Carolina Conductor

Volume 5 Number 8 **Monthly Newsletter of the Carolina Railroad Heritage Association, Inc.** August 2018

Preserving the Past.
Active in the Present.
Planning for the Future.

Web Site: hubcityrrmuseum.org
Facebook: Carolina Railroad Heritage Association

Meeting Site:
Woodmen of the World Bldg.
721 East Poinsett Street
Greer, SC 29651-6404
Third Friday of the Month at 7:00 pm

Hub City Railroad Museum and SOU Rwy Caboose #X3115:
Spartanburg Amtrak Station
298 Magnolia Street
Spartanburg, SC 29301-2330
Wednesday 10-2 and Saturday 10-2

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Articles can be submitted anytime.

Republic Locomotive Works

Republic Locomotive Works began business in 1980 in Greenville, South Carolina, as a locomotive rebuilder. Since that time, Republic Locomotive Works has rebuilt virtually every type of locomotive from the smallest yard switchers to the largest road locomotives including industrial switchers, Class I switchers and road units, commuter locomotives, and branch line units. The company also offers field service and repairs, contract maintenance, consulting services, engineering studies, and operator training.

The manufacturing plant consists of approximately 30,000 square feet situated on 10 acres with six tracks under roof as well as outside storage tracks. The facilities include heavy overhead cranes, metal fabricating equipment, a machine shop, a modern paint booth, and offices.

Republic Locomotive, Greenville

Beginning in 1990, Republic Locomotive Works began building new locomotives as well, culminating in the RX500 an AC traction powered industrial switch engine.

The patented RX500 industrial locomotive is the first major redesign of the industrial locomotive since diesel replaced steam and is the only all new industrial locomotive built in North America. The RX500 uses an AC traction drive, like that in the modern GE and EMD road units. The greatly enhanced adhesion available with AC technology allows the RX500 to be lighter and more compact than the old DC switchers yet delivers the same tractive effort. The AC drive also eliminates all the old high maintenance DC equipment such as brushes, commutators, and switchgear. In addition, it makes dynamic braking available for the first time on a switcher which improves braking and virtually eliminates brake shoe wear. The system also incorporates wheel slip and wheel slide control along with advanced diagnostics and programmable top speed control.

In our locomotive application, the RX500 uses only one third the fuel of the old EMD switchers saving over

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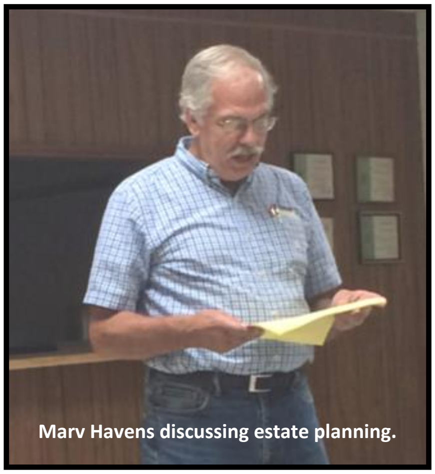
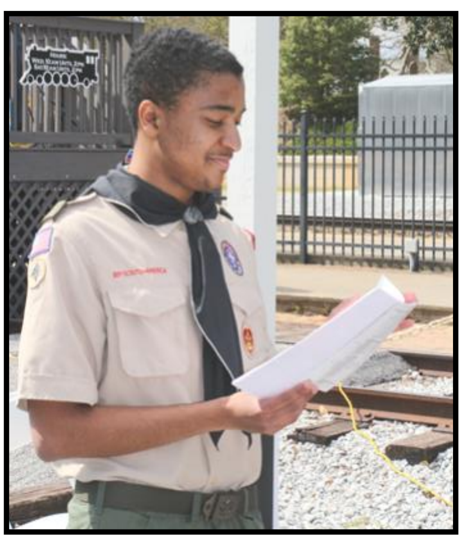
Presidential Ramblings

PRESIDENT'S MESSAGE

July Meeting

Our July meeting was held at the Woodmen of the World building in Greer on the 20h of July. Twenty two members and guests attended the meeting. Marv Havens gave a talk about the value of having our collections documented and also having a plan of what we want to happen to the collections after we are gone. The documentation can also be valuable if you need to document what you own to an insurance company, should you have a fire or other disaster that destroys your collection. This can pertain to books, magazines, model equipment and other collectables.


