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## Temperature and Vibration Testing on Zafety Lug Lock

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3 Pages, 2 Appendices

Proposal No.: 09-003-5651

Date: October 14, 2009

## 1.0 INTRODUCTION

TAFCAN Consulting Ltd. submitted one (1) wheel sample for combined temperature and vibration testing. The sample was identified as follows:

<u>EXOVA Sample No.</u>	<u>Description</u>
09-03-C0193-1	26" Hub Pilot Alloy Rim

## 2.0 TEST EQUIPMENT

- *THERMOTRON DS-6842* vibration table, A/N 20041-1
- *THERMOTRON F-32-CHV* thermal chamber, A/N 11464
- *m + p* vibration controller, MII No. A13871
- *PCB* accelerometer (control), MII No. B04867
- *KISTLER* power supply, MII No. B05501
- *OMEGA* digital thermometer, MII No. A04387

## 3.0 PROCEDURE

A TAFCAN representative was present to install the Safety Lug Locks onto the hand tightened lug nuts of the wheel prior to attachment to the vibration platform. All nuts were hand tightened. The position of the nuts was indicated by lines made with a permanent marker pen on the Safety Lug Locks.

The vibration at temperature tests were performed on a vertical motion *THERMOTRON DS-640* shaker table situated inside a *THERMOTRON* thermal chamber. The wheel was attached to the vibration platform with its vertical axis parallel to the vibration platform's thrust direction. Hence, the sample was vibrated in the vertical direction (Z axis), as shown in Appendix A, Figure 1A. One accelerometer which provided the control signal was attached to the vibration platform in thrust direction.

We were instructed to perform the vibration test as a sinusoidal vibration dwell at 30 Hz and 3 g acceleration amplitude at temperatures of 150°C and -40°C, employing a 60 minute dwell at each temperature. The internal chamber temperature was verified with an *OMEGA* digital thermometer.

## 4.0 RESULTS

The tests were performed on September 18, 2009, in the following sequence:

1. 26" Alloy Rim, vibration test at 150°C,
2. 26" Alloy Rim, vibration test at -40°C.

The position of the lug nuts was documented with photographs prior to testing, as well as after the vibration test at 150°C and the vibration test at -40°C.

Post-test visual inspections indicated the Zafety Lug Locks did not sustain any external damages or physical degradation. Photographic documentation is provided in Appendix A, as follows:

1. 26" Hub Pilot Alloy Rim, prior to vibration testing: Figure 1A and Figure 2A,
2. 26" Hub Pilot Alloy Rim, after vibration testing at 150°C: Figure 3A and Figure 4A,
3. 26" Hub Pilot Alloy Rim, after vibration testing at -40°C: Figure 5A and Figure 6A.

Based on the photographic documentation there was no evidence that any of the nuts had moved. However, some of the cap washers (located inside the nut) had moved due the effect of high temperature and vibration. A cap washer is shown in Appendix A, Figure 7A and Figure 8A.

Vibration controller generated plots for the vibration tests are provided in Appendix B, Figures 1B and 2B.

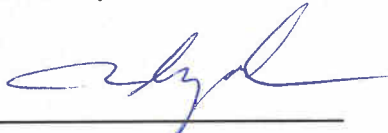
The sample was returned to TAFKAN Consulting Ltd. for further assessment.

Reported by:



Andy Hansmann, B.Sc.  
Scientist, Component Testing  
Product Testing Group

Reviewed by:



Steven Huynh, P.Eng.  
Project Manager, Component Testing  
Product Testing Group

**APPENDIX A**

**Photographs**

(4 pages)

