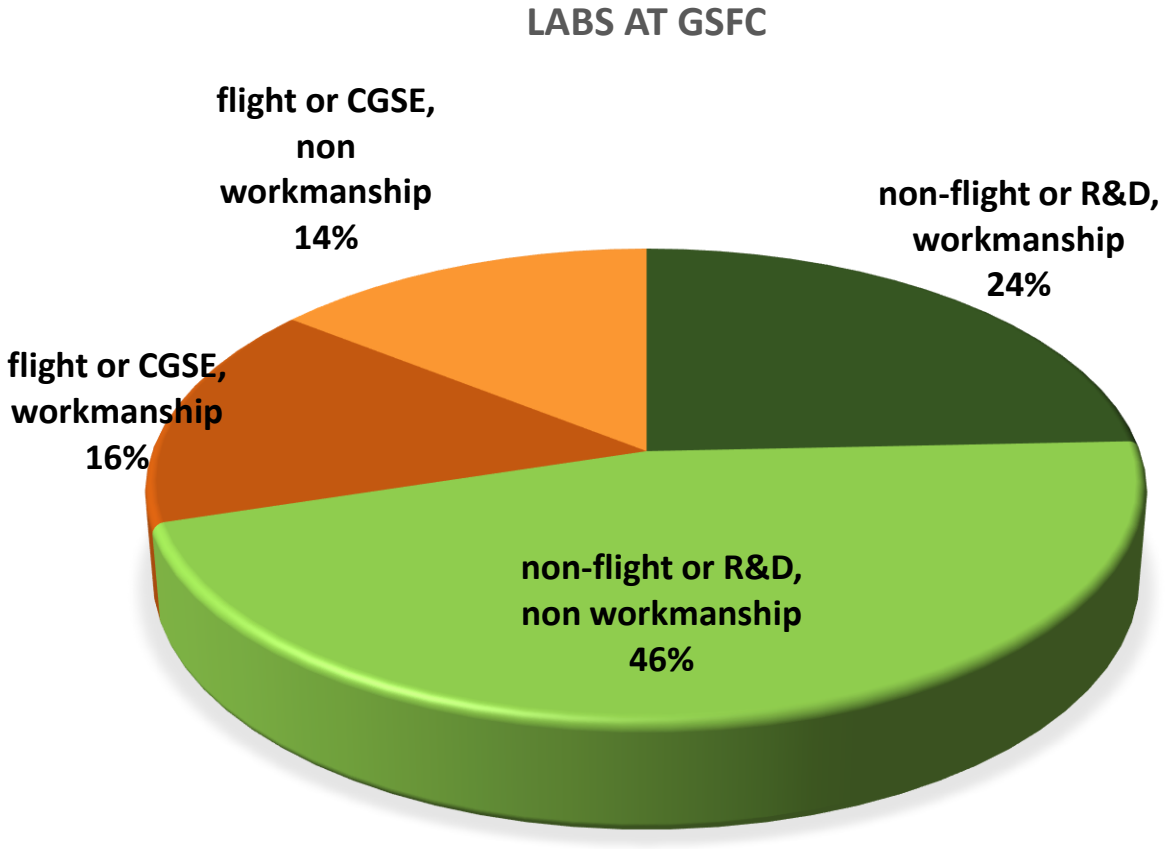
	Training	Enviornment	Procedures	Tools	Handling	Fabrication	Fabrication Crimping	Fabrication Polymerics	Fabrication Soldering	Fabrication Fiber Optics	Inspection	Rework/Repair	Record
Machine Soldering	0	0	0	0	0	0	0	0	0	0	0	0	0
Hand soldering	0	0	0	0	0	0	0	0	0	0	0	0	0
PWA	0	0	0	0	0	0	0	0	0	0	0	0	0
SMT	0	0	0	0	0	0	0	0	0	0	0	0	0
Tinning	0	0	0	0	0	0	0	0	0	0	0	0	0
Staking	0	0	0	0	0	0	0	0	0	0	0	0	0
conformal coating	0	0	1	0	0	0	0	1	0	0	1	1	0
Bonding	0	0	0	0	0	0	0	0	0	0	0	0	0
Encapsulation/Potting	0	0	2	0	0	0	1	2	0	0	1	2	0
splicing	0	0	0	0	0	0	0	0	0	0	0	0	0
crimping	0	0	0	0	0	0	0	0	0	0	0	0	0
connector assembly	0	0	0	0	0	0	0	0	0	0	0	0	0
Electrical Test	0	0	0	0	0	0	0	0	0	0	0	0	0
Fiber/Optics	0	0	0	0	0	0	0	0	0	0	0	0	0
ESD	0	0	0	0	0	0	0	0	0	0	0	0	0

