Far Detector Scintillator Filling
WBS 2.9.3

Jim Musser

Indiana University

Scope

- This talk covers WBS 2.9.3
  - FD Scintillator Filling Equipment
  - Filling procedures and personnel under WBS 2.9.4

FD Filling Requirements

- Total Scintillator Volume: 3.9 million gallons.
- Block volume: 102,600 gal

- Filling is carried out in parallel with block lifting, following 1 superblock behind. The filling rate is set by the block lifting rate, 1 block/2.6 weeks.

- 4 ten hour shifts/week assumed, with 8.5 useful hours/shift.

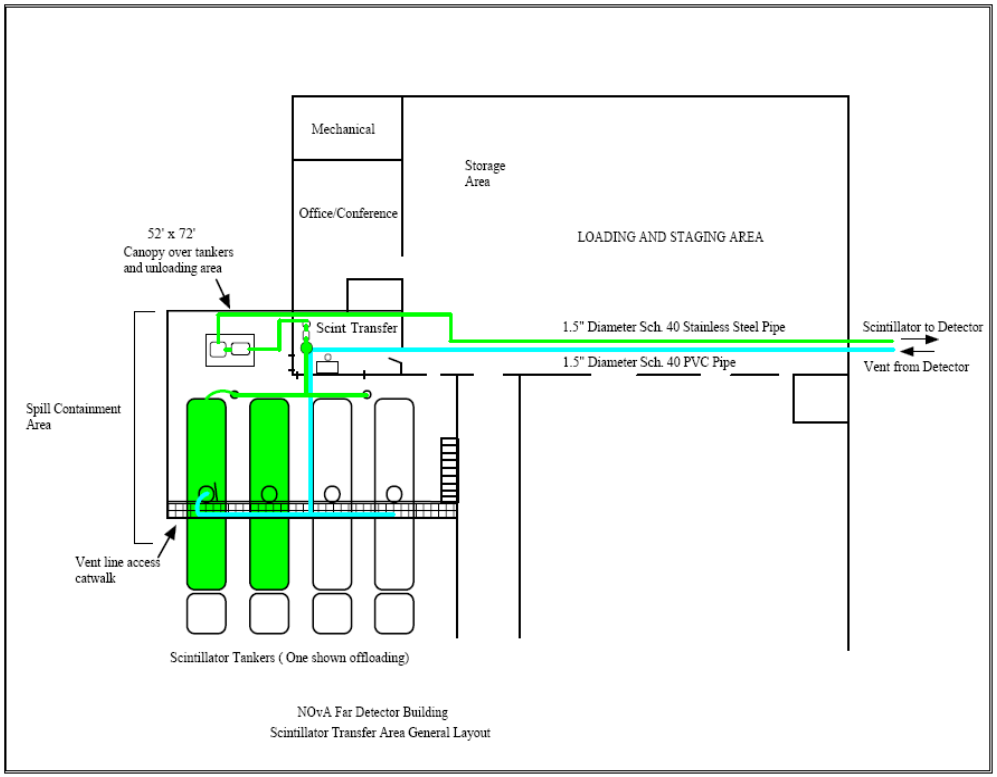
- 8 modules are under fill at a given time, with an average flow rate per module of ~3 gal/min.

- Duration of an 8-module filling step: 1.5 hours.

- Manpower: 2 techs. (Covered in 2.9.4)
  - Tasks:
    - Scintillator filling/topup
    - Delivery/logging
    - QA/QC on delivery

