Indicator Test Report
for SpotSee

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1.0 INTRODUCTION

SpotSee contracted MxV Rail to perform initial durability tests on a temperature indicating sticker (indicator strip) developed for application in the rail industry. This indicator strip will be affixed to the surface of a bearing cup or adapter to record and display the highest temperature experienced on that surface. Potential application of these indicator strips includes recording the bearing temperature to identify bearings alerted at wayside detectors. The durability testing performed by MxV Rail involved accelerated testing of environmental conditions similar to those seen in revenue service. The durability test lasted for 60 simulated days of extreme temperature situations at varying humidity levels.

2.0 TEST SETUP

MxV Rail chose a class F bearing cup and a class F bearing adapter for the indicator strip testing. Figure 1 shows an installed bearing assembly. Wayside bearing temperature detectors (i.e., hot box detectors) measure the bearing temperature on the cup surface.

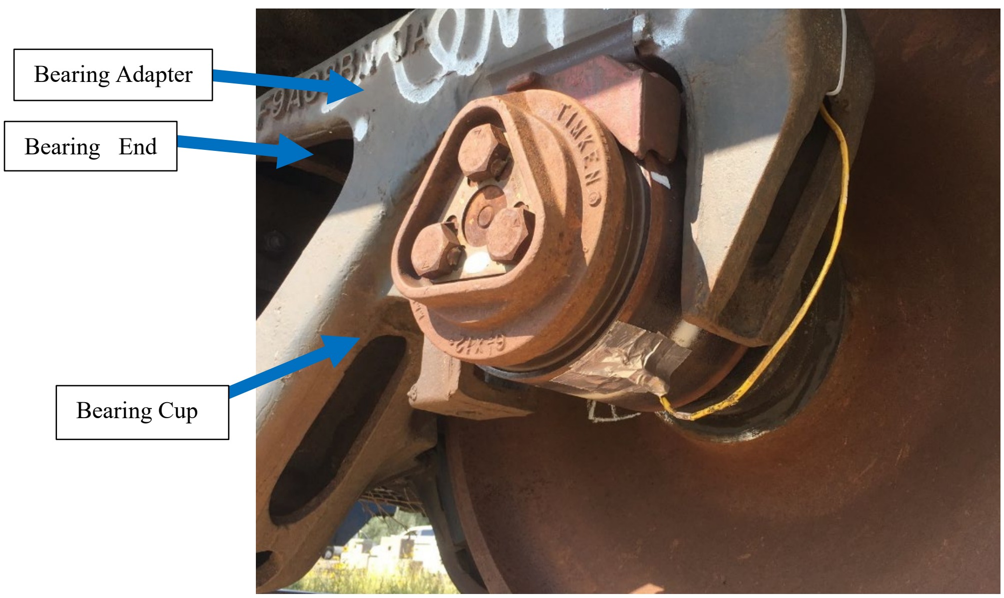

Figure 1. Installed bearing

The bearing adapter makes contact with the cup and, therefore, the adapter could have the same temperature as the bearing. At this stage in testing, it is important to ensure the indicator strips will adhere to and survive on any surface chosen for operations. One advantage of placing the indicator strip on the bearing adapter is that, because the adapter is stationary, the indicator strip will remain visible 1) during walk-by visual inspections or 2) to wayside detectors. Figure 2 shows the bearing adapter.

Figure 2. Bearing adapter

Thirty indicator strips were used during testing. Twenty indicator strips were placed on the bearing cup, and ten indicator strips were placed on the bearing adapter. These indicator strips were placed in the areas most likely to experience temperature variations during operations. The bearing cup and bearing adapter surfaces were cleaned with degreasing soap and dried before the indicator strips were applied. The indicator strips were placed against the surface of both the bearing cup and the bearing adapter and pressed in place by hand to ensure complete contact. Figures 3 and 4 show the indicator strip placements.

Figure 3. Bearing cup with indicator strips

Figure 4. Bearing adapter with indicator strips

The temperature values used during testing were chosen from the average low and average high temperatures seen around North American railroad tracks. These temperatures do not represent the absolute extreme temperatures seen on the continent (i.e., temperatures during which the railroad may not operate), but they could be typical in many areas of operation. For example, the average low temperature in January in Winnipeg, MB, Canada is 0°F.[1] The average high temperature in July in Jacksonville, Florida is 92°F.[2] This test is designed to determine the indicator strips' suitability for service, and it is dependent on the ability of the indicator strips to survive and function within this temperature range.

