

1.9 Quality Control, Transport, and Installation

The HV consortium has developed a comprehensive quality control (QC) plan for the production, shipping and installation of the SP module HV components. It is based partly on QC procedures developed and implemented on ProtoDUNE-SP and on the NOvA experiment's successful use of barcode tagging for identifying and tracking detector components. Inventory tagging and tracking each component is crucial. For DUNE, the purity requirements of the LAr place restrictions on the introduction of material into the cryostat, precluding either permanent tags or ink or paint markings on the detector. We will implement a system of temporary tags containing QR or barcodes in which the tags are removed when their codes are scanned. The tags will be large enough and of bright enough color to be seen from both ends of the cryostat. We are considering bright yellow cattle tags – plastic tags of about 10-12 square inches (~70 cm²) on which a unique QR or barcode can be printed; they can be purchased very inexpensively in quantities of hundreds or thousands.

1.9.1 Quality Control

Power supplies used in a SP module will be tested before installation. Output voltages and currents must be checked on a known load. The feedthrough and filters should be tested at the same time, preferably with the planned power supply. The feedthrough must be tested to hold the required voltage in TPC-quality LAr ($\tau \geq 1.6$ ms) for several days. The ground tube submersion and E field environment of the test setup should be comparable to the real field cage setup or more challenging (e.g., the test liquid level can be lower than that in the SP module but not higher). Additionally, the feedthrough must be leak-tight to satisfy cryogenics requirements. The QC process for mechanical components starts at the production factories by attaching a cattle tag with a unique code to each production element. A file linked to each code contains the individual measurements and properties contained in the QC checklists for that element. The following is an example of how this system will be implemented for the CPA components:

1. During assembly, QC checklists are filled out electronically using a smart phone or tablet. Once a CPA Unit is completely assembled and all checklists are complete, a coded temporary cattle tag is attached and scanned, linking the checklist information to the code on the tag. (The CPA Unit's individual parts are not tagged separately.)
2. A shipping crate will contain six CPA Units, each with its removable coded tag, plus any included hardware packages, each with a coded sticker.
3. A coded label on the shipping crate (paper sticker) will identify the contents of the crate (six tag codes + codes of hardware packages).
4. In the SURF clean room, the first CPA Panel is assembled – a coded tag is attached to the CPA Panel and scanned. The three individual CPA Unit tags are then scanned and removed, linking them to the CPA Panel code.
5. The same procedure is followed for the second CPA Panel from the crate. Each CPA Panel now has a single tag attached it.

6. The CPA Panels are then combined into a CPA Plane, and a single coded tag is attached to the CPA Plane and scanned. The two individual CPA Panel tags are then scanned and removed, linking their codes to the that of the CPA Plane.

7. Top and bottom FC modules are attached to both sides of the CPA Plane, and a single coded tag is placed on this CPA/FC assembly identifying the codes of each of the four FC modules and the code of the CPA Plane; these five tags are removed after scanning.

8. When moving into the cryostat the code of the position tag on the DSS is scanned as well as the tag on the CPA/FC assembly, then both tags are removed.

At this point, a sequence of linked codes associated with QC checklists identify which CPA and FC modules are mounted in which DSS positions and no tagging material remains in the cryostat. A similar sequence is anticipated for the production of the FC top and bottom units up to step 6 and separately for the EndWalls. At the completion of installation in the cryostat and before FC top and bottom deployment, visual inspection will confirm the absence of any tags.