ONTARIO HYDRO
RESEARCH DIVISION REPORT

To Mr. J.R. Leslie
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MEASURING CURRENT IN THE HIGH CURRENT LABORATORY

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Measurements on the 50 kA current transformer (Lab No 3091) indicate that, in the presently installed position, the transformer may have excessive errors at currents exceeding 140 kA peak. An additional shield winding should allow measurements of approximately 225 kA peak. A custom designed and built current transformer is indicated if repetitive measurements on offset waveforms are to be made with little error.

THE REQUIREMENTS

The requirement of the current measuring system in the High Current Laboratory is to measure current up to 100 kA rms, completely offset with a transient having 30 ms time constant (first peak about 250 kA). In most of the applications the trasnformer would be terminated with a shunt of suitable value to provide a voltage in the range of 1 to 10 volts to an oscillograph.

PRESENTLY USED EQUIPMENT

Installed in the High Current Laboratory at the present time is a 50 kA current transformer, Lab No 3091. This transformer was designed for accuracy testing of metering current transformers over the range of 8 kA to 50 kA. Its errors over this range and at steady state conditions are less than 0.02 per cent at the specified secondary burden. (See NRC Certificate No ERC-659, dated February 14, 1974, File 815.53). This transformer can and has been used, with limitations, to measure the test currents in the High Current Laboratory. For this application the whole secondary winding should be used (50 kA-5 ampere connection) and the value of the shunt may be chosen to be in the range of 0.1 to 10 ohms to obtain the required voltage signal for the oscillograph. Tests and calculations indicate that, in the presently installed position, this current transformer may saturate due to stray magnetic field at a current of 140 kA peak, approximately. To extend this current upward, it is necessary to move the transformer to a location where stray magnetic field is not as severe, install an additional magnetic shield, or both.

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Since a better location for the transformer has not been found, the installation of an additional magnetic shield is indicated. Measurements indicate that a magnetic shield of a particular design will extend the operating range of this transformer to about 225 kA peak.

In addition to stray magnetic field, the transformer may saturate due to the transient component of the test current. Assuming that the transformer is demagnetised before the application of test current, the current transformer is capable of transforming 50 kA with a full offset having a 80 ms time constant on the 50 kA ratio. In the presence of stray magnetic field, however, the time constant of the transient has to be substantially reduced, if saturation is to be avoided. The graph in Figure 1 indicates the safe, or error-free, operating limits for the transformer in the installed condition, before and after the installation of the second magnetic shield.

Similar to the upper current limit, the transformer has a lower current limit at which the errors become unacceptably large. The errors for the transformer discussed here are estimated to be less than 0.1% at 4 000 amperes.
0.3% at 2 000 amperes.
and 1% at 1 000 amperes.

CUSTOM DESIGNED TRANSFORMER

A special transformer must be designed and built if problems due to stray magnetic field and saturation due to transient component are to be eliminated. A transformer similar to the one built for the vacuum breaker application, with the addition of shield windings, is indicated (Research Division Report 70-304). Specifications for that transformer are appended to this report. It is estimated that, in the installed condition, the specified transformer will not saturate due to a current of 100 kA fully offset with a transient having an 80 millisecond time constant, or to stray magnetic field due to a peak current of in excess of 300 kA.

The errors of the transformer are estimated to be less than 0.1 per cent over the range of 2 000 to 100 000 amperes, reducing to about 1% at 200 amperes. This accuracy would apply to the transformer loaded with a shunt having resistance in the range of 0.1 to 10 ohms.

The finished transformer is expected to be a minimum of 9 inches inside diameter, about 21 inches outside diameter, and about 6 inches high. The weight is expected to be about 300 pounds, including 200 pounds of copper and 75 pounds of iron.

CONCLUSIONS AND RECOMMENDATIONS

The current transformer presently used for measuring current in the High Current Laboratory may have unacceptable errors at high peak currents or currents with transient components having a long time constant. An additional shield winding, if placed on this transformer, will extend its operating range, and is recommended as an interim measure.

A special current transformer is required for the High Current Laboratory and its procurement is recommended. A description of the special transformer is appended to this report.

