DUNE Quality Assurance/Quality Control Plan

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Agenda

- Quality Assurance and Quality Control Plan Purpose
- Design Review Quality Assurance Requirements
- Quality Control Plan Development
- APA Requirements
- Critical Components that Require Inspection and Test
- APA Quality Control Plan Checklist
- Quality Control Plan Use

Quality Assurance and Quality Control Plan Purpose

To document and ensure all the steps required to control a process are taken during operations to maintain the credibility and conformity of a product.

Quality assurance - *Process oriented and focuses is on defect prevention*

Quality control - *Product oriented and focuses is on defect identification through inspection and test*

Design Review Quality Assurance Requirements

- Preliminary Design Review
  - *Draft quality assurance and quality control plans*
  - *Draft procurement and manufacturing plans*

- Final Design Review
  - *Complete manufacturing drawings, schematics, and specifications*
  - *Production site manufacturing plans for all production sites*
  - *Final quality assurance plan and quality control plan and equipment design*

Quality Control Plan Development

- Evaluate how you plan to test quality
  - (1) List the components being inspected or tested
  - (2) Describe the inspection or test
  - (3) Where in the process will the inspection and test be located?
    - (a) Component site
    - (b) Assembly site
    - (c) Warehouse site
    - (d) Cavern clean room
    - (e) Cryostat final position
  - (4) Technical justification of the inspection or test
- Define the critical steps or processes for testing the components or assemblies

APA Requirements

- Flatness of APA support frame
- Laser survey performed on bare frame to show amount of bow, twist and fold
- Confirm electrical contact between the mesh sub-panels and APA support frame
- Component inspection and QC checks
- Wire tension measurements
- APA visual inspection
- Cold cycling

Critical Components that Require Inspection and Test

Inspection and test are performed in accordance with approved procedures. Procedures include acceptance criteria and are utilized throughout all production sites so that there is consistency in the APA assemblies.

(1) What component is being inspected or tested?

(a) Pins and sockets
(b) Printed circuit boards
(c) Frame planarity
(d) Flatness and wire spacing
(e) Wire tension
(f) Channels
(g) APA assembly

(2) Describe the inspection or test.

(a) Pins and sockets – Tests of pins and sockets will be conducted using representative boards and stacked structures
Insertion forces and withstand forces will be measured with sample sizes of 100 pins and 100 sockets to gather adequate statistics. Total number of devices tested: 200
- Pin and socket mating forces will be measured with sample sizes of 100 for each of two possible combinations: pin-to-pin and pin-to-socket. Total number of devices tested: 200
- Electrical tests will be performed with groups of 100 mated pin-and-socket combinations configured in representative board structures. Tests will involve cycling boards to LN2 temperatures and measuring the combined resistance of series-connected pin and socket combinations. Temperature cycling will be repeated five times for five different board-stack structures to demonstrate the repeatability of the tests and gather sufficient statistics. Total number of devices tested: 500

(b) Printed circuit boards
- All boards will be inspected when received to assure conformance to specification
- Compex mechanical features are to inspected to insure they are within specification
- Manual insprection of printed circuit boards is required
- Vision systems are being evaluated as automated boards inspections to replace manual inspection

(c) Frame planarity
- Detailed mechanical studies of frame distortions will be perforemd for different bending modes (twist, bow, fold)
- Frame planarity (twist limit) < 5 mm

(d) Flatness and wire spacing requirments – Wire plane spacing is very important to ensure transparency of the different layers.
- Flatness and wire spacing requirements are required: the tolerance of both is +/-0.5 mm, which translates to requirements on the mechanical positioning of the wire boards and on the flatness of the APA frame.

