NOvA Safety Advice

The material amounts then are:

Rigid PVC – 5,740 metric tons

This contains 15% titanium dioxide, perhaps 5% acrylic impact modifiers, perhaps 3% calcium carbonate, perhaps 3% of an organo-tin compound (e.g. methyltin mercaptide stablizers), and apparently 1% lubricants (waxes)

Liquid Scintillator – 19,260 metric tons

The liquid is mixture of several components:

17,330 metric tons of mineral oil similar to that in MiniBooNE

1,932 metric tons of pseudocumene (or 1,2,4-Trimethybezene)

3 - 6 metric tons of PPO (or 2,5-diphenyloxazole) – about 3.9 metric tons

25 - 50 kg of POPOP (or 1,4-bis(5-pheyloxazol-2-yl)benzene)

50 -100 kg of bis-MSB (or 1,4-bis-(2-methylstyryl)-benzene)

Wavelength shifting optical fiber – 29,462,146 meters, 0.8 mm in diameter

(At a density of 1.05 g/cc this is 13.3 metric tons.)

The fiber is mostly a fluor-doped polystyrene core, clad in a thin acrylic intermediate layer, then on the outside clad in a thin polyfluor (we would use Kuraray fiber exactly like that in MINOS, or Bicron BCF91A is another example).

856,000 channels of electronics using Hamamatsu 16 channel Avalanche Photodiodes.

These “APDs” get about 400 volts applied and are thermo-electrically cooled to -10 degrees C. The thermo-cooler is probably the biggest heat load, maybe 40 watts for 64 channels – still, that’s 500 kW distributed in perhaps 50,000 spots over the top and one long side of the detector.

NOνA Safety Advice

I would like advice on fire protection issues, on environmental issues (including byproducts from a fire or from fighting a fire), on the requirements for decommissioning , on “pressure vessels”, ….(on whatever else am I missing)…. for the proposed NOνA experiment. NOνA would be located in far far northern Minnesota, 810 km from Fermilab, just south of Voyageur’s National Park on the Canadian border.

What would we have to do to build this device at Fermilab?

Don Cossairt, Jim Priest, Paul Kesich, Mary Logue,Eric Mc Hugh, Keith Schuh

NOvA Safety Advice

General Environmental Concerns:
Construction Phase
NEPA environmental assessment will be needed.

Environmentally sound and safe management of the liquid scintillator inventory is probably the most significant issue to be covered in the EA and the countermeasures to address it may draw considerable interest from DOE and the government agencies consulted during the NEPA process. State and local government laws, ordinances, and codes may be applicable and should be explored as part of the NEPA process.

- Waste stream evaluation should be conducted.
- If wetlands are involved it will require a permit and potential construction of new wetlands.
- If over an acre in size it will require a state NPDES construction permit and stormwater
- pollution prevention plan.
- If there is a potential for lose of any of the oil, special precautions will need to be imposed to eliminate or control the
- hazard.
- If impact to cultural resources than this will need to be addressed through the state with potential additional
- characterization, placement of controls, etc.
- Special precautions should be taken during fill-up phase to reduce any potential for release.
- Any release requires cleanup and disposal.
- Evaluation of needed utilities.
- Another possible outcome is the determination of the need to do the much more extensive Environmental Impact Statement (EIS).

NOvA Safety Advice

General Environmental Concerns:

Operation Phase

Monitoring, limiting, and containing spills.
Potential to emit oil to surface waters outside of our control from a systems failure will require a
SPCC plan.

Potential to activate soil will need to be addressed through controls, i.e.. shielding and monitoring system.
Waste stream evaluation should be conducted.

implement protective measures in a timely manner.
Appropriate countermeasures should be built into the experiment as reliance on the local emergency response personnel in this rather remote, near-wilderness area are likely to be volunteer firefighters inadequately prepared

Safety Issues

The Fermilab safety assessment process will need to be followed in accordance with Chapter 2010 of the Fermilab ES&H Manual. Given the cost and scope of this project, the preparation of a preliminary safety assessment document (PSAD) would be required.