LQMS Workmanship Module Objective

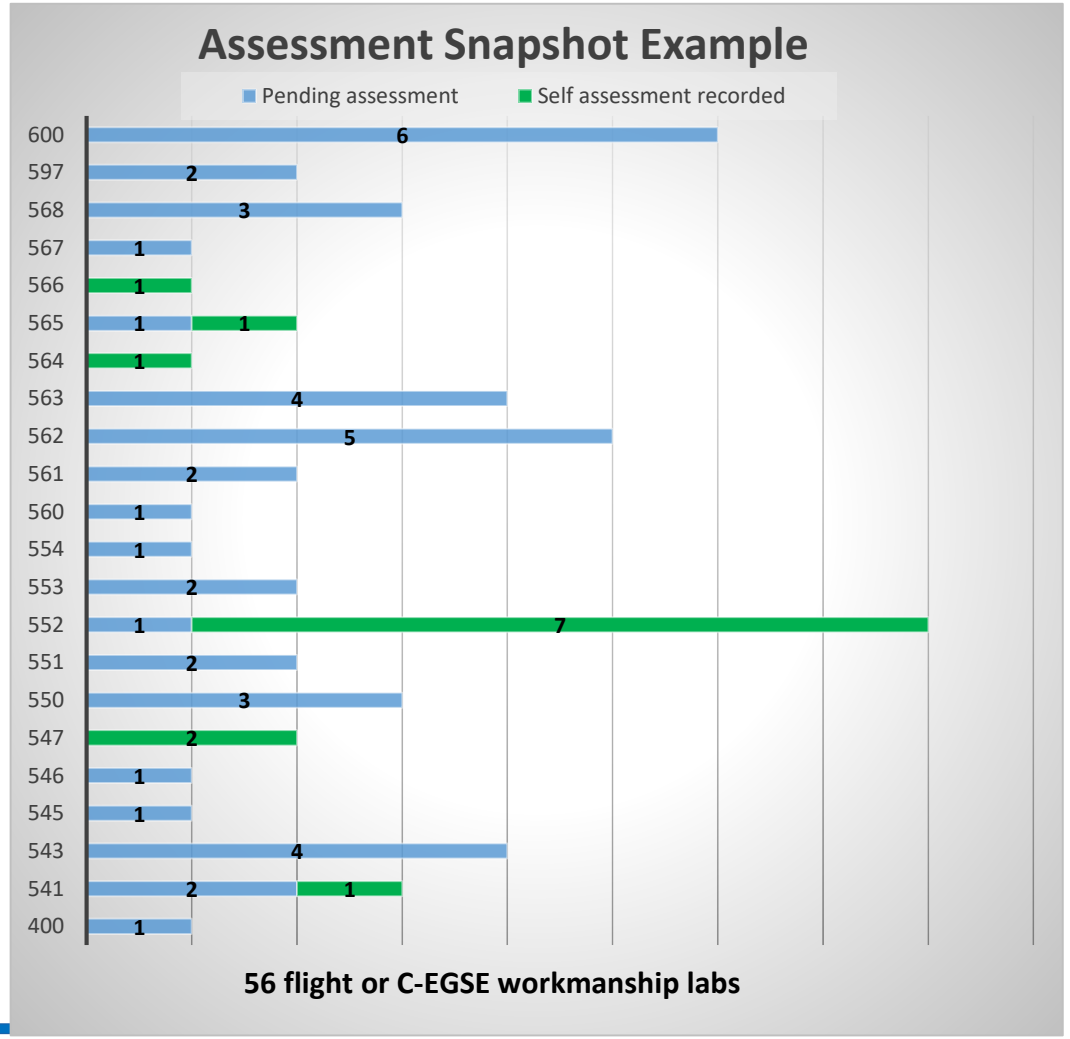
- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.

- Allow workmanship group and branch to effectively track lab performance regarding workmanship.

Know the Big Picture of the Lab



Total lab count as of Feb 2019: 362
labs within code 400,500,600, flight non-flight defined.



56 flight or C-EGSE workmanship labs

Deployment Status

- LQMS Workmanship module developed and available in the production server.
- Survey focused on code 500 labs.
- Developed GPR for center-wide adoption.
- In process of developing a PG.

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve the standards flow down.

- Allow workmanship group and branch to effectively track lab performance regarding workmanship.

