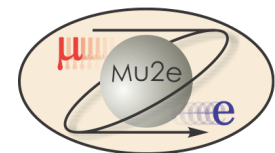




U.S. DEPARTMENT OF
ENERGY Office of
Science

Mu2e Quality Management

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Quality Management Plan

- Quality Management Plan is documented in mu2e-docdb-677
- Primary objective is to implement QA in order to protect
 - Public
 - Personnel
 - Environment
 - Project objectives
- Relies on
 - Utilizing an Integrated QA program
 - Employing a tailored and graded approach
 - Ensuring adequate training
 - Developing appropriate documentation

Integrated Quality Assurance

- QA is the responsibility of each member of the Mu2e project team.
- QA is being practiced from project inception through project end.
- QA is discussed in these meetings
 - Integrated Project Team
 - Project Management Group
 - Technical Board
 - Mu2e-Procurement Meetings
 - L2 sub-system meetings

Integrated Quality Assurance

- Mu2e personnel with primary QA responsibility
 - Project Manager, DPM (Ron Ray, Doug Glenzinski)
 - Project ESH Coordinator (Dee Hahn)
 - Project QA Manager (open)
 - Project ME (Kurt Krempez)
 - Project EE (Marcus Larwill)
 - Project Procurement Manager (Steve Gaugel)
 - L2, L3 managers

Tailored approach

- The QA plan is tailored so that it is appropriate to the current project activities.
- To date, has been focused on developing, documenting designs that
 - Satisfy physics and technical requirements
 - Satisfy ESH requirements
 - Have a plausible acceptance and calibration plan
 - Have realistic resource assignments
- Over next year we will need to transition to
 - Finalizing design work
 - Fabrication

Graded approach

- The QA program employs progressively more formal criteria depending on the risk associated with a given activity
 - Higher risk: more formal documentation, custom QC plans, independent reviews and dedicated oversight
 - Lower risk: less formal documentation, standard FNAL QC, line management oversight

Training

- All Fermilab personnel have their training needs regularly updated via ITNA (Integrated Training Needs Assessment)
- Sub-contractors and vendors are required to follow relevant ESHQ guidelines
 - Spelled-out in Statements of Work, acceptance criteria, and procurement specifications

Documentation

- Requirements documents have been established with formal sign-off (procedure: mu2e-docdb-3083, 3624). Status:
http://mu2e.fnal.gov/atwork/project/Approvals/Approval_Summary.php
- A Change Control procedure has been established.
(mu2e-docdb-509, 2971)
- For each sub-system a QA plan has been documented.
(relevant TDR chapter)
- Mu2e employs a document database with version control.

Example: Total Loss Monitors

- Total Loss Monitors – new beam loss monitoring system for future IF experiments here at FNAL.
- Dedicated development team in AD led by Paul Czarapata and Tony Leveling
 - Web page
 - Documentation in accel-docdb
- Design reviews organized by laboratory that include technical and ESH expertise.
- First stage sign-off obtained. Next will employ pre-production prototypes in the field to gain operational experience.

Example: Solenoid conductor procurements

- Developed a staged plan:
 - Vendors first produce short R&D lengths (100s of meters)
 - If successful, vendors asked to produce full production lengths (1000s of meters)
- Detailed procurement specifications and QC plan developed and provided to vendors as part of bid process
 - mu2e-docdb-2493, 2488
- Independent external oversight established via the “Solenoid Acquisition Oversight Committee”

<http://mu2e.fnal.gov/public/project/reviews/SolenoidAOC/index.shtml>

Example: Solenoid conductor procurement

- Key components of conductor QC program
 - Detailed list of tests vendor must perform at each stage of procurement.
 - Require vendor to provide results of these tests to FNAL in a timely manner.
 - Detailed list of tests FNAL performs at each stage of procurement. Many of these overlap vendor tests.
 - Results of vendor tests recorded in travelers, results of FNAL tests recorded in DB.
 - Regular FNAL/vendor meetings.
 - FNAL visits to vendors at key junctures in fabrication process.

Example: Solenoid conductor procurement

- Key components of conductor QC program
 - FNAL oversight provided by dedicated personnel:
 - Vito Lombardo (Conductor Procurement and QC Manager)
 - Steve Gaugle (Project Procurement Manager)
 - Weekly meetings of Mu2e Project and Procurement Department
- Excellent results (mu2e-docdb-4221)

Conductor	NbTi Strand	Ruth. cable	Final cable
PS	completed	completed	completed
TS	completed	completed	completed
DS-1	completed	completed	completed
DS-2	completed	completed	completed

Example: Solenoid conductor procurement

Quality Control Overview

- For each of the procurements, three hold points were placed throughout the development process.
- At each hold point, test data and samples are sent to Fermilab from the various vendors. Tests are performed at Fermilab and compared to vendors' results. After an internal review, Fermilab releases the hold point and allows vendors to proceed with the next development phase or final shipment of the conductor.
- Frequent conference calls were done throughout the process to monitor progress and discuss technical details. Fermilab visited all the vendors at crucial times of the progress.

Time schedule for TS conductors (Base quantity ; 3000m)

Process	2013												2014	
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	
Procurement	→													
Single billet and wire	↔	↔												
Multi billet and wire		↔	↔	↔	↔									
Cabling in USA														
Procurement of Al		↔	↔	↔	↔	↔								
Conformal extrusion & cold work														

ROUND WIRE

Wire diameter *
Wire ovality *
Critical Current *
n-Value *
Cu RRR *
Cu-SC ratio *
Twist pitch length and direction *
Filament diameter and spacing *
Sharp bent *
Eddy current

RUTHERFORD CABLE

Rutherford Cable thickness *
Rutherford Cable width *
Cable lay direction *
Cable transposition length *
Rutherford cable Bend test
Mechanical stability *
Residual twist
Surface condition
Crossovers or broken strands
Sharp edges *
Critical Current *
Cu RRR *

STABILIZED CABLE

Stabilized Cable thickness *
Stabilized Cable width *
Conforming parameters
Surface condition of the cable after conforming
Surface condition of the final cable
Al-Cu Bonding strength *
Aluminum RRR before conforming
Aluminum yield at 300 K after cold work *
Aluminum yield at 4.2 K after cold work
Aluminum RRR after cold work *
Critical Current *
Cu RRR *

* Also tested at FNAL

- Excerpt from mu2e-doc-4221 (V.Lombardo)

Examples: More

- Additional examples and discussion in Dee Hahn's presentation regarding the Mu2e ESH Plan.

Summary

- Mu2e has an established Quality Management Plan.
- Mu2e has been performing QA using a tailored and graded approach.
- To date, QA has been largely focused on ensuring high quality designs.
- Over next year QA program will have to transition to ensure high quality fabrication.
 - Solenoid conductor procurements offer a good example.
- In near term, for QA, Mu2e needs to
 - Identify Project QA Manager
 - Develop and formalize procedures to make transition to fabrication centered project