

HUB ALERT™

Heat Sensing Labels

REPORT NUMBER 11-15-C0165A Revision 1

“Pressure Washing Resistance Test (Adhesion Effectiveness) on HUB ALERT™ Heat Sensing Labels”

NOTE TO READER:

The attached report prepared by Exova Canada for Spectra Products Inc. details the independent testing undertaken to confirm the adhesion effectiveness of HUB ALERT™ heat sensing labels when exposed to water pressure under extreme heat, cold and ambient temperatures.

The test was conducted to determine the pressure washing resistance of the HUB ALERT™ heat sensing label when applied to the three most common hub/hubcap materials, Plastic, Aluminum and Steel.

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Pressure Washing Resistance Test (Adhesion Effectiveness) on HUB ALERT™ Heat Sensing Labels

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1.0 INTRODUCTION

Spectra Products Inc. submitted forty (40) HUB ALERT™ heat sensing labels for performance testing in accordance with customer-supplied test protocol. We were informed that such labels are applied to the wheel hubs and caps of trucks, trailers and buses in order to provide an early warning temperature alert for wheel hub oil. Specifically, the label will turn black permanently if the temperature reaches 250°F in order to alert the driver that further inspection is required (wheel end manufacturers recommend a detailed inspection if temperatures reach 250°F in order to address potential seal and bearing problems).

The received test samples were assigned an Exova sample number and cross referenced to Spectra Product's description as listed:

<u>Exova Sample No.</u>	<u>Description</u>
11-15-0165-1 to 40	Forty (40) HUB ALERT™ heat sensing labels #16914 SWISS CelsiDot® Label dimension: 19 mm x 25 mm

We were instructed to evaluate the heat sensing labels in terms of Pressure Washing Resistance (Adhesion Effectiveness) and Temperature Activation. This report contains the results from the Pressure Washing Resistance test.

Also submitted for testing were the following items:

- One aluminum hub cap on a wooden stand (STEMCO HUB-SEAL 2, Longview, Texas, 4009).
- One plastic hub cap on a wooden stand (International 3531209C91, U.S. Pat. 5,505, 525).
- One steel hub and hub cap (6-X-1350 FOM B110-9).
- One KÄRCHER pressure washer, K5.540, 120 V, Pmax = 2000 psi, Q = 1.4 gpm, S/N 014847.

2.0 TEST EQUIPMENT

- *THERMOTRON F-94CHMV* environmental chamber, MII No. A14571

3.0 PROCEDURES

Three (3) sets of tests were performed, as follows:

1. Pressure Washing Resistance after overnight conditioning at ambient laboratory temperature.
2. Pressure washing resistance after overnight conditioning at 107°C (225°F).
3. Pressure washing resistance after overnight conditioning at -32°C (-25°F).

The high and low temperature conditioning was performed in a *THERMOTRON F-94CHMV* environmental chamber in which the three hub caps were conditioned after heat sensing label application. The internal chamber conditions (temperature and RH) were monitored at 5-minute intervals by means of the *THERMOTRON 7800* control system's data logger. The test set-up is shown in Appendix A, Figure 1A.

Prior to testing, the HUB ALERT™ heat sensing labels were manually applied to the hub / hub caps on surfaces pre-cleaned with a de-greaser and/or sandpaper, as required. The labels were applied as follows:

Steel Hub and Hub Cap

- 3 labels manually applied to the steel hub cap only (Exova sample no. 11-15-0165-1 to 3), prior to conditioning at ambient temperature (27°C, 81°F).
- 3 labels manually applied to the steel hub cap only (Exova sample no. 11-15-0165-10 to 12), prior to conditioning at high temperature (107°C, 225°F).
- 3 labels manually applied to the steel hub cap only (Exova sample no. 11-15-0165-19 to 21), prior to conditioning at low temperature (-32°C, -25°F).

Aluminum Hub Cap

- 2 labels manually applied to the side of the aluminum hub cap (Exova sample no. 11-15-0165-4 and 5) and 1 label manually applied to the end of the hub cap (Exova sample no. 11-15-0165-6), prior to conditioning at ambient temperature (27°C, 81°F).
- 2 labels manually applied to the side of the aluminum hub cap (Exova sample no. 11-15-0165-13 and 14) and 1 label manually applied to the end of the hub cap (Exova sample no. 11-15-C0165-15), prior to conditioning at high temperature (107°C, 225°F).
- 2 labels manually applied to the side of the aluminum hub cap (Exova sample no. 11-15-0165-22 and 23) and 1 label manually applied to the end of the hub cap (Exova sample no. 11-15-C0165-24), prior to conditioning at high temperature (107°C, 225°F).