LQMS Workmanship Module Objective

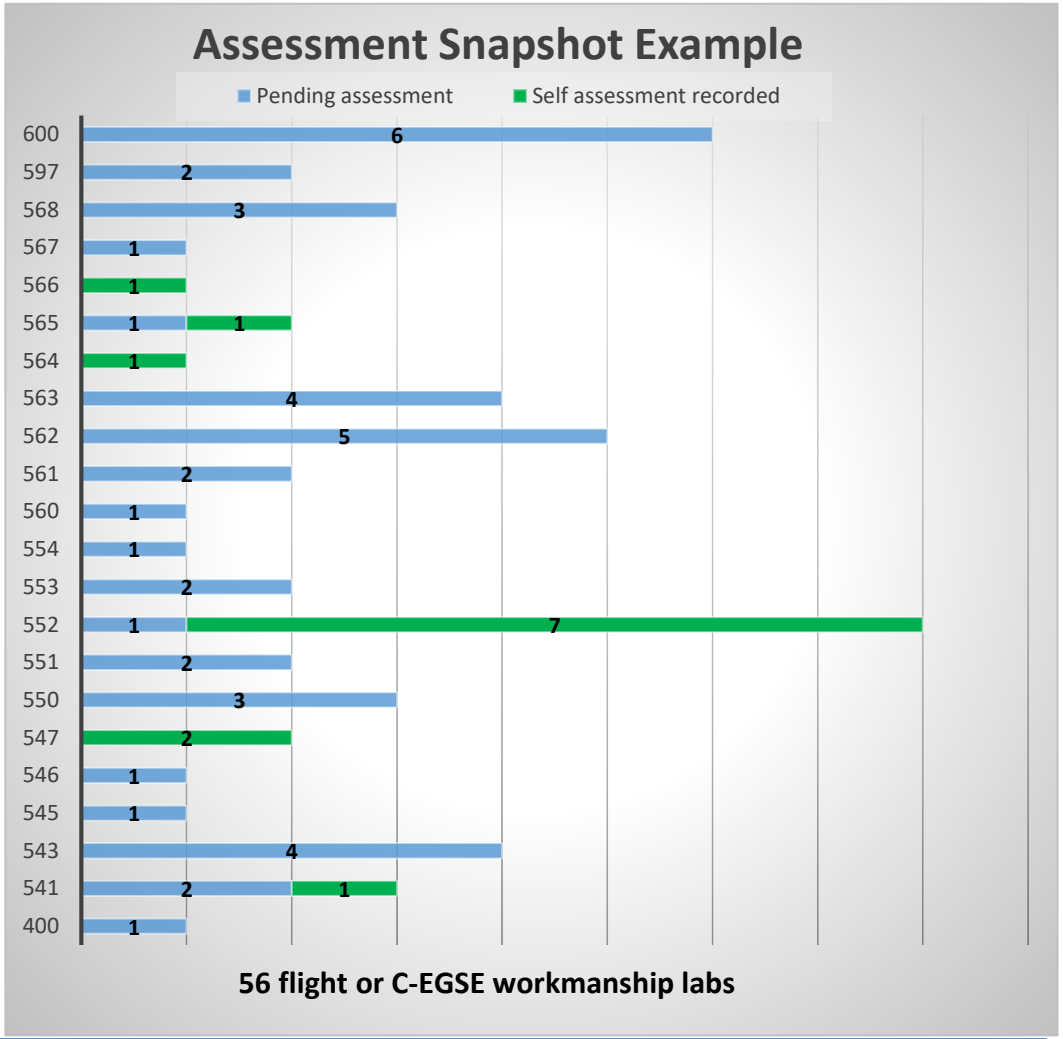
- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.

- Allow workmanship group and branch to effectively track lab performance regarding workmanship.

