part 1: Inspection from the machine room

Service Bulletins are directed specifically to elevator field personnel and will deal with the hands-on issues normally faced by the group. Whereas our Technical Bulletin series addresses cause-and-effect issues related to elevator ropes, the Service Bulletins will discuss the mechanics, or how-to’s of wire rope usage.

The first Service Bulletin provides a guideline for investigating elevator problems believed to be wire rope related. Utilizing a common investigative procedure ensures the investigator (certified inspector, service mechanic, field sales representative) has covered all bases before leaving the job site. Following this outline may resolve many questions in the field. However, it should be noted that not all issues can be resolved quickly. In some cases the information gathered will be used by the wire rope manufacturer to aid in additional analysis.

Getting Started

Prior to beginning the inspection, conduct some preliminary groundwork. Documentation is very important for current and future traceability. Record:

- Job site and address
- Elevator car number(s)
- Number of floors serviced by the subject car(s)
- Type of hoist rope reeving, such as 2:1 Double Wrap
- Rope description, length and manufacturer’s reel number, if known
- Customer purchase order number
- Date of rope installation
- Groove configuration of primary and secondary sheave, if applicable
- Previous service problems or car history, if available
- Nature of problem, providing as much detail as possible, including seemingly insignificant items

Tools Needed for Inspection

WW recommends the following tools for rope inspection and investigation.

- Dial or digital gauge caliper for measuring rope diameter
- Lay paper (adding machine paper) and keel for lay length measurements
- Circumference tape to measure drum diameter
- Metal straightedge and feeler gauges for determining groove depth
- Level to check drum balance
- Chalk for performing a slippage test
- Magnet to determine metallic content of throw off
- Flashlight
- Groove gauges to check groove contours
- Torque wrench/pressure gauge
- Camera for documentation purposes

In the Machine Rooms

Record Machine Plate Information

Before inspecting the ropes, note and record the information on the machine plate—rope requirements, car weight, etc. This information is very important in the event the elevator OEM needs to be contacted for clarification.

Modernization

Has the car undergone a modernization? If so, when and to what extent? If the car weight has increased as a result of a mod job, compare its new weight with that recorded on the machine plate. An increase in car weight may cause rope slippage, particularly if the new weight requires a change in rope specification (construction or grade) that has not yet been addressed. In the event the car has become heavier, contact the elevator OEM to verify the correct rope specification for the new weight of the car.

Observe Ropes in Operation

From the machine room, observe the ropes in operation. When investigating a wear problem, ask that the car be taken to the lobby. Typically, the worst area of wear is visible at the drive sheave when the
Elevator Rope Investigation

Car is in the lobby. To help in locating this section of wear when on top of the car, mark the ropes with chalk in this area while still in the machine room. As a reminder, always make sure the the car is clear before touching the ropes or any part of the elevator system.

**Inspect the Drive Sheave**

Using the sheave groove gauges, place the respective gauge into the first groove. Obviously, this needs to be in an area where the rope is not seated. Begin with the groove closest to the machine, and record this groove as Rope Groove 1. Hold the flashlight behind the gauge. If light passes beneath the gauge, a tight sheave condition is indicated. Light shining on either side of the gauge signals an oversized groove. Standard sheave gauges work best for U-grooves, but with a little practice can also be used with undercut U and progressive grooves.

To measure for differential groove depths, place a metal straightedge across the ropes at the drive sheave. Make sure the straightedge is a length which will not hinder its ability to properly indicate groove depths. The straightedge should sit nearly on all of the ropes without teetering or wobbling. A seesaw movement may signify differential groove depths. To verify the findings, measure the amount of space or clearance between the ropes and straightedge using the feeler gauges. Record the findings and mark the sheave and rope where the readings were taken. Move the car to rotate the drive sheave to a new section and repeat the procedure. If the findings are consistent with the first measurement, differential groove depths are present. If the readings are different, run the car through a few cycles and return to the original area on the sheave where the first reading was taken. Make sure that a different section of rope is in groove area to be remeasured. Remember, this area was marked with chalk and should be easy to locate. Using the straightedge and feeler gauges, run through the procedure a third time. If the findings verify the first test, a differential groove depth condition exists. If, however, the results are different from the first two readings, this points to a wire rope diameter problem requiring the attention of the manufacturer’s engineering department.

Finally, place the level on top of the drive sheave to determine its horizontal alignment. Misaligned or skewed sheaves may cause unusual wear patterns, vibration and premature wire breakage. For more information on rope groove conditions, please refer to Bethlehem Elevator Rope Technical Bulletins 7, 9, 10, 11, and 12.