Plastic Hub Cap

- 3 labels manually applied to the side of the plastic hub cap (Exova sample no. 11-15-0165-7 to 9), prior to conditioning at ambient temperature (27°C, 81°F).
- 3 labels manually applied to the side of the plastic hub cap (Exova sample no. 11-15-0165-16 to 18), prior to conditioning at high temperature (107°C, 225°F).
- 3 labels manually applied to the side of the aluminum hub cap (Exova sample no. 11-15-0165-25 to 27), prior to conditioning at high temperature (107°C, 225°F).

The pressure washer test procedure was as follows:

- 2000 psi pressure at a distance of 12 in. from the hub cap (from tip of spray nozzle).
- Cold tap water spray.
- Horizontal "pass-by" stroke spray.
- Labels subjected to constant water pressure for 3 seconds per stroke.
- Repeated for two additional "pass-by" strokes (total of 3 strokes).

The test-set up is shown in Appendix A, Figure 2A and Figure 3A.

4.0 RESULTS

The pressure washing resistance tests were performed on HUB ALERT™ heat sensing labels applied to aluminum, plastic and steel hub caps after conditioning at ambient temperature (27°C, 81°F), hot temperature (107°C, 225°F), and cold temperature (-32°C, -25°F). The hot and cold temperature conditioning was performed in a *THERMOTRON* chamber. A graph of the chamber conditions is provided in Appendix B, Figure 1B.

Regarding the pressure washing resistance tests performed after conditioning at ambient temperature (27°C, 81°F), none of the labels applied to the aluminum, plastic and steel hubs exhibited any visible loss of adhesion after the pressure spraying, nor any other visible signs of deterioration. This was documented with photographs taken before and after the pressure washing resistance tests, as follows (see Appendix A):

- Figure 4A - Hub Alert™ heat sensing labels applied to aluminum hub (before pressure washing);
- Figure 5A - Hub Alert™ heat sensing labels applied to plastic hub (before pressure washing);
- Figure 6A - Hub Alert™ heat sensing labels applied to steel hub (before pressure washing);
- Figure 7A - Hub Alert™ heat sensing labels applied to aluminum hub (after pressure washing);
- Figure 8A - Hub Alert™ heat sensing labels applied to plastic hub (after pressure washing);
- Figure 9A - Hub Alert™ heat sensing labels applied to steel hub (after pressure washing).

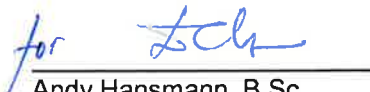
Regarding the pressure washing resistance tests performed after conditioning at hot temperature (107°C, 225°F), none of the labels applied to the aluminum, plastic and steel hubs exhibited any visible loss of adhesion after the pressure spraying, nor any other visible signs of deterioration. This was documented with photographs taken before and after the pressure spray test, as follows (see Appendix A):

- Figure 10A - Hub Alert™ heat sensing labels applied to aluminum hub (before pressure washing);
- Figure 11A - Hub Alert™ heat sensing labels applied to plastic hub (before pressure washing);
- Figure 12A - Hub Alert™ heat sensing labels applied to steel hub (before pressure washing);
- Figure 13A - Hub Alert™ heat sensing labels applied to aluminum hub (after pressure washing);
- Figure 14A - Hub Alert™ heat sensing labels applied to plastic hub (after pressure washing);
- Figure 15A - Hub Alert™ heat sensing labels applied to steel hub (after pressure washing).


Regarding the pressure washing resistance tests performed after conditioning at cold temperature (-32°C, -25°F), none of the labels applied to the aluminum, plastic, and steel hubs exhibited any visible loss of adhesion after the pressure spraying, nor any other visible signs of deterioration. This was documented with photographs taken before and after the pressure spray test, as follows (see Appendix A):

- Figure 16A - Hub Alert™ heat sensing labels applied to aluminum hub (before pressure washing);
- Figure 17A - Hub Alert™ heat sensing labels applied to plastic hub (before pressure washing);
- Figure 18A - Hub Alert™ heat sensing labels applied to steel hub (before pressure washing);
- Figure 19A - Hub Alert™ heat sensing labels applied to aluminum hub (after pressure washing);
- Figure 20A - Hub Alert™ heat sensing labels applied to plastic hub (after pressure washing);
- Figure 21A - Hub Alert™ heat sensing labels applied to steel hub (after pressure washing).

