

LBNF/DUNE Far Site Detector Grounding System Requirements

- This document sets forth the LBNF infrastructure requirements necessary for the implementation of an isolated detector ground.
- This document does not address all the internal grounding rules of the detector. That scope will be covered in a separate document.

Revision History

9/29/2015 TMS Original Document

1/6/2016 TMS Document updated with drawings showing:

1. General construction placement of rebar (UFER ground), wire mesh and Ground Bars
2. General scheme of Detector Ground (not to scale and not all details are shown)

Grounding Committee Members

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Grounding Point Summary

At the SURF 4850 Level where the Neutrino Detectors will be located, the electrical conductivity of the various rock masses are unknown but expected to have extremely poor and inconsistent conductive properties. To insure adequate sensitivity of the detectors a special ground systems must be put in place that will isolate the detectors from all other electrical systems and equipment, and minimize the influence of inductive and capacitive coupling and ground loops. The objective of the following grounding system requirements is to reduce or eliminate ground currents through the detector which will affect detector sensitivity, maintain a low impedance current path for equipment short circuit and ground fault currents, and insure personnel safety by limiting equipment/equipment and equipment/ground touch potentials.

Basic Ground Structures

Cavern Ground consists of overlapping welded wire mesh supported by rock bolts and covered with shotcrete. The LBNF/DUNE **Cavern Ground** includes all walls and crown areas above the 4850 sill level in the North and South detector caverns and their associated central access drifts, plus tin plated copper bus bars specified to run the length of the detector vessels on each side along the cavern walls and mounted external to the shotcrete. The **Cavern Ground** structure:

- Spans the full length of the cavern from the West end access drift entrance through the mid-chamber to the East end access drift entrance.
- Spans the full width of the cavern from the 4850 sill (top of the detector vessels and mid-chamber floor) on both sides up and across the crown of the cavern.
- Includes the East and West end walls of the cavern, from the 4850 sill to the crown.

Detector Ground consists of the steel containment vessel enclosing the cryostat and all metal structures attached to or supported by the detector vessel.

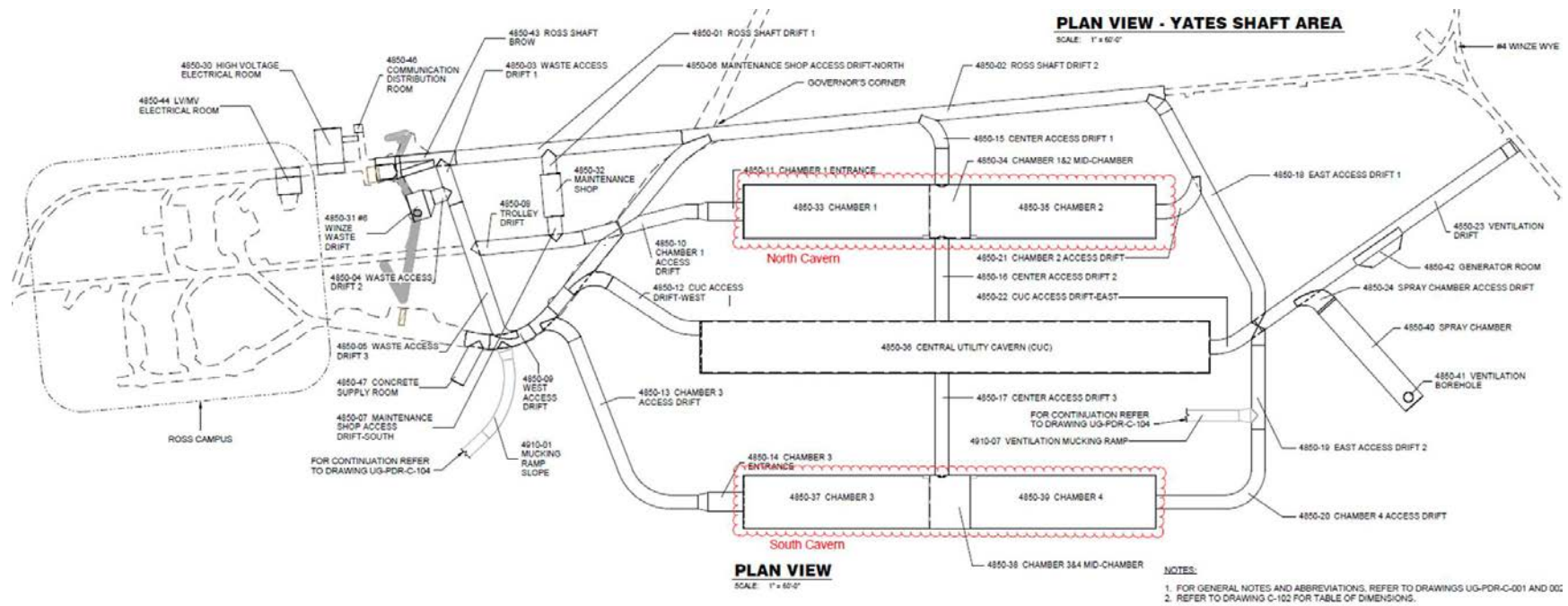
UFER Ground consists of the metal rebar embedded in the concrete floors. The LBNF/DUNE **UFER Ground** system includes the concrete floors in the cavern mid-chambers, center access drifts, and central utility cavern.