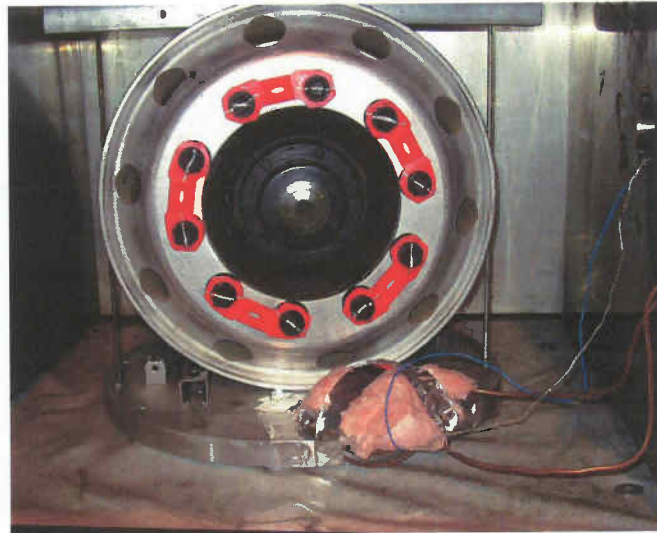


Figure 1A  
Vibration test set-up inside the *THERMOTRON* chamber (26 in. Hub Pilot Alloy Rim)

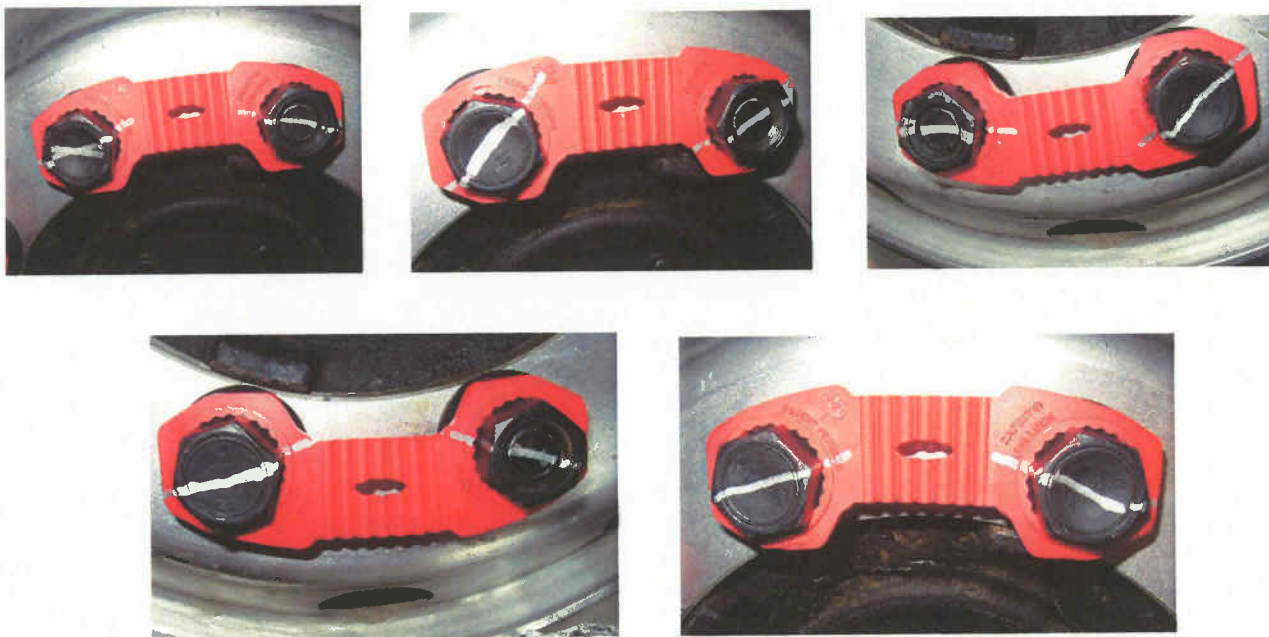


Figure 2A  
The various lug nuts and Zafety Lug Lock units, indicating the position of the lug nuts prior to testing

(Note: the photographs above indicate that the respective nuts did not move; however, some of the cap washers rotated due to vibration and high temperature.)