Marv Havens discussing estate planning.


Jesse Guillory dedication of historical marker.

We also showed the video taken by Duane Heard of the unveiling of the State Historic Marker at the Hub City RR Museum that took place on March 23rd. Our student member and Eagle Scout Jesse Guillory obtained the marker as his Boy Scout Eagle project.

August Meeting

Our August meeting will be held at the Woodmen of the World building on US 290 on August 17th at 7:00 pm. The program will be given by member Bill Legare covering several of his recent railroad excursions.

Calendar of Events

Mark your calendars for the following events:

August 16, 2018 – FDR Funeral Train program presented at the Taylor's Library, 7:00 pm
August 17, 2018 – Regular meeting at the WoW Lodge, Greer, 7:00 pm
August 25, 2018 – Train Show, Infinite Energy Center, Duluth, GA
August 25, 2018 – NMRA Summer Mini Tour of two layouts in Greenwood, plus the Greenwood RR Museum
September 10, 2018 – Board Meeting at Taylors Library, 6:30 pm
September 15, 2018 – Greer Rail Fest, City Park, Greer
September 21, 2018 – Regular meeting at the WoW Lodge, Greer
September 28-30, Day with Thomas, NC Trans Museum, Spencer, NC
October 5-7 – Day with Thomas, NC Trans Museum, Spencer, NC

Spartanburg Depot

The roof repairs to the Spartanburg Depot are completed, however, the City is having the exterior of the building painted. Please be aware of any contractors working when you visit. Park away from the building so that we do not interfere with the work. Thank You.

Field Trip to Saluda Depot Museum

We will be scheduling a field trip to visit the Saluda, NC Depot and museum in the near future. Please be on the lookout for information on this trip in future editions of the Carolina Conductor or other email messages sent out to members.

HO Model RR Cars in the Caboose

We have a number of used HO railroad freight cars that have been donated to the Chapter. Marv Havens has bagged the cars in clear bags and they are hung on the peg board display in the Caboose. These are very reasonably priced at $4.00 each. Cars typically have non-metal wheels and NMRA couplers. Remember - Christmas is only 5 months away!

eBay Sales

The Chapter has established an eBay account and we have listed several items on eBay. As of the writing of this message there have been at least 3 sales that have been completed. Thanks to Duane Heard for helping organizing and running

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Presidential Prolixity

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this project. To see the items that are for sale do an advanced search by seller for: **hubcityrr-46**.

Volunteers Needed

Volunteers are always needed at the Spartanburg Museum and Caboose on Wednesdays and Saturdays from 10:00 AM to 2:00 PM. Normally at least one Director will be there to open and close the facility, but members are needed to welcome guests, receive donations and handle sales of items. We will be creating a volunteer sign-up sheet to help us schedule our volunteers.

2018 has been a banner year so far. Our visitor numbers and revenue to date has eclipsed the total for 2017. Your help as a volunteer would ensure that every visitor leaves having an enjoyable visit. Please let me know at the email or phone number below if you have a day you would like to spend as a volunteer. Volunteering one day each month would help us out greatly. Thank you to those who have volunteered recently.

July Minutes

Approved June Board of Director's Minutes are attached to the email newsletter separately.