Relative humidity changes with the temperature. Warm air holds more moisture than cold air. When the temperature drops, the moisture settles out of the air and condenses onto the surfaces. Surface moisture will freeze at the lowest temperatures, and this moisture will thaw and evaporate as the temperature rises. A moderate relative humidity at a high temperature will cause the indicator strips on the surface to experience frost and potential degradation from the water freeze and thaw cycle.

MxV Rail used an environmental chamber during the durability tests (see Figure 5). The sealed chamber is temperature and humidity controlled. For the testing, the relative humidity in the chamber was set at a higher temperature (92°F).

Figure 5. Environmental chamber

3.0 TESTING

The environmental chamber ran for 60 hot and cold cycles. MxV Rail started each cycle with the bearing components at a temperature of 110°F and then dropped the temperature down to 0°F. The chamber held that temperature until the bearing components cooled to 0°F. Then, the chamber was reheated to 110°F and held at that temperature until the bearing components reached 110°F. The hot-to-cold-to-hot temperature duration is one cycle. This cycle simulates an extreme temperature fluctuation in revenue service, especially if the equipment is transported between different climates. This test simulated extreme environmental fluctuations for 60 cycles.

4.0 TEST RESULTS AND CONCLUSIONS

There was no noticeable change in the adhesiveness or readability of the indicator strips between the time the indicator strips were affixed and the time the 60-cycle test was concluded. There was no need to clean the indicator strips after the test (see Figures 6 and 7). All the indicator strips were removed from both the bearing cup and the adapter to be returned to SpotSee for further evaluation. Due to the adhesion of the indicator strip to the bearing cup and its smooth surface, a razor blade was needed to pry the indicator strip from the bearing cup. Due to the rougher surface of the adapter, the indicator strips were removed more easily from the adapter, and a razor was only needed to pry up a corner of the indicator strip before it could be pulled off.

Figure 6. Bearing adapter after 60 temperature cycles

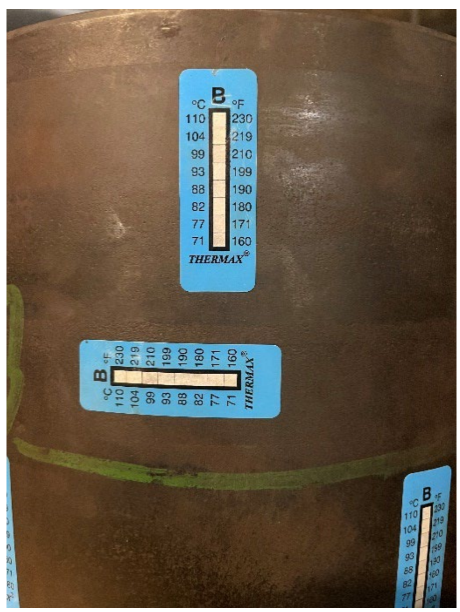

Figure 7. Bearing cup after 60 temperature cycles

Upon completion of the cyclic test, the environmental chamber was heated to 180°F. After the test bearing cup and adapter reached 180°F, the test was concluded, and the chamber was allowed to cool to the ambient temperature of the test facility before the test bearing cup and adapter were removed from the chamber and visually examined. The examination found that all the indicator strips were firmly attached to the steel parts, and the indicator strips could be clearly read. At the end of the high temperature test, the indicator strips on both the bearing cup and the adapter showed the peak temperature of 180°F (see Figures 8, 9, 10, 11, and 12).

Figure 8. Readability of bearing adapter after reaching 180°F (View 1)

Figure 9. Readability of bearing adapter after reaching 180°F (View 2)

Figure 10. Bearing cup after reaching 180°F (View 1)

Figure 11. Bearing cup after reaching 180°F (View 2)

Figure 12. Indicator after reaching 180°F

5.0 FUTURE TESTING

Future simulation testing could be conducted to determine the ability of these indicator strips to withstand even more extreme weather phenomena, e.g., the force required to remove the indicator strip from a surface. This force could be measured multiple times to indicate nominal force needed to remove the indicator strips and how that force changes after the environment changes. For instance, the pull-off force can be measured at low temperatures, high temperatures, or after water application. Simulating different wind conditions encountered in operations can also be addressed in such tests. Another simulated test that could be run is a direct water spray test. Water could be applied via nozzle onto the indicator strips to simulate rain, or even potentially flood events to determine the indicator strip's ability to handle sustained rain. A final test that could be conducted on these indicator strips is the effect of ultraviolet light fading on the indicator strip's face. Sustained ultraviolet exposure is possible if the indicator strips are in service for long periods of time. Lab testing of continuous ultraviolet exposure could be conducted to test the readability of the indicator strip after a certain period of exposure in the sun.

References

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