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Appendix A

Photographs
(11 Pages)

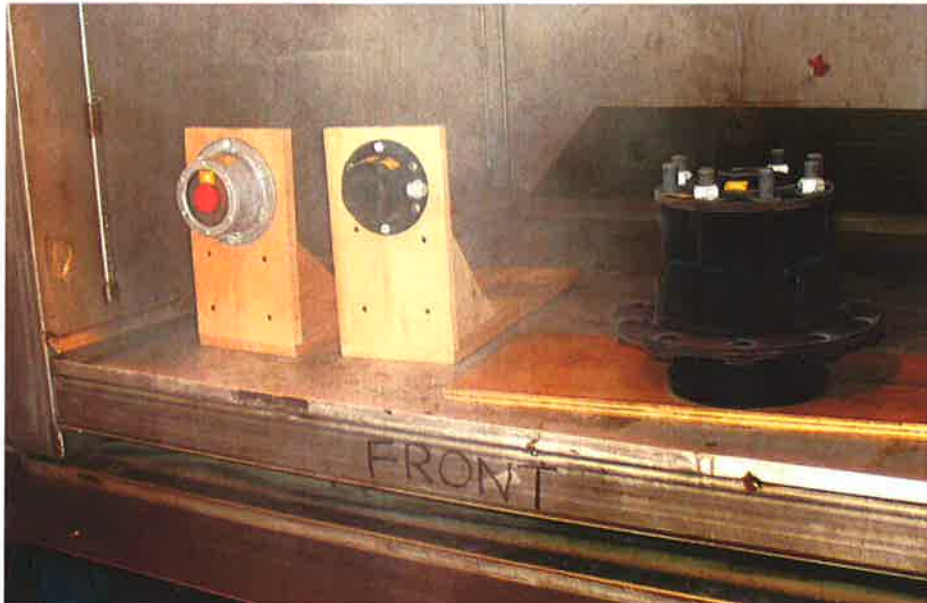


Figure 1A : Cold temperature conditioning at -32°C (-25°F).of the aluminum, plastic and steel hub caps /hub



Figure 2A : Pressure-washer resistance test set-up



Figure 3A : Pressure-washer resistance test set-up



Figure 4A : Aluminum hub cap with labels – Ambient temperature, before pressure spraying



Figure 5A : Plastic hub cap with labels – Ambient temperature, before pressure spraying



Figure 6A : Steel hub cap with labels – Ambient temperature, before pressure spraying



Figure 7A : Aluminum hub cap with labels – Ambient temperature, after pressure spraying



Figure 8A : Plastic hub cap with labels – Ambient temperature, after pressure spraying

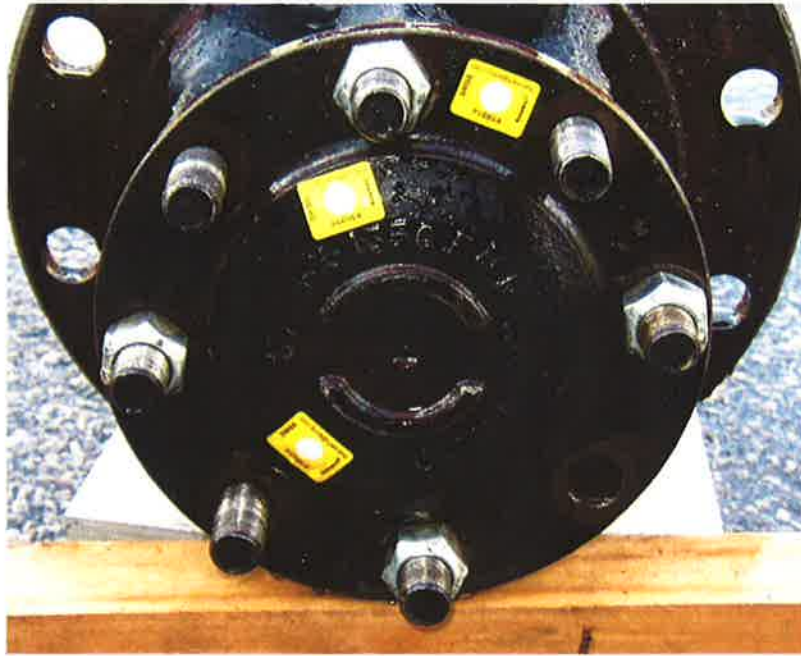


Figure 9A : Steel hub cap with labels – Ambient temperature, after pressure spraying