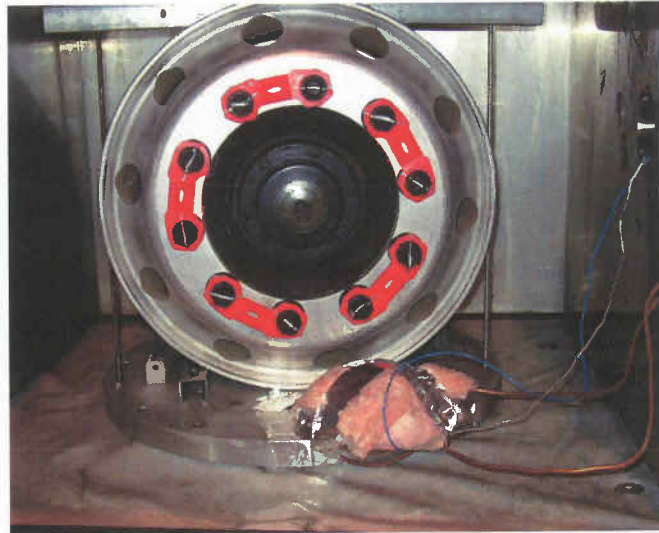


Figure 3A  
Vibration test set-up inside the *THERMOTRON* chamber (26 in. Hub Pilot Alloy Rim)



Figure 4A  
The various lug nuts and Safety Lug Lock units, indicating the position of the lug nuts after testing at 150°C

(Note: the photographs above indicate that the respective nuts did not move; however, some of the cap washers rotated due to vibration and high temperature.)



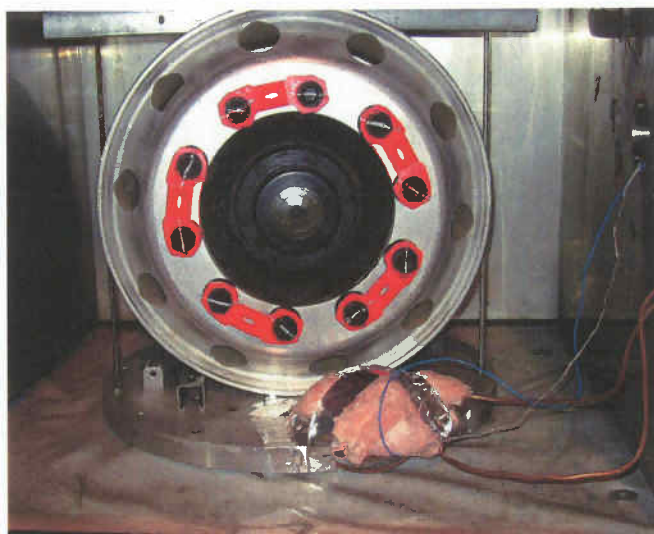


Figure 5A  
Vibration test set-up inside the *THERMOTRON* chamber (26 in. Hub Pilot Alloy Rim)