Thanks,
Dave Winans, President CRHA
864-963-4739
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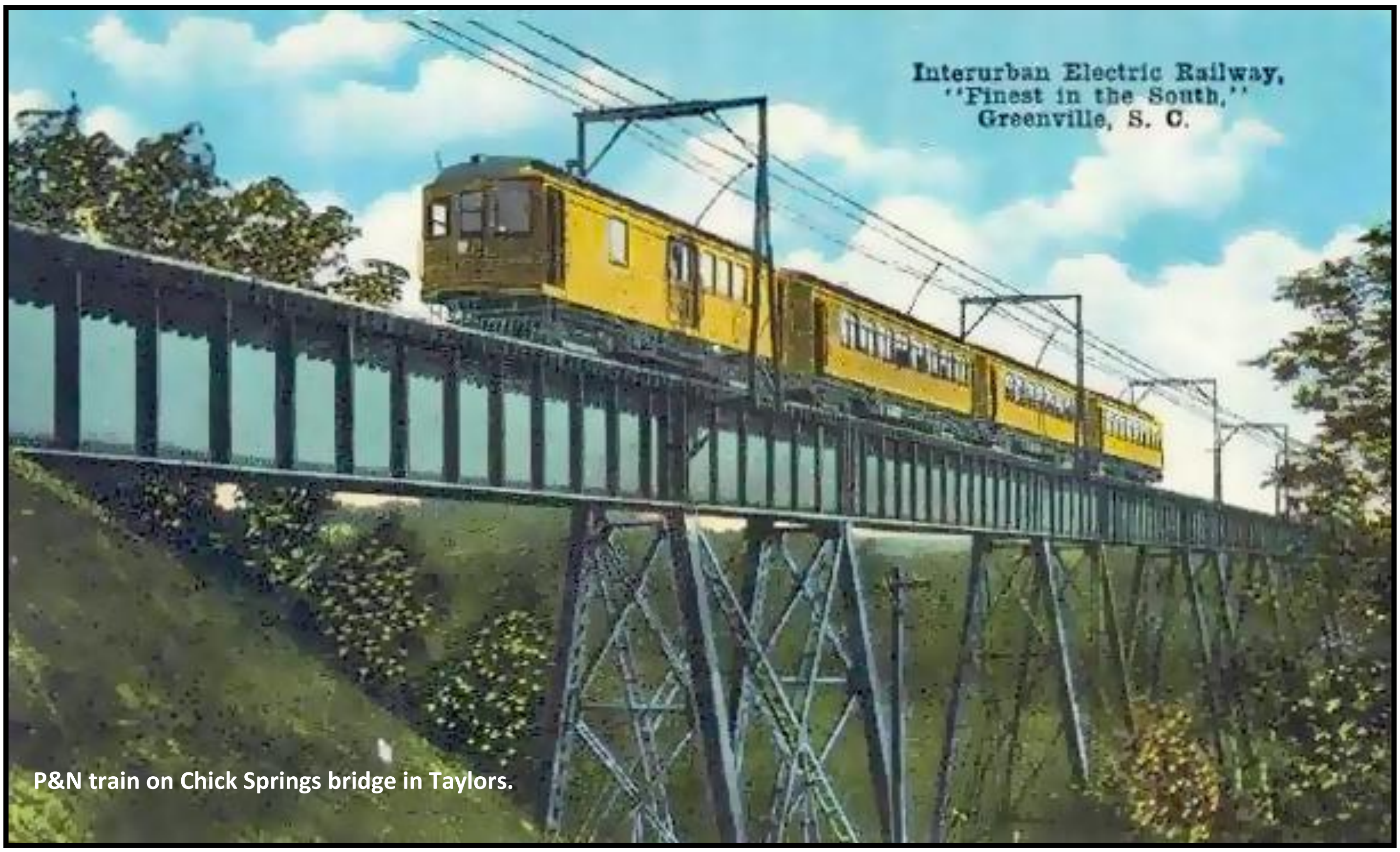

P&N train on Chick Springs bridge in Taylors.

Wanted—Articles for the Carolina Conductor

Submit an article of 200 words or more with some photos and captions and see them in print. Every one of us has some unique railroad experience that would make interesting reading for our membership. Your editor always needs more contributions of local railway history and news.

Arrivals

Republic Locomotive Works in Greenville, SC

Production run of new locomotives.

Re-trucking the GRLW Geep.


Republic Locomotive aerial view.


Inside the manufacturing facility of Republic .

CSX train passes Republic.

Departures

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Upper half of RX500 being delivered.

Lower half of RX500 being shipped.

1,000,000 gallons of fuel over the life of the locomotive. The RX500 typically ships over-the-highway on two lowboys. It arrives in a matter of days instead of the weeks or months when a locomotive is delivered by rail. Maintenance requirements are minimal on the RX500 consisting of lubricants and filters with no special tools required.