Figure 10A : Aluminum hub cap with labels – Hot temperature, before pressure spraying



Figure 11A : Plastic hub cap with labels – Hot temperature, before pressure spraying

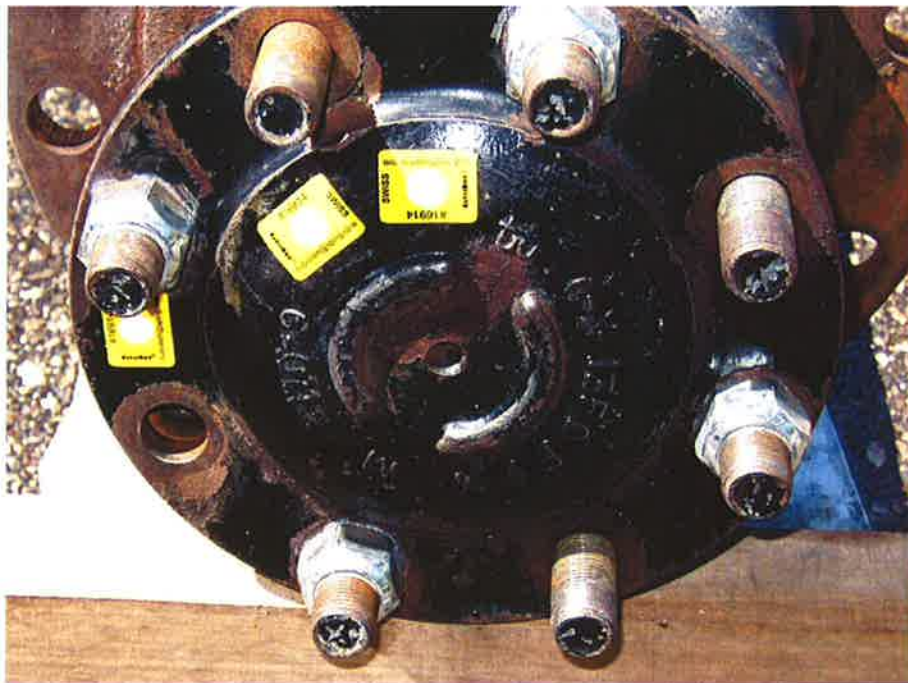


Figure 12A : Steel hub cap with labels – Hot temperature, before pressure spraying



Figure 13A : Aluminum hub cap with labels – Hot temperature, after pressure spraying



Figure 14A : Plastic hub cap with labels – Hot temperature, after pressure spraying

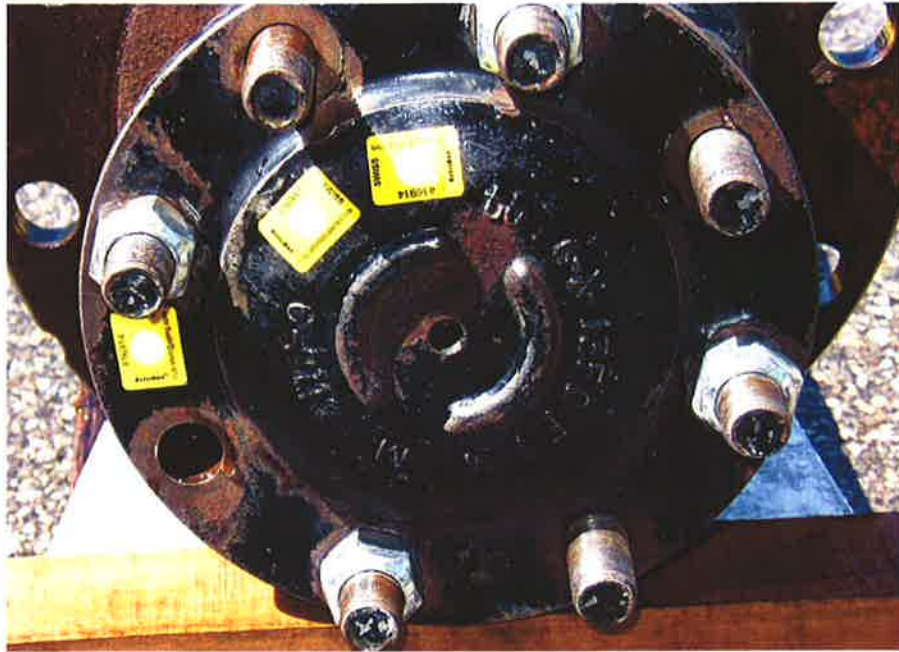


Figure 15A : Steel hub cap with labels – Hot temperature, after pressure spraying



