SNO-STR-91-052

Magnetism of Stainless Steel Plates

I. Stairs, D. Prodanos and H. Lee

July 24, 1991

The design of the SNO detector in the White Book proposal calls for the tank to be lined with 304L stainless steel. This lining would consist of many plates of steel welded together by MIG welding with SS304L filler rod, with the welded seams constituting about 1% of the total liner area. While the plates themselves are not magnetic, there has been some concern that the welds would retain magnetism, and that these excess magnetic fields could seriously affect the performance of the PMTs. Measurements by Hallman and Cluff (SNO-STR-90-167) indicate that the magnetic field from a mild steel plate falls off very rapidly, but there are no measurements for stainless steel. Is the field from the remanence at a distance of 2.5 m from the liner (the closest distance the PMTs are to the liner) small?

In order to answer this question, 25 cm × 25 cm × 1/8″ plates of 304L stainless steel with a 2B finish were welded together using two different techniques: the TIG method (plates melted together with no filler rod) was applied once and an imitation MIG weld using SS308 filler rod was used in place of a true MIG weld. These plates and two unwelded plates were placed in a large open area, and the magnetic field around each set of plates was measured using a MEDA flux-gate magnetometer. The field was measured first along a line running perpendicular to the plates and through the centre of the weld at distances of 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 40, 50, 75 and 100 cm, and secondly at 2.5 cm intervals along a line 2 cm from the plates and directly in front of and parallel to the weld.

The measurements along the line through the centre of all the welds were all taken with the magnetometer probe resting on a flat surface perpendicular to the plates, but the probe may not have been exactly perpendicular or parallel to the plates, since the angles were estimated by eyesight. The reading on the magnetometer changes by approximately 40 mG for every 10 degrees misalignment. The measurements along the TIG weld were taken with the probe held by hand and positioned by eyesight, but the others were taken with the probe resting on a flat pile of books and still adjusted by eyesight.

The fields surrounding the welded plates were compared to that around the unwelded plates. All measurements were under 600 mG (i.e. of the order of the

Earth's magnetic field). The significant differences were of the order of 20 mG or less, and there were not very many such discrepancies. Such small differences would not have a noticeable effect on the performance of the PMTs.

Improvements to these survey measurements would include:

(a) Performing the measurements in an area (such as the new SNO PMT testing facility at Queen's) where the Earth's magnetic field has been cancelled out. This would give us the sensitivity to detect any small remanence in the stainless steel.
(b) Fixing the magnetometer probe and moving the stainless steel plate. This minimizes reading fluctuations due to probe misalignment.

After the cavity liner is in place, the strength of the remanence in the welds must be measured. If it affects the field by more than 10% at the PMT positions, remedial action (degaussing, etc.) will have to be taken.