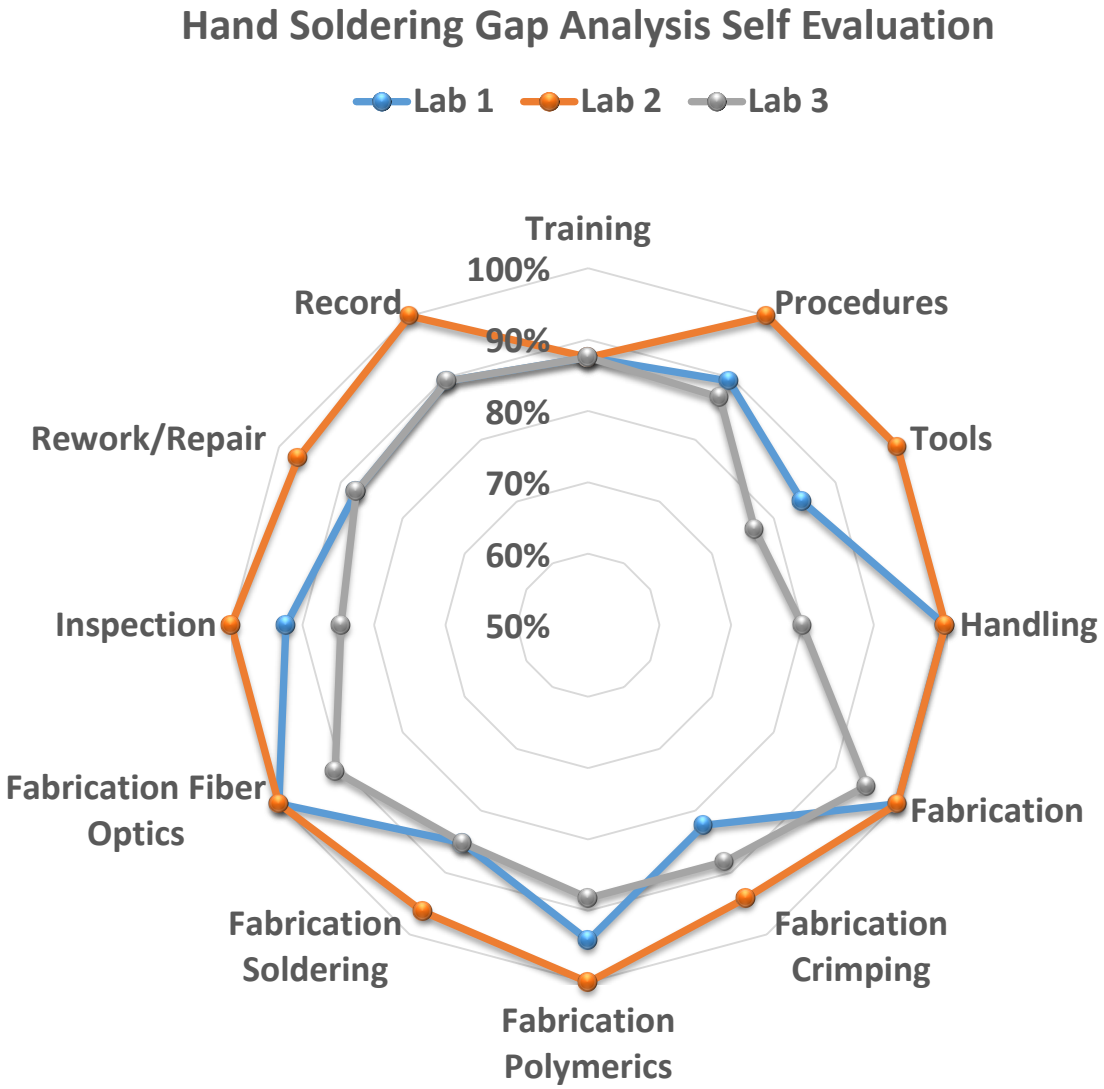
- Allow workmanship group and branch to identify lab capabilities (e.g. hand soldering, SMT assembly, cable and harness manufacturing).

GSFC Flight & CGSE Lab Workmanship Availability

Workmanship Types	Lab Counts
Bonding	26
Conformal Coating	5
Crimp Connections	21
Electrical Test	28
Encapsulation/Potting	13
Fiber Optics/Cables	9
Hand Soldering	33
Machine Soldering	1
PWA (Printed Wiring Assemblies)	23
Repair (Does not result in 100% product conformity)	18
Rework (Results in 100% product conformity)	21
Soldering	26
Staking	24
Tinning	30
Connector Assembly	3
Splicing	2
Surface Mount NEW	22
Grand Total	305



Lateral Compare of 3 Labs on Hand Soldering Activity



- Some common standard, such as NASA-STD-8739.6 impacts all manufacturing activities, not limited to hand soldering.
- Lab 2 has the highest conformance to applicable standards.
- Lab 3 shows some improvement opportunities in nearly all key areas in the assembly process. Some detail look is needed, especially in tools.

LQMS Workmanship Module Objective

- Allow labs to self check against the workmanship requirement, as well as benchmark and improve flow down of standards.

- Allow workmanship group and branch to effective tracking of lab performance regarding workmanship.

- Allow workmanship group and branch to identify lab capabilities (e.g. hand soldering, SMT assembly, cable and harness manufacturing).

Future Work

- Collaborate with different branches to support the workmanship module deployment, guided by GPR-8730.9.
- Create a dashboard to show analysis on each lab and lateral comparison.
- Analyze lab self-evaluation data and product inspection data to help determine which labs need to be audited or improved.
- Work with the lab on the area needs to be improved.
- Analyze if any clause in existing standards needs to be revised.