**Conduct a Slippage Test**

To determine slippage, place the car at the top or bottom of the shaft. Using the straightedge and chalk, draw a straight line across the ropes, and also mark both sides of the sheave. Run the car through two complete cycles and measure the distance between the lines on the rope and the lines on the drum. If operation the lines do not match as originally marked, the ropes are slipping. Record and report the findings. Refer to the Bethlehem Elevator Technical Bulletin no. Four: Elevator Rope Slippage for further discussion.

**Check for Proper D/d Ratios**

Using the circumference tape, measure the drum to determine the D/d ratio. Keep in mind that the minimum D/d ratio required, per code, is 40:1.

**Look for Signs of Throw-Off**

Check the floor around the drive sheave for throw-off. Also look in the less obvious places where a broom cannot reach. Placing a piece of lay paper over the magnet, run the magnet through the debris. A high metallic content, which will be picked up by the magnet, is indicative of a number of problems, including tight sheaves, improper tensioning, and differential groove depths.

After completing these steps, the inspection may be moved to the car top. These investigative techniques will be reviewed in Service Bulletin 2.

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part 2: Inspection from the car top
(Please SEE Service Bulletin 1 for the first half of the inspection procedure)

The most accurate rope measurements will occur from the car top. Because car tops are not designed for passenger travel the utmost care is required to ensure your safety. Be careful where you step. Work your way to the counterweight side of the car. Make sure that there is sufficient light (drop light or flashlight) to maneuver and to take measurements.

In taking measurements look for the area of the ropes that is showing the worst condition. If this area was marked in the machine room it may be easy to locate. If not move the car to the position that will allow you to observe this area. If all else fails you will have to observe the entire length of rope to find the worst area. Always check the area where the ropes are on the traction sheave with the car in the lobby. Many times this is the worst area.

When you find the worst area of wear/breakage, it is a wise idea to mark the wall (with chalk) for quicker inspection next time. You may want to draw a sketch or note the number of breaks and the date. Since wire breakage and diameter reduction are the most common reasons for rope retirement, make sure the readings are accurate. For wire breaks inspect all planes of the ropes. Oversized U-grooves may only have a single wear plane whereas undersized grooves may have a two plane wear pattern. Also note if valley breaks are visible. Be careful to distinguish a true valley break. In some cases the outer wire may have failed on the crown and through the normal bending may have had a secondary break in the valley. Generally the length of the remaining wire will determine where the primary break occurred. Keep in mind the applicable retirement criteria is based on the pattern and number of wire breaks observed in a lay length.

Rope diameters should be measured in two planes at 90%. By working to the same pattern as noted in the machine room, call out the diameter readings to someone recording the values. Apply enough gauge pressure to ensure that readings are accurate. By looking for wear patterns it may be desirable to ensure that the diameter readings are taken in the proper plane to illustrate this condition. If the rope is condemned due to excessive wire breaks and/or minimum diameter readings, your readings may be challenged. This is where the mark on the wall is critical. If the inspector marked the wall at the site of the wear/breaks, you should take your readings at this site. Too much documentation is never the problem, too little can be. Before leaving this area it would be advisable to check the lay length of the ropes. Tear off a section of lay paper (adding machine paper) approximately 24” in length for each rope. Start with rope number one by placing the paper over the crowns of the rope. Use your keel to mark the crowns of the rope and note the car number. Repeat for all the ropes. Because of working constraints it may be best to wait until you are out of the car hatch before you determine the actual lay lengths. Make sure you mark off at least 5 lay lengths on each rope. Measure the distance over the five lay lengths and multiply by 0.2 to determine the actual lay length. Record this information and note if the lay length of one or more ropes is considerably different than the other ropes. Extended lay readings may indicate loss of core support and corresponding diameter reduction readings or may also be caused by the ropes being “spun” out.

Not only is it important to determine if breakage is heavier to certain strands, but the pattern of breakage to the other ropes is also important. If one or two ropes are showing the prominent breakage, the ropes may not be equalized. If abrasion and wear are all to one side of the rope it may be a case of improper alignment. If the breakage is throughout, the problem may be related to groove problems, heavy loading, worn out rope, or rope quality. The best place to inspect the entire circumference of the rope is from the car top. Look for uneven wear between the ropes. Note which rope(s) appear to be worn more or less than the others. Wear patterns as confirmed by the groove differences (covered above) and inconsistent tensions (covered below) may be the answer. Generally the heavier the rope appears to be worn, the lower the rope tension since the ropes are sliding through the sheave groove. Another scenario may be that the tight rope may wear excessively for a while, seating itself deeper in the grooves, then it will be the loose one and start slipping.