WBS 2.9.3.1
Scintillator Transfer Facility

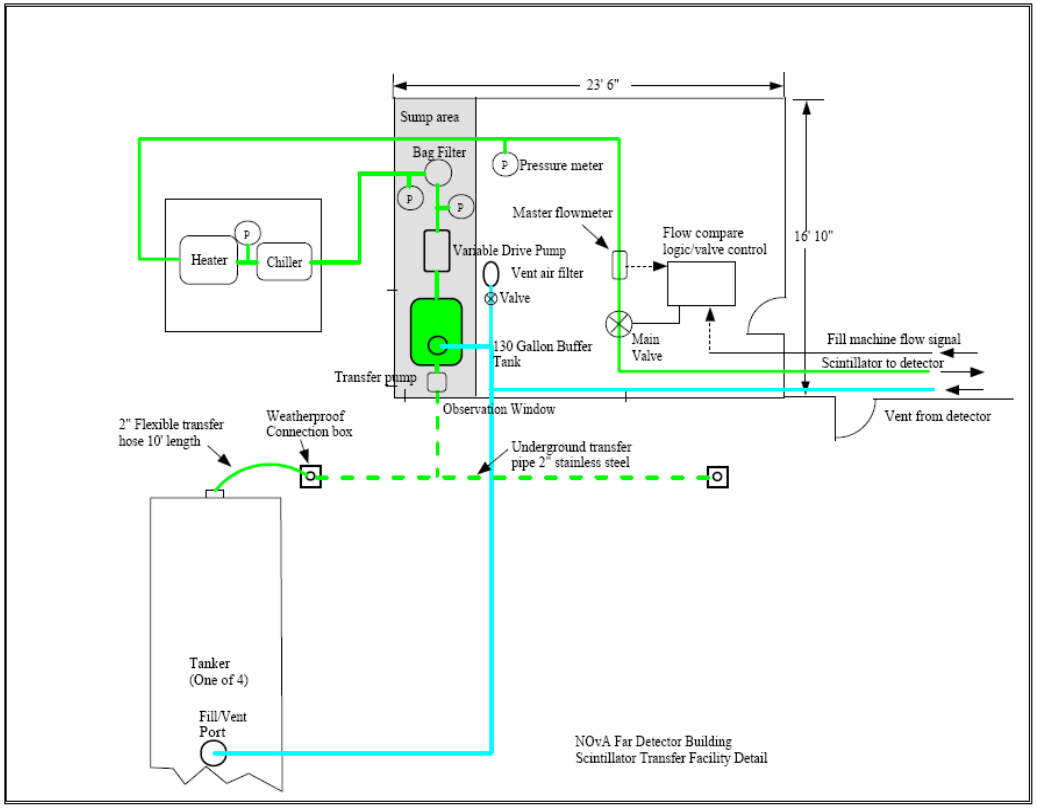
1. Blended and tested liquid scintillator arrives in tankers at the rate of roughly 1 per day.
2. A sample is drawn from the tanker and tested for light yield and attenuation length.
3. The tanker is then connected to the receiving system with both liquid and vapor return lines.
4. The tanker is emptied at a rate of ~24 gpm.



WBS 2.9.3.1
Scintillator Transfer Facility

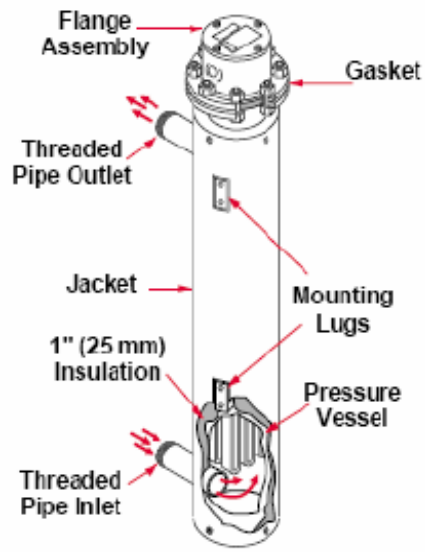
4. Receiving system:

- Filters scintillator to remove any particulate from the connection hoses and piping.
- Adjusts (cools or warms) the scintillator temperature to match the temperature of the detector hall.
- Control/Monitor flow rates.
- Flow monitored at receiving station and @ filling station. Detection of a line loss closes a shut-off valve, terminating flow.



WBS 2.9.3.1
Thermal Control System

- The temperature of the tanker is set at the loading site based on the expected conditions in transit. The load is delivered within +/- 10^0 C of the hall temperature. Upon arrival tankers are attached to a steam heat loop if necessary to maintain temperatures within this range.
- The receiving system includes a chiller and heater in series that are sized to bring the scintillator to within +/-1^0C of the ambient hall temperature.
- In extreme conditions in which the input temperature range is exceeded, the flow rate will be lowered to accommodate.
- All interior plumbing is SS.
- Circulation heater heating elements 8W/in^2.