New vs Old Locomotives

We are frequently asked why you should invest a substantial amount of capital in a new RX500 locomotive as opposed to rebuilding an old unit or leasing one from a third party. Most of the old units were built in the 1950s or 1960s. A few were built in the 1970s and a handful are still running from the 1940s. Therefore, most of the older units are 50 or 60 years old. There have been great improvements since then.

Operating Costs - The RX500 typically uses about one-third the fuel of an equivalent old locomotive. This results in a fuel savings of 1,000,000 gallons over the life of the unit, which will justify the purchase price. The other big contributor is maintenance costs. A new locomotive, under warranty, can be expected to have far less costs than the older units, and can easily rival fuel costs in savings. In addition, new parts are readily available, unlike with the old locomotives.

Reliability - It is rare for the new RX500 to be out of service, unlike the older units. In fact, it is not unusual for one or two backup locomotives to be provided in a rental application to keep an old one running. On the other hand, the RX500 frequently operates without a backup.

Safety - Of paramount importance is the safety of the crew and plant operation. The RX500 has a stellar safety record thanks to improved visibility, better braking, fail-safe systems, event recording, video monitoring, and very quiet operation. Non-spark exhaust and traction motors eliminate fire risk and low voltage controls prevent electrical shock and arcing.

Emissions - The RX500 is the cleanest locomotive in operation. The Tier 3 or Tier 4 engine reduces emissions by more than 90% and greenhouse gases by two-thirds.

Ease of Operation - The RX500 is far simpler to operate than the old units. A simple joystick control makes for fast training and safe operation. In addition, maintenance consists primarily of lubricants and filters which are easily changed and readily accessible. Also, no special tools or skills are required either to maintain or to operate the unit.

AC vs DC Traction

The AC (alternating current) Drive, also known as Variable Frequency Drive, has been the standard in industry for many years. While it has been used in locomotives for over two decades (especially in Europe), it has only been recently that the price of the drives has allowed them to be used in most of the new diesel-electric locomotives in the United States. The AC drive works by converting the traction alternator output to DC (direct current) and reconverting it to a variable frequency AC which powers AC traction motors. Because AC motors operate at approximately the frequency of the current, the drives must adjust the frequency so that the motors can have a speed range of zero to maximum rpm.

AC traction for locomotives is a major improvement over the old DC systems. The primary advantages of AC traction are adhesion levels up to 100% greater than DC and much higher reliability and reduced maintenance requirements of AC traction motors.

The tractive effort of a locomotive (whether AC or DC) is defined by the equations: Tractive Effort = Weight on Drivers x Adhesion

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Adhesion = Coefficient of Friction x Locomotive Adhesion variable.

The friction coefficient between wheel and rail is usually in the range of .40 to .45 for relatively clean, dry rail in reasonable condition and is essentially the same for all locomotives. The locomotive adhesion variable represents the ability of the locomotive to convert the available friction into usable friction at the wheel rail interface. It varies dramatically from about .45 for old DC units to about .90 for modern AC units. This variable incorporates many factors including electrical design, control systems, truck type and wheel conditions.

First generation DC locomotives such as SW1200s, GP9s, SD40s, and GE center cabs typically have adhesion levels of 18% to 20%. More modern units with adhesion control such as SD60s and Dash 8s have adhesion levels of 25% to 27%. The newer AC traction units such as the SD80MAC and the C44AC are usually rated at 37% to 39% adhesion. Thus, the newer locomotives have about twice the adhesion of the older units and the Class I railroads are, in fact, typically replacing two older units with a single new AC unit.

There are three primary reasons that AC traction offers so much more adhesion. First, in a standard DC drive, if wheel slip occurs, there is a tendency for the traction motor to speed up and run away, even to the point of mechanical failure if the load is not quickly reduced. As the wheel slippage increases, the coefficient of friction also drops rapidly to a level of 0.10 or less, and because all the motors are connected, the load to the entire locomotive must be reduced. Therefore, maximum adhesion is obtained by operating at a level with a comfortable margin of safety below the theoretical maximum. More modern DC systems incorporate a wheel slip control which senses the beginning of a slip and automatically modulates the power to retain control. This allows the locomotive to operate safely at a point closer to its theoretical maximum.

