Elevator Rope Investigation

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.

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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 half way 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 readings 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.

Trial	Rope #1	Rope #2	Rope #3	Rope #4	Rope #5	Rope #6
1	72	69	75	77	70	85
2	74	73	75	73	68	81
Avg.	**73**	**71**	**75**	**75**	**69**	**83**

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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