Figure 16A : Aluminum hub cap with labels – Cold temperature, before pressure spraying



Figure 17A : Plastic hub cap with labels – Cold temperature, before pressure spraying

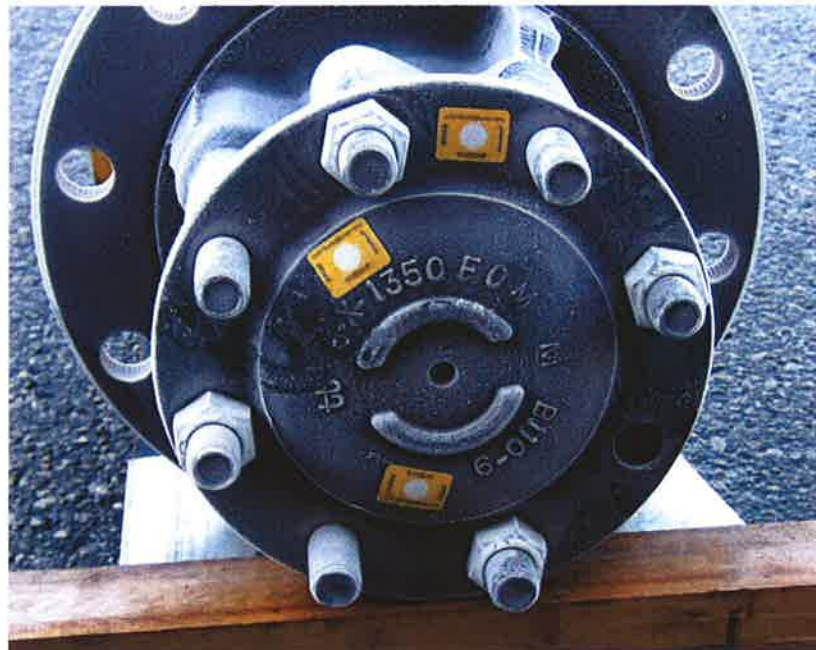


Figure 18A : Metal hub cap with labels – Cold temperature, before pressure spraying



Figure 19A : Aluminum hub cap with labels – Cold temperature, after pressure spraying



Figure 20A : Plastic hub cap with labels – Cold temperature, after pressure spraying

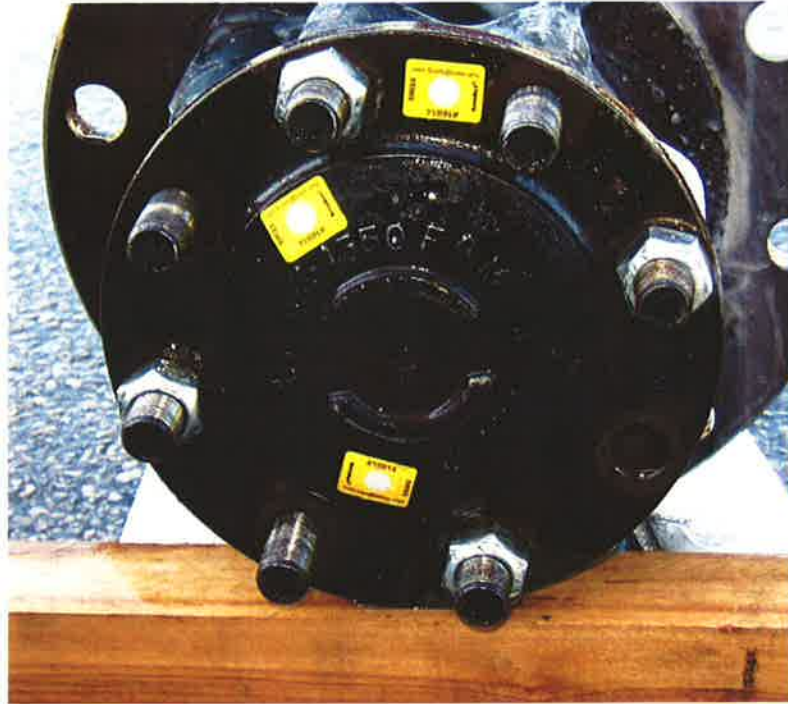


Figure 19A : Metal hub cap with labels – Cold temperature, after pressure spraying