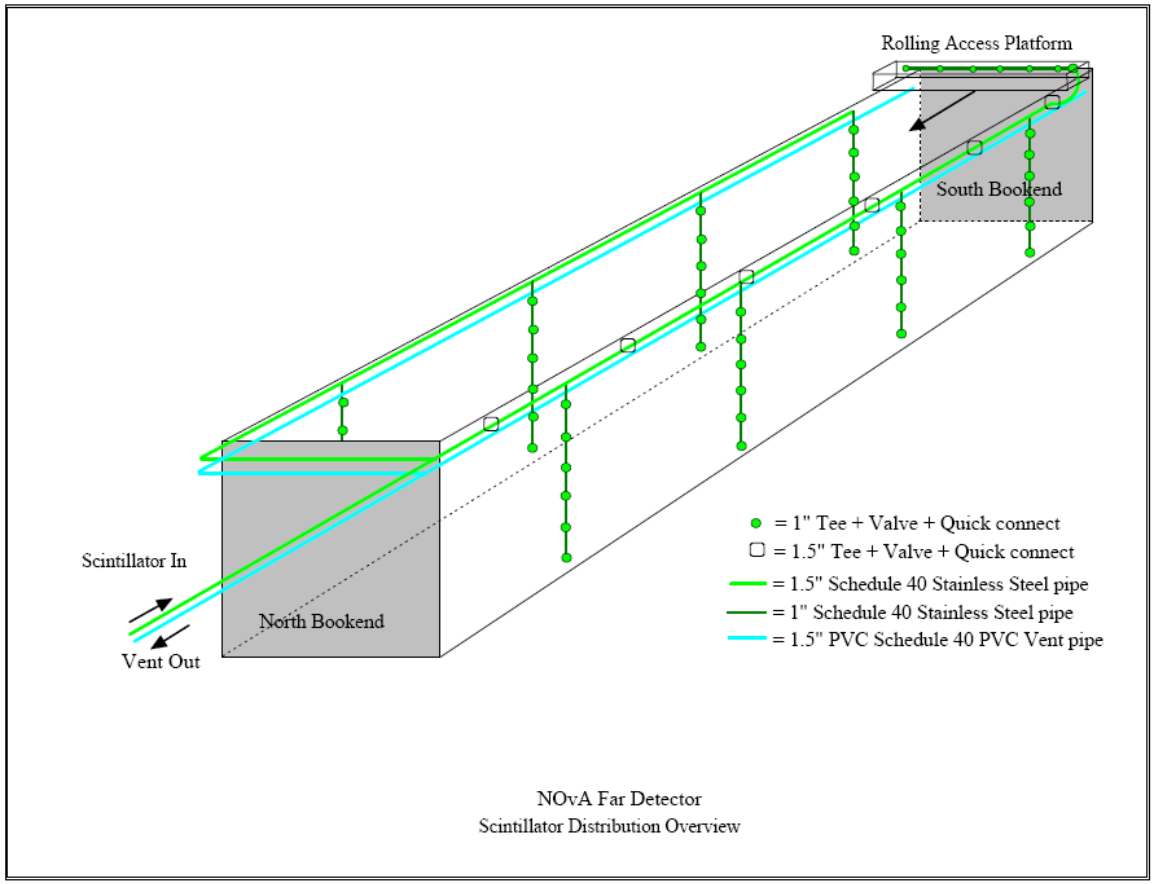
WBS 2.9.3.2
Fixed Hall Piping

- 1.5” SS pipe provides scintillator to access points around the hall.

- Access ports for filling vertical modules located @ 6 points along W. wall at 6th catwalk level. Connections from these to access platform-mounted pipe made through flexible hose.