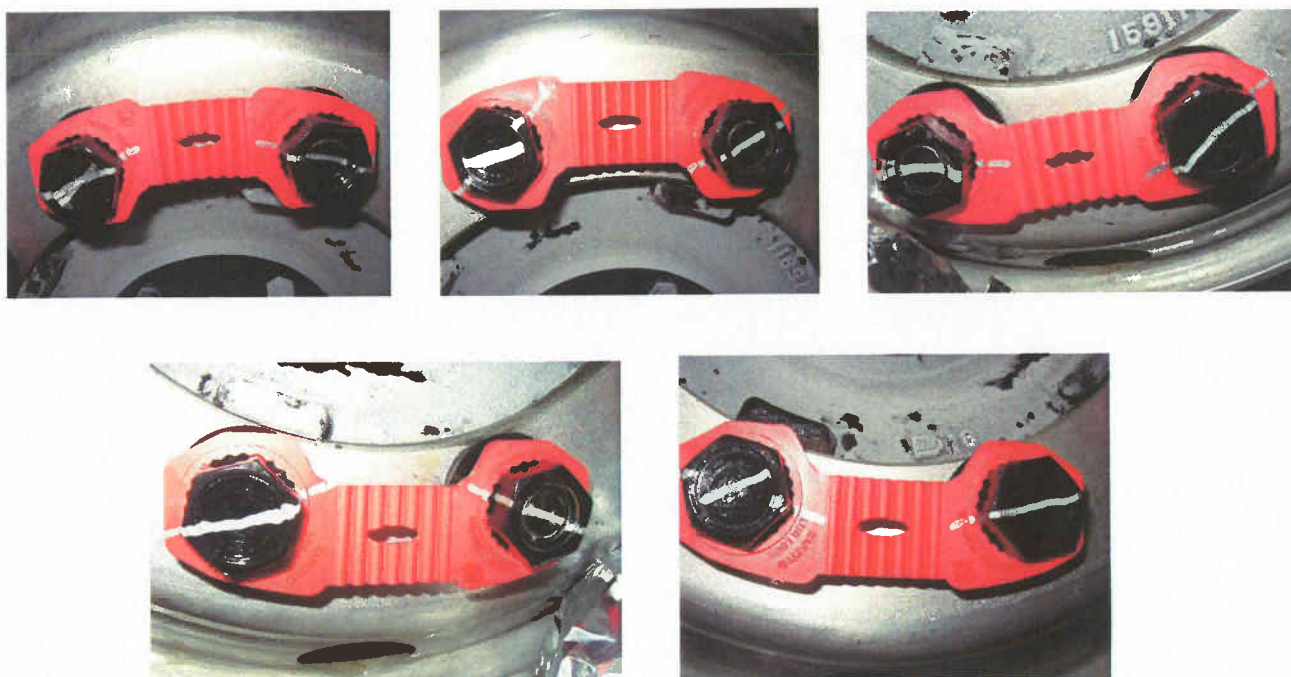


Figure 6A

The various lug nuts and Zafety Lug Lock units, indicating the position of the lug nuts after testing at  $-40^{\circ}\text{C}$

(Note: the photographs above indicate that the respective nuts did not move; however, some of the cap washers rotated due to vibration and high temperature.)