(e) Wire tension – The wire tension requirements has been recently changed to 6+/-1 N to decrease the risk due to tension relaxation
- Small sample of wires are to be measured before and after cold test

Critical Components that Require Inspection and Test (continued)

(f) Channels are to be checked for missing/unreadable channels
- Number of working channel requirement is > 99% (continuity, isolation, tension)
- Requirement is <1%, with a goal of <0.5%

(g) APA assembly inspection and test
- Unpack the APA and visually inspect
- Survey APA flatness and measure plane spacing
- Measure wire tension and wire continuity/isolation
  - Current plan with laser method: 10% wires have tension measurement
  - Alternative plan with electrical method: 100% of wires are measured (preferred and currently under investigation)
- After integration with cold electronics and photon detectors, the APA is inserted in a cold box
- Once the cold electronics and cables have been installed, we cannot really assess the quality of the wires alone anymore (e.g. cannot measure tension with the electrical method)
- Cold tests of the electronics inform the state of wires
- Noise measurement in cold could inform on wire tension. Studies are currently undergoing about using cold electronics output to correlate to tension.

(3) Where is the location of the inspection or test?

(a) Component site
(b) Assembly site for Pins and sockets, Printed circuit boards, Frame planarity, Flatness and wire spacing, Wire tension, Channels
(c) Warehouse site
(d) Cavern clean room for APA assembly
(e) Cryostat final position

(4) What is the technical justification of the inspection or test?

(a) Inspect mechanical and electrical quality of all pins and sockets
(b) Inspect mechanical and electrical quality of printed circuit boards
(c) APA transparency. Ensures wire plan spacing change of <0.5 mm
(d) Enables 100% efficient MIP detection, 1.5 cm yz vertex resolution
Interplane electron transparancy; dE/dx, range, and MCS calibration
(e) Assure quality of measurement by wire tension requirements
(f) Reconstruction efficiencey to ensure > 99% working channels
(g) Assure quality of completed APA assembly after shipment

APA QC Plan Checklist

DEEP UNDERGROUND NEUTRINO EXPERIMENT		CHECKLIST
Title: DUNE APA Quality Control Plan Checklist		
Author(s): James Mateyack	Approved: Kevin Fahey	Page: 1 of 1
Document ID: EDMS ########	Version: 1	Version Date: 29Apr2020

REVISION HISTORY

Version	Description of Change	Author	Effective Date
1	Initial release	James Mateyack	3Jan2020

Process Description or Quality Assurance Activity	Ref Doc, Drawing, Procedure	Acceptance Criteria	Verifying Document	Verify, Witness, Perform	Signature	Date
Flatness of APA support frame.	Consortia Procedure		Traveler	Verify		ddMMMyyyy
Laser survey performed on the bare frame to show amount of bow, twist and fold in the frame.	Consortia Procedure		Traveler	Verify		ddMMMyyyy
Confirm electrical contact between the mesh sub-panels and the APA support frame.	Consortia Procedure		Traveler	Verify		ddMMMyyyy
Component inspection and QC checks.	Consortia Procedure		Traveler	Verify		ddMMMyyyy
Wire tension measurements.	Consortia Procedure		Traveler	Perform		ddMMMyyyy
Cold cycling.	Consortia Procedure		Traveler	Perform		ddMMMyyyy
APA visual inspection.	Consortia Procedure		Traveler	Perform		ddMMMyyyy

Comments:

WARNING: This version of the document may not be the current or approved revision.
The current revision is maintained in the Engineering Data Management System (EDMS).

Quality Control Plan Use

- **Define information**: A QC plan describes all the information about the critical processes by which these products are going to be made. It includes the critical steps that will be signed off in the plan, the procedure section for the step, the acceptance criteria, identifies the verifying document which contains actual inspection or test data, whether the step was verified, witnessed or performed by the person signing off, the signature of the individual verifying the step and date of completion.
- **Define objectives**: A QC plan ensures that the critical processes in the project and the work packages are used effectively to develop quality project deliverables.
- **Consortia Satisfaction**: A QC plan checklist will have the results of the critical processes in easy view format. The consortia can review the details and verifies that the product formed is exactly what was described prior to shipping and upon receipt at SURF warehouse.