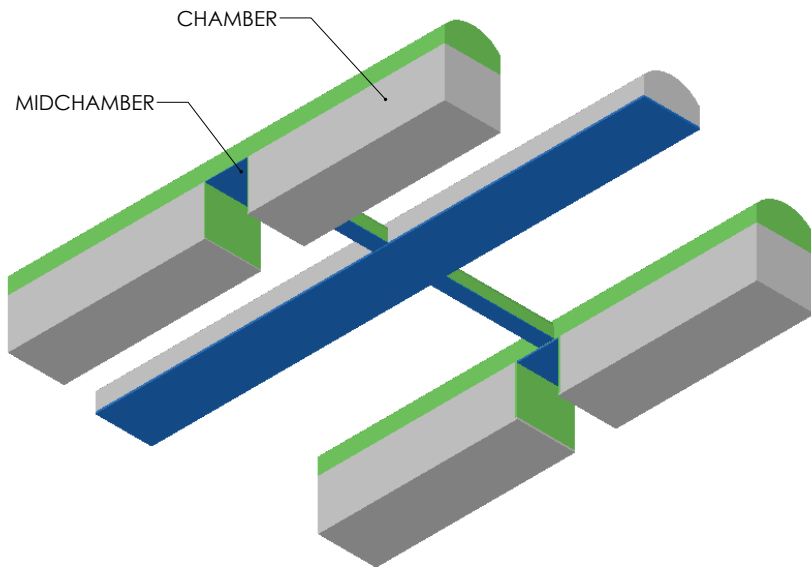
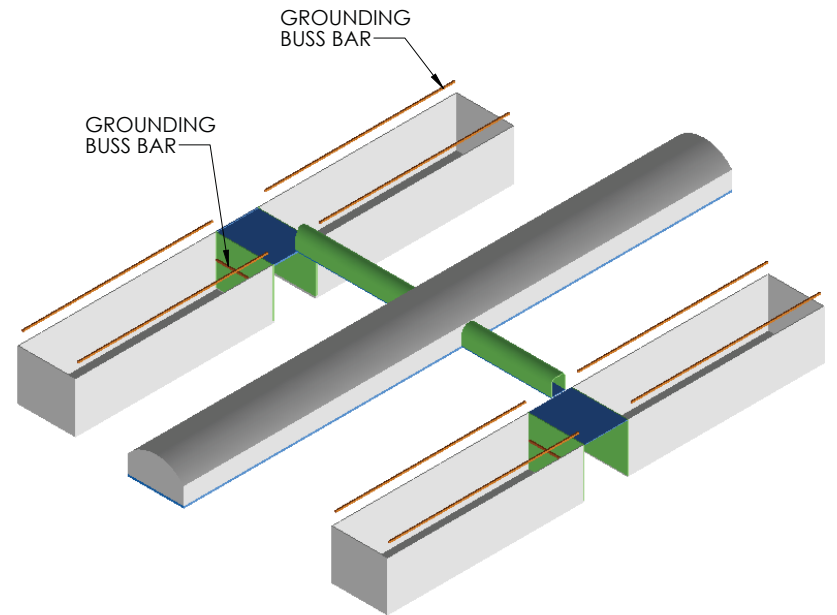
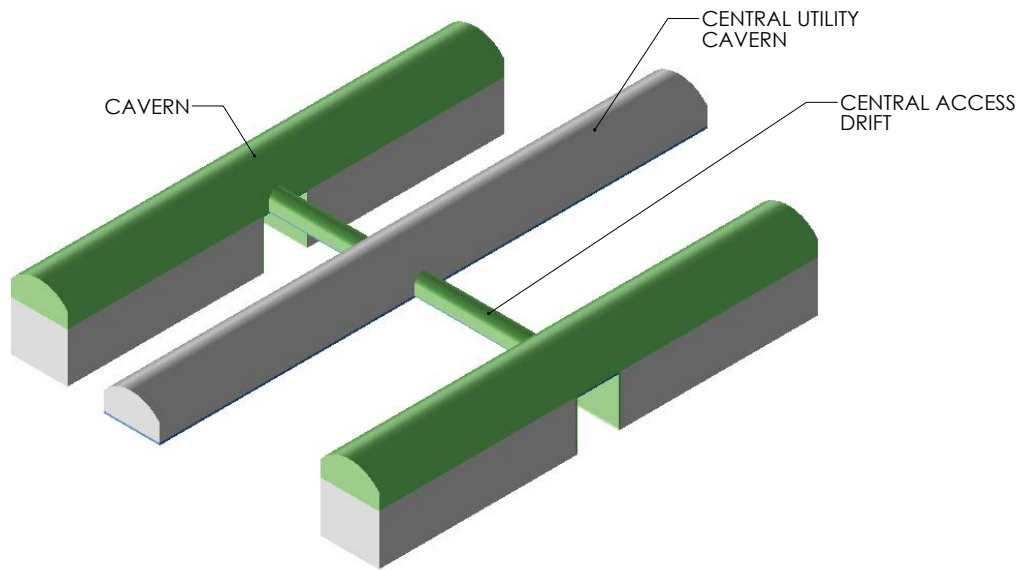
High Level Requirements (apply to both North and South caverns and all detector chambers)

