Scintillator Handling Sequence

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- **Surface building**

  Scintillator shipping boxes arrive at the surface building via dedicated flatbed truck. Approximately every 7 weeks, a truck from the Caltech module factory will arrive with 8 long narrow shipping boxes. Eight empty boxes will be shipped back to Caltech on the same truck. Wide diagonal modules shipping boxes from the University of Minnesota factory will arrive every 2 weeks with only 2 crates. Again 2 empty crates will go back on the same truck. The trucks will be unloaded using the surface forklift or the 7 ½ ton overhead crane in the surface building. Boxes will not be opened unless obvious outside damage to the shipping box can be seen. A detailed shipping schedule, worked out by Jim Grudzinski and Leon Mualem, is available at http://www.hep.umn.edu/~mualem/minos/moduleflow_out.pdf.

- **Boom truck**

  A flatbed truck with a 14,000 lb capacity boom will be used to haul the scintillator to the headframe. Boxes can be loaded with either the surface building overhead crane or the truck boom. Two boxes turned on edge can be carried at one time. The boom truck hoist also supplies the needed horizontal pull as the box is pulled into the cage. Four loaded scintillator-shipping boxes can be hauled underground and 4 empty bought back to the surface in one shift. This means the truck must go back down to the surface building to unload the 2 empty boxes and pick up 2 new full ones. Before each box is pulled into the cage it is lowered down to the ground. The back end of the box is placed on a scintillator skate and the front lifting fixture is hooked to the materials handling cage hoist.

- **Materials handling cage**

  The materials handling cage is designed to come apart in as short as time as possible. Removing a few bolts and lifting it off the lower deck removes the passenger pod. The lower deck has 5 back panels and the door to remove and it is ready to take either the steel bundle holding fixtures or the scintillator box holder. Fermilab is designing both of these. Once the cage is apart it is ready to pull the scintillator box into the cage. The boom truck holds the box back as it is pulled in. This process takes about 15 min. It takes an additional 15 min to secure the load and prepare the cage to go underground. Once the load is at the 27th level a combination of permanently mounted hoists and the monorail are used to pull the box out of the cage. Once the monorail suspends it, it is rotated perpendicular to the monorail and lowered onto a scintillator shipping box cart. It is flipped from its edge to the bottom during this process. It is now ready to be pulled into the Soudan Lab via a hand tugger.

  An empty scintillator box will be shipped to the surface in the empty cage. Total round trip is expected to be between 75 and 90 min. Four scintillator boxes should be moved underground in one shift.

- **Scintillator shipping box cart**

  These carts have yet to be designed but they are simple, very sturdy that can be pulled by a battery-operated tugger. This increases the maneuverability of the large 29 ft x 5 ft crates instead of using a forklift. A total of up to 4 carts, depending on final design, are needed in the Soudan Lab.

- **Testing sequence**

  The scintillator-shipping box is moved into position next to the module mapper. Modules are picked up by the Fermilab vacuum lifter, which is attached to the overhead crane, and placed on the mapper. The beefier frame on this vacuum lifter is also used as a spreader bar for moving the scintillator plane boxes on the mezzanine. While a module is being mapped the

area must be marked off as a stay-out zone and only authorized personnel are allowed. Once a module has passed all its tests and been mapped it is lifted up onto the mezzanine and placed in one of the 3 scintillator plane boxes closest to the lifting bay. These modules must be stacked in the correct order for direct placement on the steel plane. Total time for this test is expected to average about 1 hour, including crane movement, and require one minecrew and one physicist/tester.

Once the first 50-60 planes have been tested this way a decision will be made based on the original module map at the factory if this high level of testing is needed. If not modules will go through a simpler light leak test and be sorted into their plane box.

- **Scintillator plane boxes**

  Scintillator plane boxes are lightweight 3-sided boxes that hold 1 plane worth of modules each. There is room for 9 stacks of them on the Soudan Mezzanine and they can be stacked 5 ft or 6 ft high. Current plan is to have the minecrew build these. Materials cost about $250/box and we need approximately 60 boxes.

- **Scintillator plane box carts**

  These carts can be had pushed by hand into the MINOS lab. The carts should be low enough so modules can be slid directly off the cart onto rollers on the steel plane. The carts will have one set of fixed wheels in the center of the cart and two sets of casters on the ends set slightly higher then the wheels. When pushing on the back end of the cart the front casters come just off the ground making it easier to steer.

- **Roller method of moving scintillator modules**

  From experience at the module factories, the most efficient method of moving modules with 2 people is to use roller strips (different length bars with roller balls on top). Strips are laid down on the steel plane and used to roll each module from a scintillator plane box into position. A complete set of roller strips needed for 1 strongback will be purchased before BO. A

second set for the other strongback will be ordered if this method proves easier than the gantry-crane method, described below.

- **Gantry-crane vacuum-lifter method of moving modules**
  A vacuum lifter attached to the gantry crane may be used for placing modules on the strongback, if this method works easier than the roller method. It takes 2-3 people to use the gantry crane method. It may be that a combination of both module-moving methods will prove most efficient. A single vacuum lifter, available from Argonne, will be used to try out this method in parallel with the roller method. If an additional lifter is needed for the second strongback, it will be ordered later.