Appendix B

Figure 1B

(1 Page)

Hub Cap Thermal Soaks (Internal Chamber Temperature)

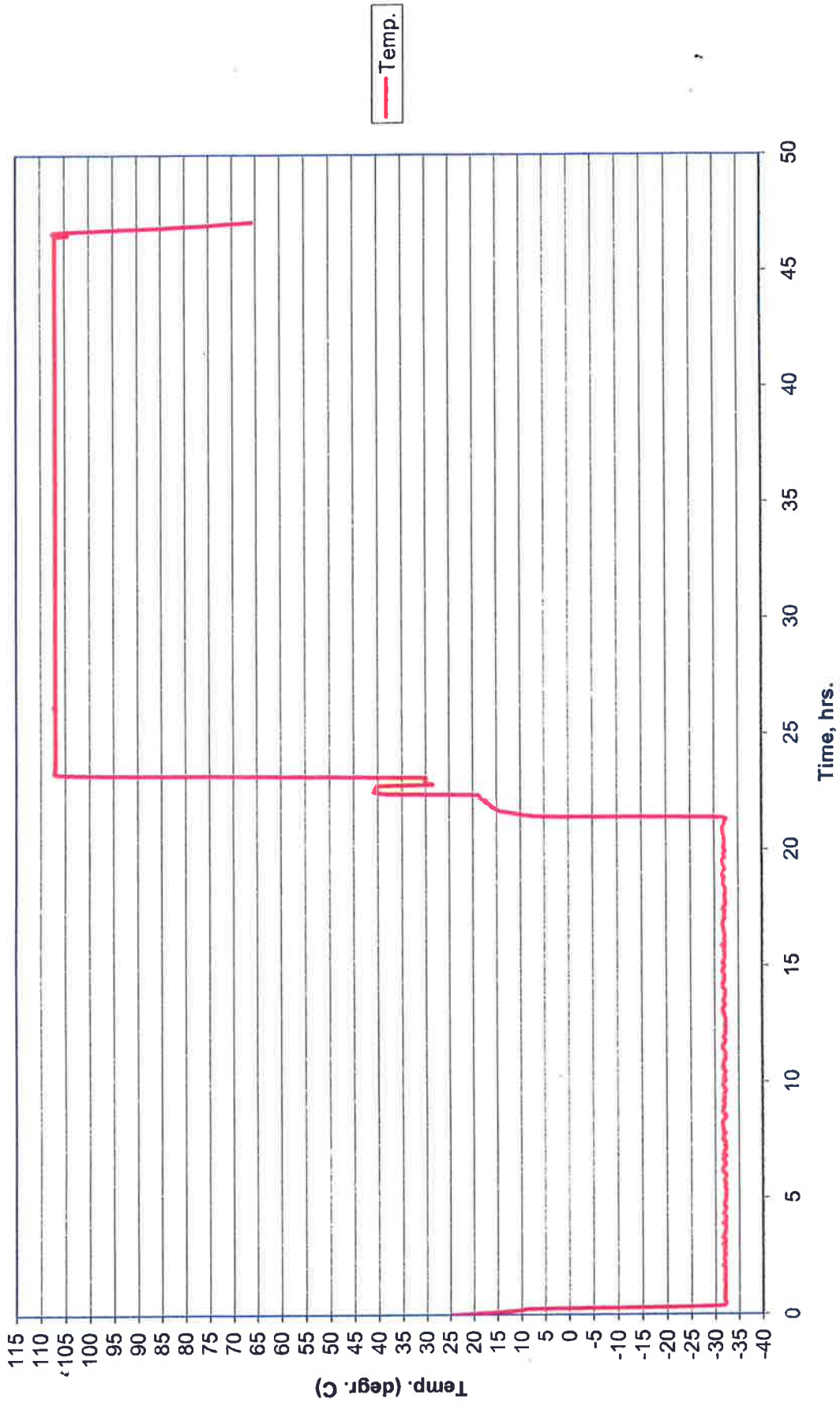


FIGURE 1B