1. Require a solid electrical bond between all welded wire mesh panels that make up the **Cavern Ground**.
2. Require that copper buss bars be installed on each side of the cavern parallel to the detector vessels, and across the width of the detector chambers, for grounding electrical equipment located within the caverns. The buss bars must be made of flat copper bar to provide sufficient surface area and ground conductor properties. They must be tin plated to resist copper oxidation. Splice connections must be made with overlapping buss bar plates to maintain a minimum cross sectional area.
3. Require that the buss bars be tied to the **Cavern Ground** wire mesh at 5 foot intervals along the entire length of the ground buss.
4. Require that the **Cavern Ground** wire mesh be tied to the **UFER Ground** rebar in the mid-chamber and central access drifts, to create a single, solid, and continuous low inductive grounding system.
5. Require that the concrete floor rebar in the mid-chamber, center access drifts, and central utility cavern all be tied together to form a single, continuous **UFER Ground** system that originates at the electrical substation transformers.
6. Require that the **Detector Ground** be electrically isolated from everything except the concrete chamber floor. The only allowable conductive connections to the detector vessels are through saturable inductors.
7. Require the concrete chamber floor to have non-conducting fiber reinforcement
8. Require that **NO** welded wire mesh be installed on the chamber walls from the 4850 sill down to the chamber floor, except for the chamber wall on the mid-chamber end as described below. (This assumes that there is no electrical equipment installed between the vessel and the other chamber walls.)
9. Require welded wire mesh and shotcrete on the chamber wall that is at the mid-chamber end of each detector chamber where cryogen piping, valves, pumps, fans, and other electrical equipment are located. The wire mesh on these chamber walls must be tied to the mid-chamber **UFER Ground** rebar.
10. Require a minimum 2 foot high, moisture resistant **exclusion zone** between the chamber floor and the bottom of the shotcrete on all four chamber walls to isolate the Detector from the **Cavern ground**.
11. Require that ground monitoring instrumentation (GIZMO) be installed to insure that the **Detector ground** remains electrically isolated from all other grounding systems.

Other Detailed Requirements

12. Require all shotcrete areas, which do not contain wire mesh, to use non-metallic containing shotcrete.
13. Require that tin plated copper bus bars shall be ~6" wide and a minimum of 3/8" thick.
14. Require all conductive piping and conduit entering/exiting the cavern must be bonded to local **Cavern Ground**. This can be accomplished with copper cable ties to the shotcrete mesh or through the creation of a local bus bar.
15. Require that the only AC distribution transformer(s) located inside a detector cavern is the detector double-shielded isolation transformer.
 - a. The location of this transformer will be on the detector structure.
 - b. Galvanized Rigid Conduit (GRC) for 480 VAC circuits must be isolated from the **Detector Ground**.
16. Require a minimum of two saturable inductors to be located near the detector double shielded transformer with some separation >6 feet between the pair.
17. Require all metal structures to be bonded to a ground structure – No floating metal. (Note: This rule does not apply to isolated rock bolts.)
18. Require that no VFDs or motor controllers shall be used in the detector caverns unless reviewed by and approved by DUNE Grounding Committee.
19. Require galvanized rigid metal conduit (GRC) to be used for all electrical circuits.
20. Require that cavern light fixtures must be non-arcing or non-sparking.
21. Require dielectric isolators on piping between **Cavern** and **Detector Ground** structures. The Cryogenics team should work with DUNE Grounding Committee so that capacitive coupling can be minimized.
22. Require a local bus bar tied to **Cavern Ground** mesh in the mid-chamber area to provide a reference for any cryogenic equipment located in that area.





