

CONCRETE, SULFURCRETE, SHIELDING RESEARCH  
FOR THE SUDBURY NEUTRINO OBSERVATORY

PROGRESS REPORT CON-9-90

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## SUMMARY:

Work at Laurentian during July-August 1990, has been centred on:

- a) the preparation and stability testing of various high boron content glasses, for boron loading in shielding materials.
- b) arrangements for the testing of boron glasses in concretes and sulfurcrete.
- c) a survey of Ontario Portland cements re radioactivity.
- d) ongoing strength and stability testing of previously prepared concrete samples.
- e) arrangements for the production of 100 sulfurcrete/dolomite prototype blocks.
- f) an initial investigation of boron additives in the backfill ready-mix concrete and shotcrete.
- g) preparation of cost figures for materials and block preparation for both concrete and sulfurcrete options.
- h) boron glass procurement or production - materials, producers cost options.

## PROGRESS:

## (a) BORON GLASSES

Although stable concretes containing 1 % boron and dolomite aggregate have now been demonstrated for use in shielding blocks, there is a potential need for a more inert additive which could be easily added to concrete mixes or shotcrete. Although commercial glasses appear to have at best 3-4 % boron, we have prepared a glass (#1) made of 50 % borax ( $\text{Na}_2\text{B}_4\text{O}_7$ ) and 50 % silica ( $\text{SiO}_2$ ) (boron content = 10 %). This glass is stable at temperatures up to 500 C, and does not significantly dissolve in water (or a 5 % salt solution) at room temperature. It does dissolve significantly in water at 95 C. A second glass (#2) with 43 % borax, 53 % silica and 4 % calcium oxide has very good hot water resistance as well. A third glass consisting of 65 % Corning #7070 labware glass, 33 % borax, and 2 % calcium oxide also has 10 % boron content and excellent stability against salt and hot water. Several batches of each type have been prepared, and further assessments of water resistance and aging properties are continuing.

(b) BORON GLASS CONCRETE & SULFURCRETE

Boron glass #1 has been added to dolomite concrete to give a 1% boron content. Setting time was normal for this concrete, and 7 day strength tests are excellent - this really is a normal Portland concrete.

Boron glass #1 was tested at a 1% boron level, in lab samples of sulfurcrete (by A. Vroom, Sulfurcrete Products). Production of the sulfurcrete was normal, and subsequent hot water testing showed that no swelling or cracking problems developed. Vroom is confident that this additive is satisfactory.

(c) SURVEY OF PORTLAND CEMENTS

The collecting of samples from N. Ontario suppliers and quarries is continuing. Radioactivity tests are scheduled for October, using the 3 crystal HP Ge detector (from Univ. of Guelph) now installed at Laurentian.

(d) CONCRETE STRENGTH & STABILITY TESTING

Previously prepared concretes are tested as per testing standards at 7 and 28 day intervals. A water-immersion aging test has been added recently, to look for long-term stability for various boron concretes.

(e) SULFURCRETE BLOCK PRODUCTION

A quote for the production of 100 - 200 blocks, with dolomite aggregate and a boron-loading option has been prepared by A. Vroom. After a discussion of optimum block size at the SNO meeting, these blocks will be ordered, with probably 10% containing 0.5 % boron. Discussions held thus far, indicate that a 6" x 6" x 12" (15 x 15 x 30 cm) block (about 45 lb) or a 8" x 4" x 12" (20 x 10 x 30 cm) block (about 40 lb) appears optimum, considering that the SNO shield block thickness is to be 30 cm.

(f) BORON IN BACKFILL CONCRETE & SHOTCRETE

With a stable, high boron content crushed glass available at moderate cost, boron additives to selected liner backfill concrete or other shotcrete should be possible, with minimal changes in concrete/shotcrete properties. Test batches of ready-mix concrete and shotcrete are being arranged for, and suitable testing will be carried out this fall.

(g) BORON CONCRETE/SULFURCRETE BLOCK PRODUCTION COSTS

We are continuing to update material and production costs for these two options. A summary report will be available at the SNO meeting.

(h) BORON GLASS PROCUREMENT OR PRODUCTION

Glasses described above have been prepared in test-crucible sizes, in the pyrometallurgical laboratories at Laurentian. Investigations

show that batch glass to our specs could be prepared at many foundry/ refinery or glass operations. Inquiries at Corning Glass and at a gold assay firm in Timmins, suggest a processing cost of around \$ 1.00 per kg. With preliminary raw material costs available, the boron glass costs appear to be between \$ 2.00 and \$ 2.50 per kg. An estimate for a 1 ton batch production has been received. If approved at the SNO meeting, we will proceed with an order of the most suitable composition glass.

#### OTHER LAURENTIAN ACTIVITIES

- preparation of reports on the measurement of dust, radon and magnetic fields near the SNO site.
- transportation and set-up of the 3 crystal HP Ge detector from the University of Guelph, at Laurentian.
- assistance with the proposal for a World's Fair display (1992 - Seville Spain) on SNO (with A. McDonald & J. Pink, Science North).
- further discussions/negotiations re SNO space at Laurentian, and with INCO re an underground Ge detector site.