

The Atmosphere in the Cavity During the Fill Period

SNO-STR-94-033

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Introduction

The decision not to purge the cavity with nitrogen during the fill period has been explained in SNO-STR-94-007. Here I examine some of the implications of this decision on the following:

- (i) Using N₂ as make-up gas as the AV volume breathes.
- (ii) When to turn on the blanket gas.
- (iii) Protecting the concentrators from corrosion.

(i) The AV Volume

It is proposed that, as the AV breathes with air pressure changes, the air lost be replaced by LN₂ boil-off in order to get an early start on excluding mine air. Let us now calculate the possible safety hazards as the AV air, enriched in nitrogen, exhales into the working area above the deck. We will use pressure change data from David Sinclair's "Ventilation Systems' Impact on Barometric Pressure at the SNO Site", 94/01/19. We also assume that the LN₂ cover gas system can supply make-up gas for any pressure change encountered.

AV volume: 1000 m³

Volume above deck: 1600 m³

Maximum observed rapid pressure change (fans): 10" w.g. (2.5%) in 10 minutes.

Typical atmospheric pressure change: rises of average 1.2% were observed three times in one week in November 1993. I believe mine procedures have now been changed to prevent the large pressure changes induced by fans. I will concentrate on the atmospheric changes. Assuming the 93/11 data to be typical, during the three month fill we expect a 1.2% rise in pressure to occur 40 times. This will result in a 38% change in the gas in the AV; *i.e.* a final oxygen content of 13%.

A worst case safety hazard might occur if the AV exhaust gas leaked into the working area above the deck at the half-way fill stage. The leak could be of the order 15 m³ (3% of 500 m³) of air with a 17% O₂ content. I do not believe this to be a serious hazard, although this must be checked with INCO safety people. (N.B. The alarm on my oxygen monitor goes off at 19.6%).

(ii) Turning on the Blanket Gas

In deciding when to turn on the LN₂ boiloff blanket gas we have to balance three factors:

- (a) radioactivity and other problems in the detector.
- (b) worker safety above the deck.
- (c) surge capacity of the blanket gas system.

If the surge capacity of the blanket gas system can handle the AV volume then it can handle pressure changes in the whole cavity approximately two weeks before the fill is complete, when about 1000 m³ of air remains above water. If the blanket gas system is turned on at this point, the system capacity of 3.3 l/s gives a replacement time τ of 3.5 days. The time for the remaining fill, two weeks, is 4τ or 2.5 radon mean lives. Hence when the fill is complete the blanket will be only 2% residual air. The radon at this point will be 1.5×10^{-3} times its original level.

If we assume the same safety hazard as before - a 3% exhalation half-way through the period, then we will have 15 m³ of gas above the cavity with a 3% O₂ content. This may be enough to cause asphyxiation if the leak occurs near a worker. The pressure change time is comparable with the air change time above the deck (10 min), but a leak may suddenly open up in the deck and flood a small volume with blanket gas in a very small time. Such a catastrophic occurrence may have a tiny probability. At end of the fill period this hazard would be 4.5 m³ gas with no oxygen content. It is not clear if there is a qualitative difference between these two cases.

Recommendation: turn on blanket gas between zero and two weeks before fill is complete depending on a review of safety issues.

Cautions: cover gas system capacity.

(iii) Concentrator Corrosion

Attached is a document "Aging of Dielectric-Coated Aluminum (DCA) in DI Water" by Rob Newman, a UBC summer student. In it, evidence is presented which supports the idea that the corrosion of DCA requires both CO₂ and O₂ dissolved in the water. Tests on DCA under a blanket of CO₂-free air showed no failures after one week at 92°C. Given that we have rejected a nitrogen purge during the fill, it would be advantageous to remove the CO₂ from the air at this time. In fact, this will probably happen naturally if we keep the air stagnant (*i.e.* no circulation) as currently planned. This will allay some of our worries about DCA corrosion during the fill period, when the concentrators will spend up to two months in warm water under air.

Normal air contains about 0.3% CO₂, which is very soluble in water: 1.71 l/l at 0°C and 0.88 l/l at 20°C. Hence the first m³ of degassed water in the cavity will mop up the CO₂ above it, even if the air volume is turning over. Any incoming CO₂ as the cavity breathes will be dissolved if it gets into contact with the water.

By the time the water level reaches the concentrators in about two weeks, the dissolved CO₂ will be much diluted by the incoming water, and more than half the water will have already been recycled through degasser. Thus I expect the pH to remain near 7 and that there will not be a DCA corrosion problem during the fill.