The AC system, however, operates in a very different fashion. The variable frequency drive creates a rotating magnetic field which spins about 1% faster than the motor is turning. Since the rotor cannot exceed the field speed, any wheel slip is minimal (less than 1%) and is quickly detected by the drive which instantly reduces load to the axle.

Next, the DC locomotive typically has several throttle settings with a set power level for each one. While this system is simple and effective, it does not produce a constant motor torque since power is the product of torque and speed. Therefore, the tractive effort varies significantly for each throttle setting depending on speed, making it impossible to obtain maximum adhesion.

The AC locomotive, however, can control to a specific motor torque level allowing the tractive effort to be essentially constant at the higher range of available adhesion. This fast-acting wheel slip control can counteract any wheel slip so that the torque level can be set close to the upper limits.

The third way that AC traction provides improved adhesion is through weight transfer compensation. When a locomotive is pulling a load, weight tends to transfer from the front axle to the rear axle of each truck. At maximum tractive effort, the weight on the lead axle may be reduced by about 20%. Since the tractive effort is proportional to the weight on drivers, then in a DC system where the motors are fed from a common source, the tractive effort will be determined by the lightest axle. Thus, in effect, the equivalent locomotive weight is reduced by about 20%. With an AC system, however, the drive can compensate for the weight transfer. When the lead axle goes light, the AC drive system will reduce power to that axle and apply more power to the rear axle without incurring wheelspin.

The combination of eliminating wheel slip and compensating for weight transfer gives the AC traction system an adhesion of 37% to 39% versus the 18% to 20% of the older DC systems. Therefore, a locomotive with AC traction can provide the same tractive effort as a DC locomotive weighing twice as much or can give twice as much tractive effort for the same weight.

GE and EMD added AC traction to their mainline units and were then able to replace two older DC units with one new AC locomotive. Republic locomotive took a different approach and decided to make a lighter, less costly unit for industrial switching. The DC powered SW9/SW1200, produced in large quanti-

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Rare Mileage

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ties from 1951 to 1965 and used for heavy yard switching as well as branch line service, was taken as the performance standard. At 230,000 to 240,000 pounds these units are typically rated at about 40,000 pounds tractive effort continuous (somewhat higher intermittent but limited by traction motors and generators). The AC traction RX500 at 144,000 pounds and a conservative 35% adhesion level is rated at 50,400 pounds tractive effort continuous.

With AC traction, it is also important to consider braking. As with traction, braking is a function of weight on drivers. Therefore, when using standard friction braking (tread brakes) the braking capability of the locomotive (excluding train braking) is proportional to the locomotive weight. With AC traction, however, the braking can be much higher because the drive system in braking acts just like the drive does in traction thus eliminating wheel slip. The drive converts the motors to generating mode (dynamic braking) and the electricity produced is dissipated in the braking resistors. Thus, the motors are slowing the locomotive without using the air brakes. Again, the adhesion levels are much higher, so the locomotive can again be significantly lighter for the same amount of braking. The dynamic braking in AC traction locomotives also allows full braking down to zero speed, unlike DC dynamic braking.

All in all, the AC traction locomotive offers about twice the amount of adhesion as a DC unit. Therefore, a modern lightweight AC locomotive such as the RX500 can provide as much or more tractive effort than an old-style DC unit like the SW1200 which weighs 60% more.

Tractive Effort Calculations

The tractive effort required to move a train consists of numerous factors, but for most applications only four need to be considered. First, a force of 2 to 5 pounds per ton of train weight is required to move on straight level track. At very slow yard speeds only 2 to 3 pounds is needed while increasing to about 5 pounds at higher speeds. This force is required to overcome bearing friction, rail deflection, minor flange contact, etc. Years ago, the initial starting requirements were much higher when cars had friction bearings. Today, with all roller bearing journals, this is not much of a consideration. At speeds above 30 to 40 miles per hour, air resistance becomes significant but since this depends on the aerodynamics of specific trains, it is not addressed here.

The second factor to consider is track curvature. Cars in a curve require a good deal of tractive effort because the wheels are mounted on solid axles. Thus, the wheels must slip and slide through the curve because of the difference in radius of the inside and outside rails. Wheel flange contact adds additional friction.