Figure 7A  
Wheel nut with installed cap washer

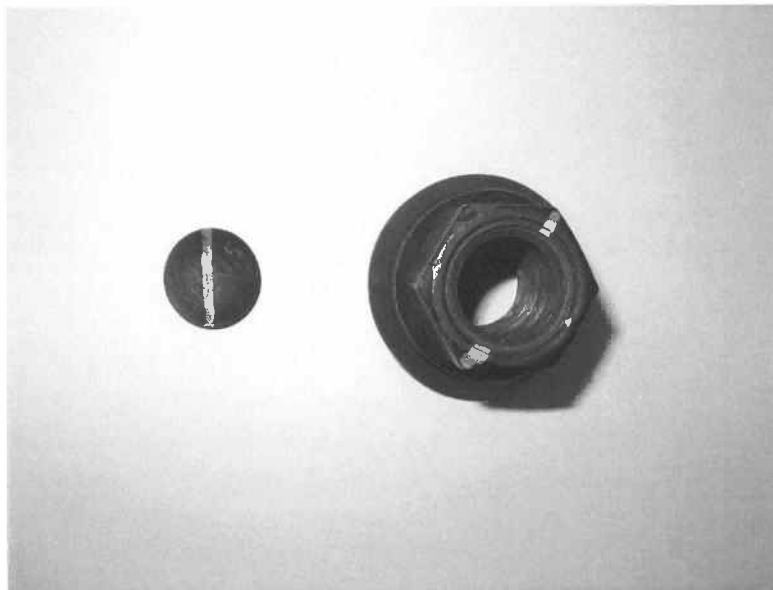


Figure 8A  
Wheel nut and cap washer

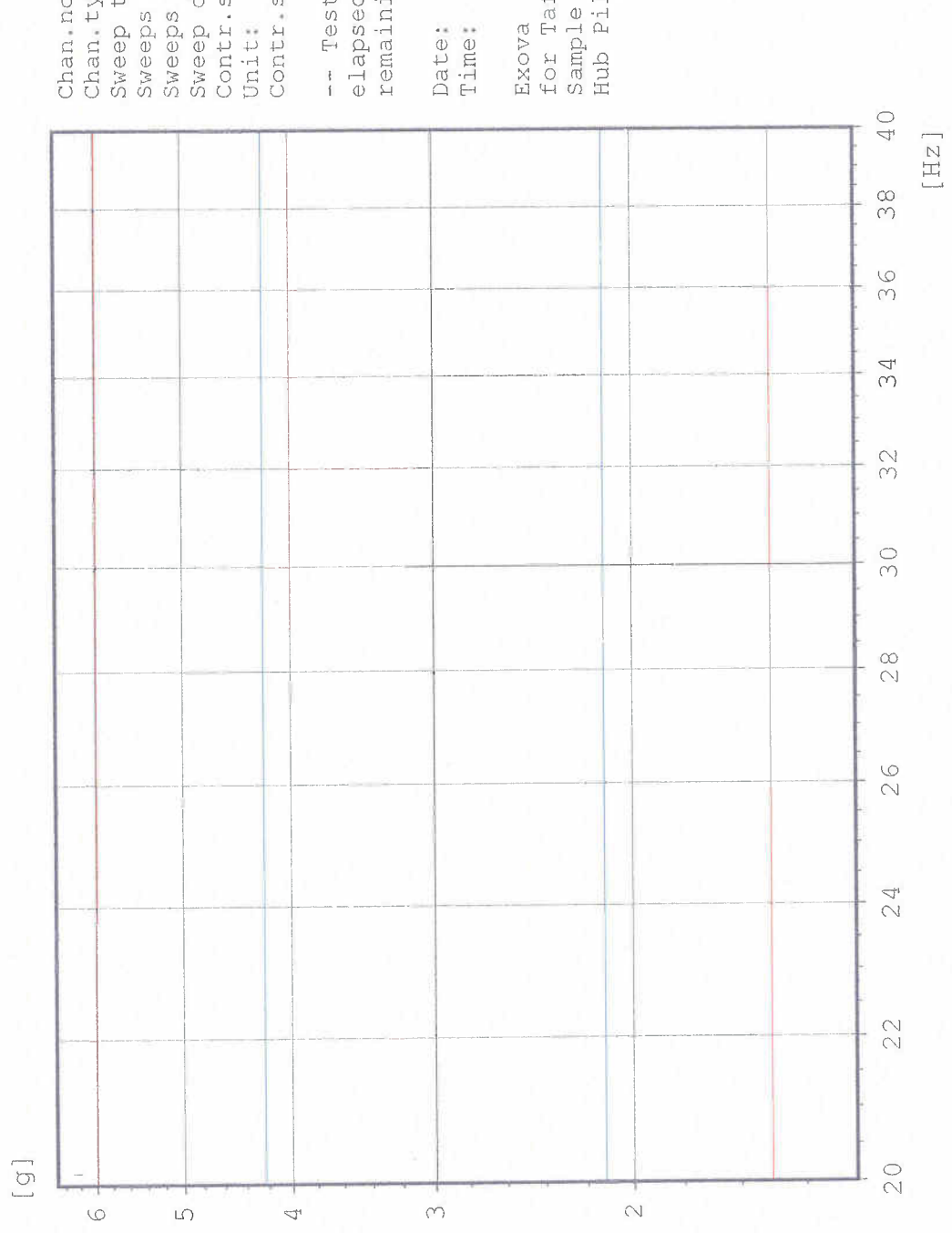


**APPENDIX B**

Figures 1B and 2B  
(2 pages)

# Control

Sine Dwell  
Vertical Direction  
1 Hr. 30 Hz & 3 g dwell at 150C



Chan.no: 1  
Chan.type: CW  
Sweep type: logarithmic  
Sweeps done: 1  
Sweeps req.: 1  
Sweep direct.:  
Contr.strat.: Average  
Unit: g  
Contr.strat.: Closed loop

-- Testing time --  
elapsed: 001:00:00  
remaining: 000:00:00

Date: 09-18-09  
Time: 12:20:20

Exova  
for Tafcan Consulting Ltd.  
Sample # 09-03-C0193-1  
Hub Pilot Alloy Rim