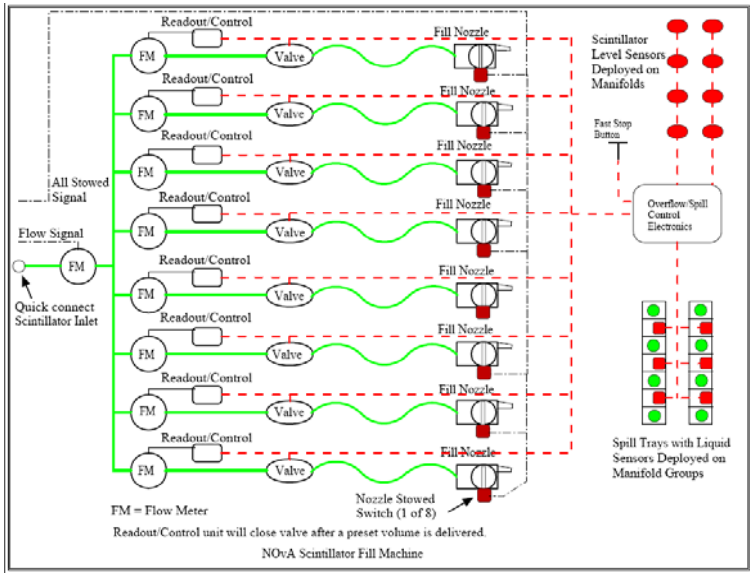
- 4 vertical pipe runs with quick disconnect access ports at each catwalk level are used for horizontal module filling

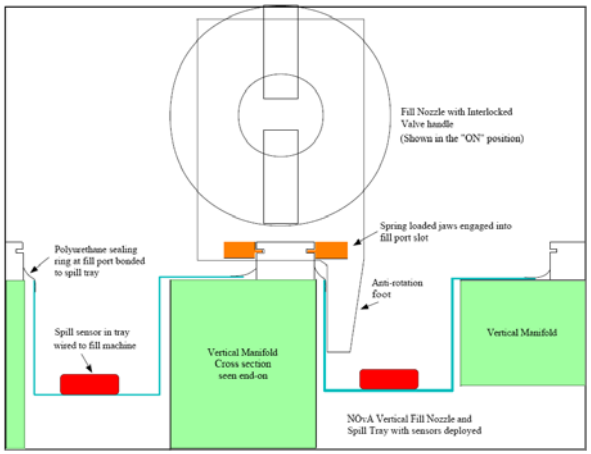
- Final runs from these access points to the filling stations are made though a combination of flexible hose and rigid extension pipes.



WBS 2.9.3.3
Fill Machines

6. Three fill stations will service the top and two detector sides.
   - Each fill station mounted on a hand truck for easy portability.
   - Each contains independent flow monitoring and control for 8 fill lines.
   - Positive displacement flowmeters and flow totalizers control shut-off valve during initial fill.
   - Each fill line terminates in a fill nozzle that is designed with interlocks that prohibit flow unless the nozzle is properly attached to the module.
   - During filling, a spill pan is placed in position surrounding the fill port. An optical sensor at the bottom of the spill pan detects the presence of standing oil, terminating flow in this case.





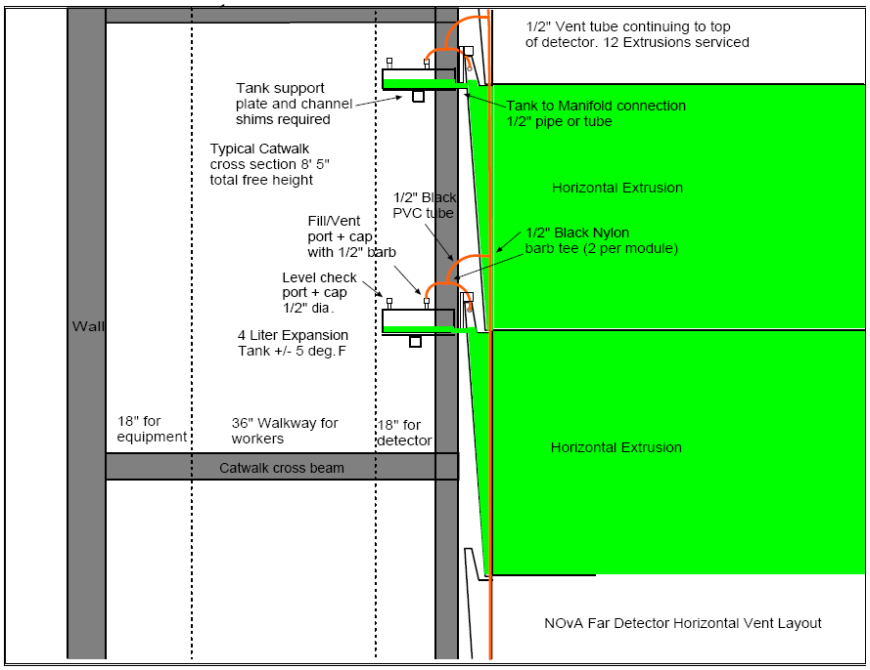
WBS 2.9.3.4
Vapor Recovery System

•Black PVC tubing is connected to the manifold vent port and horizontal expansion tank.