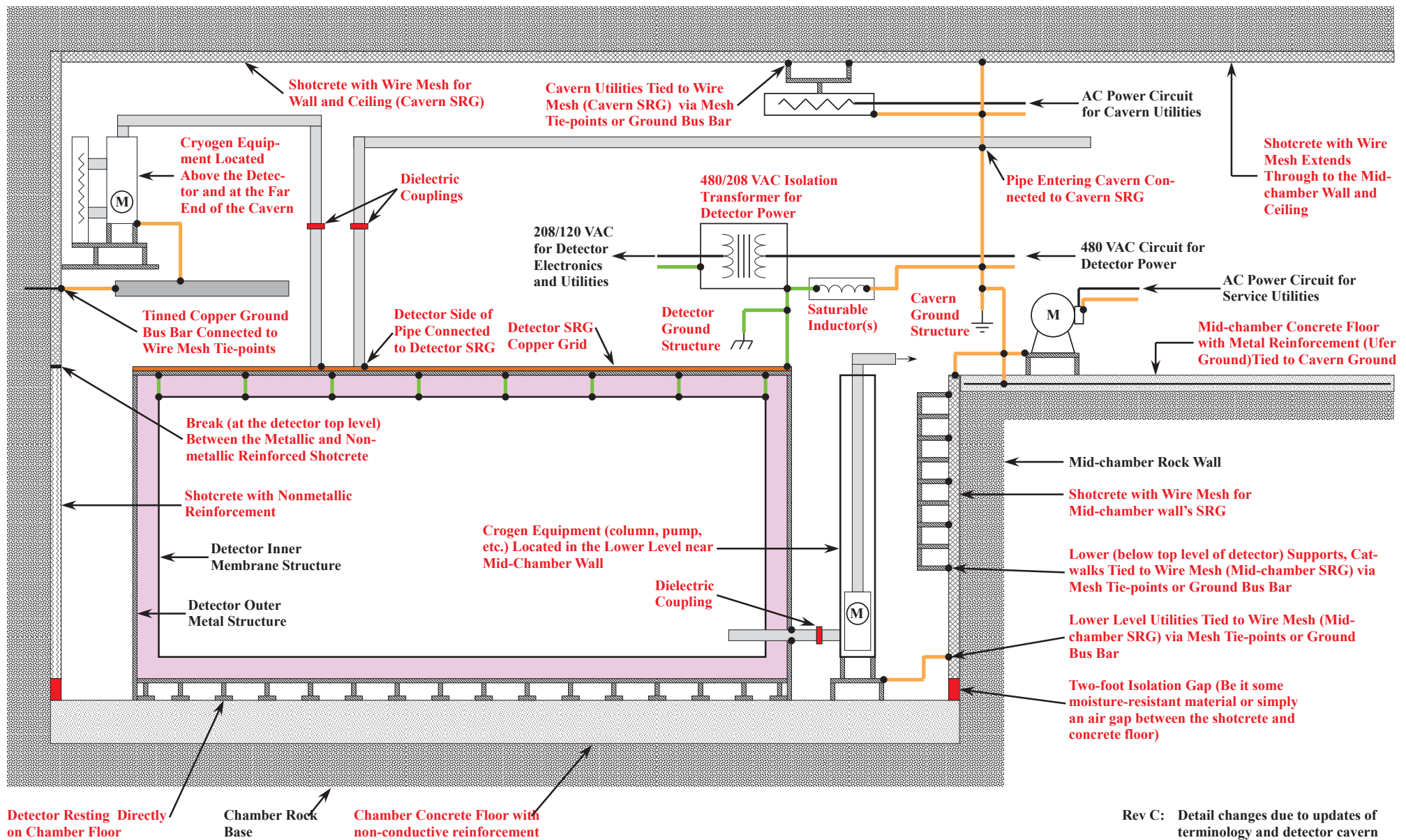
CAVERN GROUND (WIRE MESH)

UFER GROUND (REBAR)

GROUNDING BUSS BAR



MATERIAL: UNLESS OTHERWISE SPECIFIED	DRAWN BY BC	CHECKED BY PB	APPROVED BY PB	DATE 9/22/2015	SCALE: 1:1200
UNITS: INCHES	DRAWING TITLE LBNF/DUNE GROUNDING				SHEET 1
TOLERANCES: ANGULAR ± ° 2 PLACES .XX ± 3 PLACES .XXX ±	DRAWING NUMBER LBNF Grounding				REVISION 0
					SIZE B



Rev C: Detail changes due to updates of terminology and detector cavern details plus review comments.