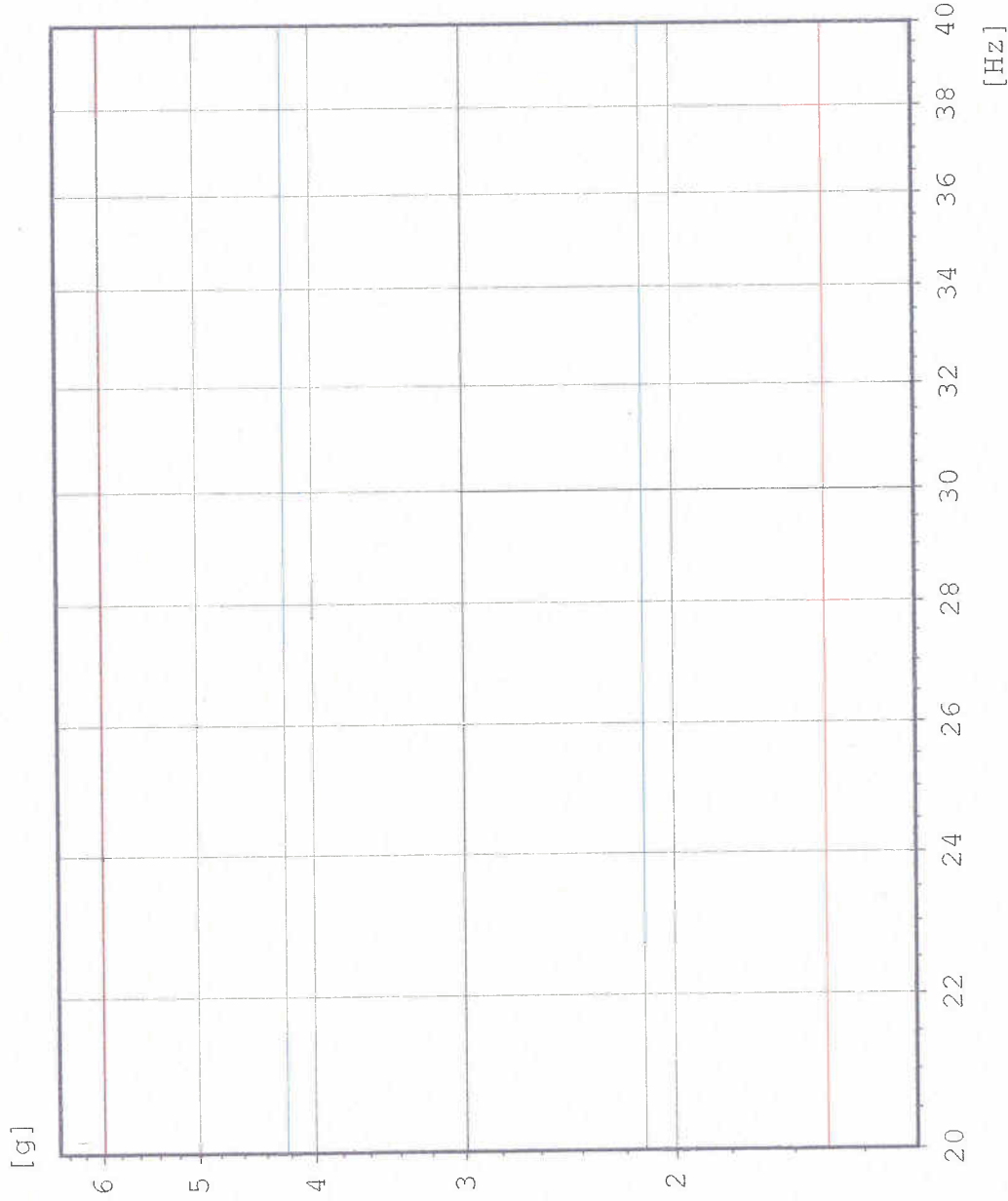
Figure 1B *[Signature]*

# Control

Sine Dwell

Vertical Direction

1 Hr. 30 Hz & 3 g dwell at 150C



Chan.no: 1  
Chan.type: CW  
Sweep type: logarithmic  
Sweeps done: 1  
Sweeps req.: 1  
Sweep direct.:  
Contr.strat.: Average  
Unit: g  
Contr.strat.: Closed loop

-- Testing time --  
elapsed: 001:00:00  
remaining: 000:00:00

Date: 09-18-09  
Time: 14:17:15

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for Tafcan Consulting Ltd.  
Sample # 09-03-C0193-1  
Hub Pilot Alloy Rim

*A. U.*

Figure 2B