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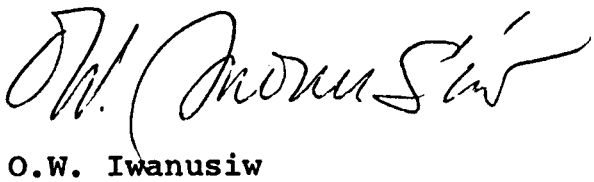

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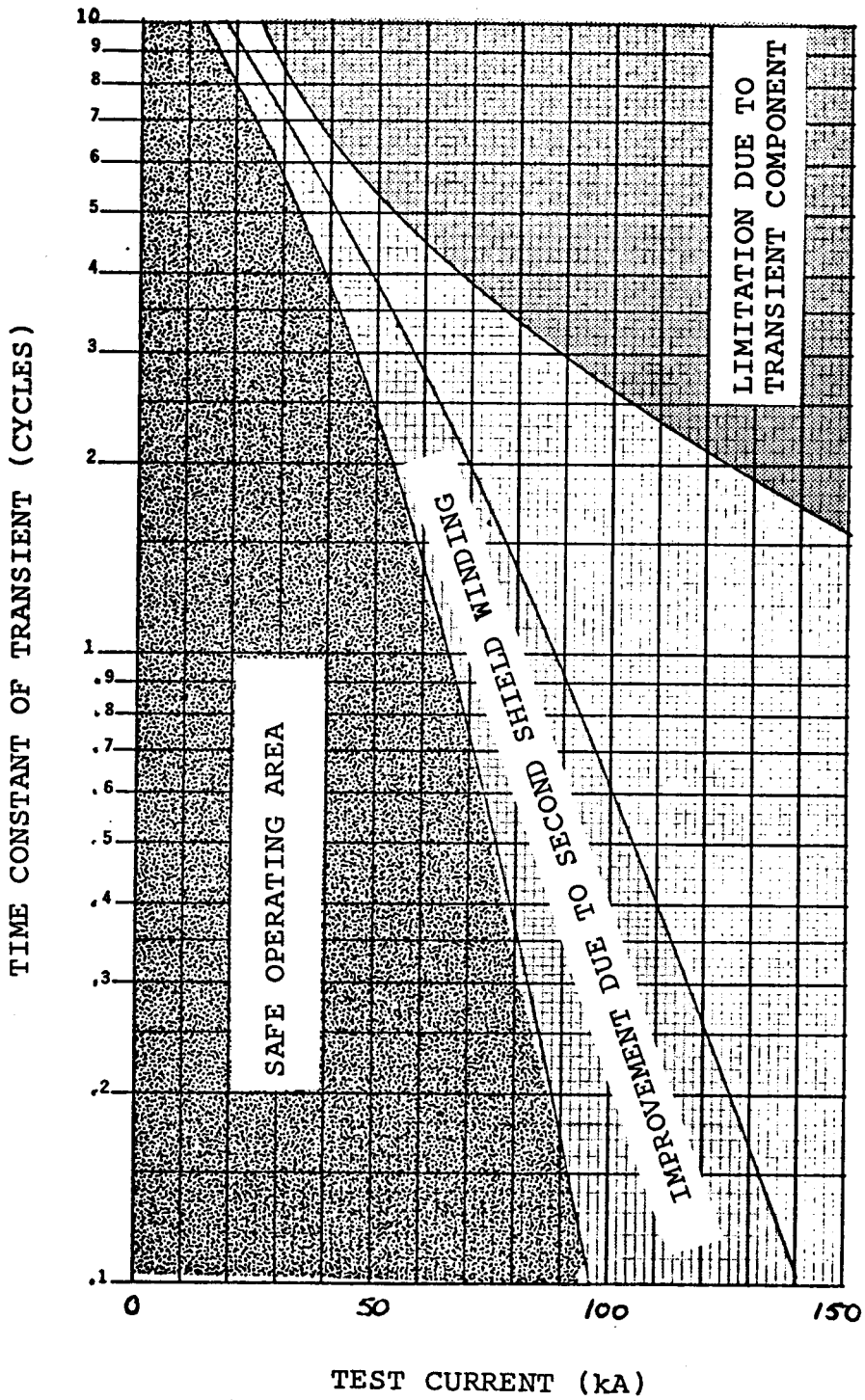

FIGURE 1

PERFORMANCE OF CURRENT TRANSFORMER
LAB NO 3091

APPENDIX

SPECIFICATION FOR CURRENT TRANSFORMER

Core - 2 tape-wound core-halves, each 15 inches inside diameter, 18 inches outside diameter, 1.5 inches strip width.

Windings - A - Shield and bias winding
9 parallel windings, each consisting of 50 turns #12 enamel wire wound over each core-half.

B - Secondary winding
10 000 turns #14 enamel wire wound over both core-halves.

C - Shield winding
6 parallel windings, each consisting of 50 turns #10 enamel wire.