•Tubing from all manifolds on a given plane are connected using barb tees/w steel compression bands. These run to a PVC pipe manifold running along the corners of a detector block, connecting through flexible tubing to fixed vent pipes running parallel to the scintillator distribution pipes to the receiving area.

•During filling, the vent line is returned to the discharging tanker.

•During steady state operation, the vent line outlet is terminated with an activated charcoal filter.



ES&H

- Liquid Scintillator is a non-conducting Class IIIB combustible material, with a flammability rating of 1, and flash point of 98^0C.

- To avoid risks from static accumulation and discharge, all plumbing is conductive, grounded, and bonded. An anti-static additive has been added to the scintillator (Stadis 425) in concentrations that increase conductivity to 50 pS/m. This reduces the steady state electric current flow in the main distribution lines by a factor of ~ 100, reducing the charge delivered to the module by this factor. Measurements of light yield, attenuation length, and aging indicate no measurable effect at the concentrations (2 ppm) required.

- A lower limit of 10 J has been placed on the Minimum Ignition Energy (MIE) of scintillator aerosols by industrial consultants (Chilworth Technology). An aerosol is the most potentially combustible configuration generated during filling. Chilworth tested aerosols over a full range of droplet sizes and concentrations, and was unable to achieve ignition under any circumstances using an electrical spark. (Nova 1521-v1)

- Nova FD scintillator handling procedures have been reviewed by an outside expert (Larry Britton, formerly of Dow Chemical, and author of '*Avoiding Static Ignition Hazards in Chemical Operations*').

- Experience shows that the most serious risk from scintillator-initiated fire would stem from improper storage and disposal of oil-soaked rags. All steps will be taken to ensure that spills are promptly dealt with, and fire-proof disposal receptacles provided.

- Use appropriate interlocks and controls to terminate liquid transfer if spills are detected.

- Scintillator vapor is recovered to protect personnel and the environment.

- Fire protection provisions for the far detector are covered in the building specifications. The presence of the liquid scintillator is a key input to the building design process

WBS 2.9.3 Schedule

WBS	*Item*	*Milestone*	*Date*
• 2.9.3.1	Transfer Facility	Preliminary Design Complete	10/21/07
		Assembly Ash River	4/25/10
		Operation Readiness	6/14/10
• 2.9.3.2	Distribution Plumbing	Preliminary Design Complete	10/21/07
		Installation Complete	4/25/10
• 2.9.3.3	Fill Machines	Preliminary Design Complete	10/21/07
• 2.9.3.4	Vapor Recovery	Preliminary Design Complete	10/21/07
		Install main lines	5/5/10

Backup Slides

Filling Procedure (2)

- Fill Sequence:
  - Fill 4 W end horizontal modules levels 1-2, prep 4 E end modules levels 1-2. 1.5 hr
  - Fill 4 E end modules levels 1-2, prep last 4 W modules end levels 1-2 1.5 hr
  - Fill last 4 W end modules levels 1-2, prep last 3 E modules levels 1-2 1.5 hr
  - Fill last E end modules levels 1-2 1.5 hr

    6 hours

  - Fill horizontal levels 3-4 6 hours
  - Fill horizontal levels 5-6 6 hours
  - Fill horizontal levels 7-8 6 hours
  - Fill horizontal levels 9-10 6 hours
  - Fill horizontal levels 11-12 6 hours
  - (4.2 shifts)

  - Prep & fill 4 vertical modules on first 2 vertical planes, top up 4 W modules levels 1-2 1.75 hr
  - Prep & fill next 4 vertical modules on first 2 vertical planes, top up last 4 W levels 1-2 1.75 hr
  - ….. …..
  - Prep & fill last 4 vertical modules on last 2 vertical planes, top up last 4 horizontal 1.75 hr

    42 hr (5 shifts)

  - Top up verticals (15 min.s per group of 8) 6 hr (0.7 shifts)
  - **TOTAL PER BLOCK** **10 SHIFTS**