For the cars in the curve, the tractive effort required is 0.8 pounds per ton per degree of curvature, where curvature is defined as the number of degrees the track curves per 100 feet. Degree of curvature can be calculated if the curve radius is known by dividing 5730 feet by the radius. For instance, track with a 573-foot radius would have 10° of curvature. Curvature can also be directly measured by the following method: Stretch a cord or tape tight across two points on the rail which are 62 feet apart. Measure the distance from the midpoint of the cord to the rail. This distance in inches is equal to the degrees of curvature.

Good engineering practice limits maximum curvature to about 12°. However, curvature may exceed 20° in an industrial yard with limited real estate, but excessive wheel and rail wear will likely result.

The percent of grade is perhaps the most important factor governing tractive effort. For every ton of train weight in a grade, 20 pounds of tractive effort is needed for each 1% of slope. (One percent of a ton or 2000 pounds equals 20 pounds.) A 1% grade is defined as a vertical increase of one foot for each 100 feet of horizontal distance. A 1% grade is considered steep; a 2% grade is unusually steep.

The final factor and one frequently overlooked is the tractive effort required for acceleration of the train. It takes about 10 pounds per ton to accelerate to a speed of 6 miles per hour in one minute or 12 miles per hour in two minutes, a reasonable rate for a heavy train. Increasing this tractive effort increases the acceleration rate proportionately.

The total tractive effort required for a train is the sum of these four components. The individual components will vary for any point on a rail system depending on the load in a

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Marker Lights

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curve or on a grade and whether acceleration is required at that point.

Power Calculations

The Power required to move a train is defined by a simple formula: P=TS/375. Where P is power in horsepower at the rails, T is tractive effort in pounds and S is speed in miles per hour. The engine horsepower at the flywheel is reduced by the auxiliaries such as air compressor, cooling fan, charging alternator, traction generator and motor losses, drive losses, and gearing losses. The net effect of these losses is to reduce power to the rail by 20% to 30%. About 80% of the rated engine power is available at the rail for a modern AC traction locomotive versus about 70% for the older DC units.

Most yard switching applications seldom exceed about 30,000 pounds of tractive effort and speeds of 5 to 7 miles per hour. Therefore, the industrial locomotive will perform well with 500 to 600 horsepower. A short line railroad or branch line with the same tractive effort requirements might require up to 2000 horsepower to move the train because of the higher speeds involved. Main line locomotives may need over 4000 horsepower each with multiple units because of both high tractive effort and higher speeds.

Performance Audit

The following is an audit prepared by one of our customers: "During 2010 we purchased 3 new technology locomotives from Republic Locomotive. In the report included in the note 'Vendor Evaluation Project', we listed the expected savings/performance expectations for the proposed locomotives. With this analysis we evaluate the actual performances of the new locomotives to verify if the expectations have been achieved."

Results

Fuel Cost Savings, the assessment is focused on the diesel volumes consumed in gallons.

Considering the monthly average diesel consumption, the average monthly diesel consumption moved from 8,198 gallons per month to 2,204 gallons per month with the new locomotives. This corresponds to a 73.1% savings which is even more than what was declared in the Republic Locomotive datasheet provided (1/3rd the consumption when compared to the SW1200 model). On a yearly basis this corresponds to 72,000 gallons of diesel fuel saved and thus an estimate of $200,000 per year savings in our fixed costs (diesel price used was $2.75 per gallon.

Other Savings

The new locomotives' oil consumption is negligible when compared to the older models, our maintenance department refills about 1 gallon per month per unit, when previously we consumed up to 55 gallons per week at an additional $30,000 per year savings. As well, no brake shoes have been replaced so far, as predicted.

Conclusions

"The expected cost savings estimation has been achieved. We can confirm that the total savings in our books sum up to $431,000 per year; $200,000 diesel fuel plus $200,000 rental fees plus $30,000 lubrication oil and plus $1,000 brake shoes. It is nice to note that this comes with a better level of service of the equipment, more availability, less internal maintenance activities, higher safety and no environmental issue exposure."

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