Another area to check for diameter variations is where the ropes do not travel over a primary or secondary drive such as near the shackles. Since the shackles will not be in a perfect line you may need to verify which rope corresponds to rope #1, #2, etc. In addition, since these ropes cannot be turned very easily, you may only get one good diameter reading.

Now is an ideal time to document the information on the car frame head plate. This will usually indicate the car weight, and the number of required ropes with their minimum breaking strength. Determine how much counterweight is being used. Look for rope tags at the hitch plate and note accordingly.
Elevator Rope Investigation

Finally before leaving the car top, it is beneficial to record tension readings of the hoist ropes for the car being inspected. Theoretically, the rope tension should be the same anywhere within the system. However, the easiest location to measure rope tension on most elevator applications will be in the area halfway between the counterweight and the secondary sheaves. In actuality, any section of the rope in which the ropes can be easily handled will work fine. Most Wirerope service personnel are equipped with an Interface Product IP300 tensioning device. This simple gauge uses two points of contact six inches apart. There is a bubble inset in the gauge. The gauge is attached to the first rope and the device is attached to a torque wrench. By pushing down on the torque wrench, the tensioning device deflects the rope in the six inch length. Since the bubble is at a precise offset angle, a set tension can be determined when the bubble is level. At this point, the tension on the torque wrench is recorded. It is best to record tensions on all the ropes and then repeat the procedure. The intent is to record tensions within 10% of the two readings. By averaging out the two readings, each rope has a measured tension in foot-pounds. For the ropes to perform equally, they should be tensioned to within 10% of the highest to the lowest reading. As an example, a car with six ropes is measured using the prescribed technique. The following values (ft/lbs) are recorded procedure.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Rope #1</th>
<th>Rope #2</th>
<th>Rope #3</th>
<th>Rope #4</th>
<th>Rope #5</th>
<th>Rope #6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>72</td>
<td>69</td>
<td>75</td>
<td>77</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>2</td>
<td>74</td>
<td>73</td>
<td>75</td>
<td>73</td>
<td>68</td>
<td>81</td>
</tr>
<tr>
<td>Avg.</td>
<td>73</td>
<td>71</td>
<td>75</td>
<td>75</td>
<td>69</td>
<td>83</td>
</tr>
</tbody>
</table>

The values between the first and second readings were averaged out and were within 10%. However, of the six ropes recorded, the difference between the lowest reading (69) and highest reading (83) is more than 10%. In this case, it would appear that rope number six is taking a greater load than the other ropes. Over time, this could lead to uneven groove pressures along with shortening the service life of both the ropes and sheaves. At all times, care should be taken when measuring tensions. Position yourself in such a way that there is proper footing when you apply the pressure to the torque wrench. Never exceed the rated capacity of the torque wrench. It is best to pull down on the torque wrench rather than push up.

Wirerope Works, Inc. does not sell the tensioning device described above, however, tensioning devises are recommended for installing wire rope and for verifying tensions. If there is no tensioning device, rope tensions can be verified by the plucking method.

**Plucking Method:** Have someone with a watch with a second hand assist you in measuring tension. If you must rely on the harp method follow the procedure below. Push the first rope approximately 2" - 6" in a plane 90% to the other ropes (so as not to effect the readings). Release the rope and count the time it takes to have the ropes complete ten cycles. If done properly the rope will visibly make a defined wave. At the tenth wave stop the test and record the time. Dampen the first rope with your hand as much as possible. Do the second rope in a similar manner. Where a test rope is obviously interfered by an adjacent rope or if for any reason the test value is questioned, move on to the next rope and come back to the rope in question after the other ropes are checked. Trying to measure the tension to a rope several times in a row can create errors because of the interference from previous tests. Keep in mind that you are looking for obvious differences in readings, maybe 10% or more. The greater the time, the lower the tension. Use this data to confirm your other observations (rope diameter and/or wear patterns). Confirm that ropes are normally tensioned as part of the elevator service. Also note that you are measuring the rope frequency (length of wave) and not amplitude (depth of wave). Therefore the differences in the amount of displacement to the ropes is not an issue in case you displace one rope 3 inches and the next 6 inches. Try to stay consistent as much as possible. Obviously the longer the distance between the end points, the longer it will take to get a reading. For tall buildings you may only get five readings before you have to do the next rope.

If an elevator rope needs to be removed due to a potential quality issue and a claim or complaint is to be entered, most manufacturers request a representative sample of the rope in question. Usually 20' on either side of the problem area is sufficient to perform an analysis. In addition, a 20' section of the same rope away from the area of damage and a 20' section of the adjacent rope will help tremendously in the technical investigation. Use a tag and include any notes pertaining to the problem when you return the rope to the manufacturer.

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