A PSAD is generally a "shopping list" of issues to be resolved with perhaps some early thoughts as to the nature of solutions. The PSAD also addresses environment, safety, and health concerns associated with civil construction of the facility and installation of the experimental apparatus. The SAD is far more comprehensive and has to demonstrate successful resolution of problems.

The fire safety concerns are currently being pursued. The extensive use of PVC and the large volume of liquid scintillator material are the major combustible loads

Electrical hazards, as always, represent an important consideration as they provide possible ignition sources.

NOvA Safety Advice

Safety Issues

Pressure safety concerns of great significance arise in direct correlation with the size, and especially the vertical height with its increased pressure head, of the vessels containing the liquid scintillator.

The toxicity of the chemicals used on such a large scale will need a complete industrial hygiene evaluation with identified necessary countermeasures implemented.

The location of the facility makes it clear that plans for the assembly of the detector, the transfer of the oil, and the eventual decommissioning of the facility including the removal of the oil are especially crucial.

While ionizing radiation is not a major concern of this experiment, the use of radioactive sealed sources for detector testing and monitoring in this location on a non - DOE site would require coordination with the State of Minnesota to assure compliance with state, and possibly Nuclear Regulatory Commission, requirements.

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Specific Concerns:

1. Can your environmental expert comment in particular on the list of chemicals?
   Are they hazards or not? Are they toxic or not?
   Are they likely to be declared hazards or toxic in the next 10-20years or not?
   Are they on hazard / toxic lists already elsewhere in the world? -- Does that matter?

Because it is a liquid that does not bind well to soil, 1,2,4-trimethyl-benzene that makes its way into the ground can move through the ground and enter groundwater. Plants and animals living in environments contaminated with TMB can store small amounts of the chemical.

PPO (or 2,5-diphenyloxazole) Is classified as hazardous on MSDS and requires cleanup and disposal.

Gran Sasso has a $6M problem

NOvA Safety Advice

Specific Concerns:

2. Would the liquid scintillator volume likely require a containment area for the whole volume?

Or can one really successfully argue that "credible" spills are smaller and so do less?

If having a modular detector helps, should we be looking at modules with 16 interconnected cells instead of 32 cells to limit the credible spill to 350 kg instead of 700 kg?

Removing the pathway to the environment for any potential spill source is the best answer.

That means surface and subsurface.

Secondary containment of all is the best answer.

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3. If we have a leak, what kinds of countermeasures might we have to take other than containment?

   What are the effect differences between contaminating water deep underground vs. contaminating surface water?

Keep it from getting into the environment. That means surface water as well as soil. Again any type of spill into the environment is costly, especially when it comes to oil, remember CHL. If it is within the site control area it means less of a nightmare but is still costly. If it gets offsite we are looking at bigger problems besides cleanup (public relations).

Minnesota considers all water to be treated as drinking water.

NOvA Safety Advice

Fire

BC-517L Oil

It is a combustible mixture rather then a flammable mixture. >140 F

Test of boiling oil

1. Exposed to low energy flame for 10 seconds. No ignition
2. Exposed to low energy flame for 30 seconds. No ignition
3. Exposed to candle wick burning at surface of BC-517. No ignition but increased flame on wick.

Low energy flame 30 seconds added to the candle flame. No ignition.

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Fire Testing Oil:

A torch was applied to the pool (BC-517L) which was at 150 F. Ignition occurred and stayed continued to burn till manually extinguished after three minutes. The interesting observation was the burning after three minutes did not migrate across the rough surface of the pan.

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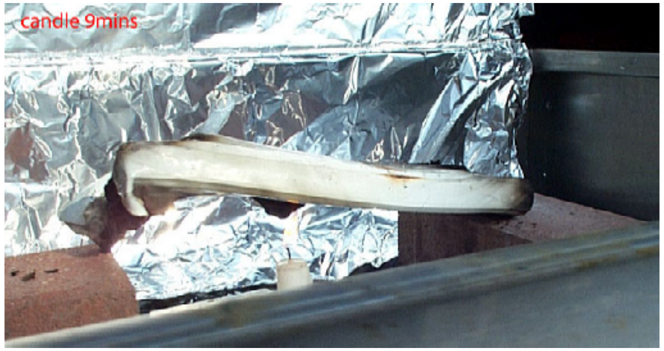
PVC Flame Testing

The PVC compounded with the formulation of 15% titanium dioxide, perhaps 5% acrylic impact modifiers, perhaps 3% calcium carbonate, perhaps 3% of an organo-tin compound (e.g. methyltin mercaptide stabilizers), and apparently 1% lubricants (Waxes).

1. Does not ignite or become flammable or drip material when subjected to various ignition sources and contaminated with the BC-517L.
2. The PVC when exposed to high temperatures point sources will form pinholes, spraying the BC-517L under pressure onto surrounding surfaces. Further testing under pressure is recommended.
3. The BC-517L will ignite in a sprayed filmed condition if exposed to the right ignition source.
4. The BC-517L was not easily ignitable from exposure to a 690 F heat gun, a low energy flame, or a candle on the interior or exterior of the PCV extrusion.
5. Ignition of the BC-517L occurred on exposure to only a high-energy flame or BC-517L reached ~50C at which I suspect the pseudocumene was igniting in the mixture.
6. It is important that the compounding of the PVC be documented and changes will require additional testing. In a future test the PVC will be tested under pressure in a fire situation with the BC-517L and the Wavelength optical fiber and the Hammamatsu Photodiodes.

NOvA Safety Advice



NOvA Safety Advice

Fire Detection and Suppression Recommendations.

1. All electronic racks should be equipped with smoke detection to shut down rack electronics. A VESDA or similar system should be installed for early warning and shut down of electronics and power on high alarm.
2. A suppression system of either dry chemical and or non-alcohol foam should be installed and zoned as to discharge to the fire area. Fighting the fire using normal sprinklers or fire department hand lines ineffective and will cause a problem of containment and run off.
3. The containment for a leak caused by a fire should be figured at a minimum of 10% of the surrounding 32 cells to the fire. This is only a guess at this point.
4. A model of fire Plume and Area of impact should be developed to aid in the analyzing a vast quantity of air, water, soil soot developed during a fire. This should include the following for the by products that will be produced from a fire of BC –517L and PVC and scintillator materials and possible by products which could include:

NOvA Safety Advice

Transport

Ash Creek Bicron BC-517L transfer considerations

BC-517L contains a slightly hazardous substance (pseudocumene at possibly higher levels than previously expected, Approx. >10% as compared to ~5% as stated in the pre-planning narrative.

-BC-517L is a class II flammable.

-BC-517L according to NFPA is a health hazard of 1 (slight health hazard),

-BC-517L according to DOT is a Class 2 hazard for transport,

-Psuedocumene has a LD 50 of 5000mg/kg (moderately toxic). Health effects: Irritant eyes, skin, nose, throat, and respiratory system. May produce drowsiness, fatigue, dizziness, and other complications.

NOvA Safety Advice

Transport

What form of transportation will be used to transport the mineral oil from point of origin to ultimately Ash Creek, Minnesota site?

- Semi tanker loads will be expensive and need secondary containment at point of origin and point of transfer.
- Rail tanker loads will need secondary containment at point of origin and point of transfer. The rail will either have to be extended, as in the case of our railhead, or there would be a transfer to a semi tanker (where there would have to be secondary containment at the rail-semi transfer site and at the final destination transfer site).
- The oils must be kept at 40F (?) to pour and retain clarity
- 919 semi tankers would be required.
- Minnesota may require site surveys performed to determine the environmental risks and travel of a spill. Spill protection of waterways and the surrounding environment will have to be considered and/or protective barriers constructed. EPA and Minnesota release and environmental protection guidelines must be consulted.
- A Spill Prevention, Control and Countermeasure (SPCC) Plan will have to be constructed by a professional engineer according to (40 CFR 112) attached (Document 1 and 2).
- Detailed transfer procedures must be drawn up for each transfer site (Document 3,4,5,and 6); training and retraining intervals must be planned (disregard of procedures, possibly due to lack of retraining, contributed to the incident and consequential shut down of Gran Sasso).
- A decommissioning plan/procedure must also be drawn up.