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NEW MEXICO STEAM LOCOMOTIVE AND RAILROAD HISTORICAL SOCIETY

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OCTOBER OPEN HOUSE

The Open House, From 9am to 4pm Saturday October 18 Will Feature A Shiny Centerpiece

Once again, the NMSL&RHS will have an October Open House at the 2926 restoration site. This year, the site tour, complete with entertainment, hot dogs and soft drinks will have an attractive new centerpiece—the fully restored 2926 water/fuel tender.

Among the largest tenders ever built, the 2926 tender now has a shiny new coat of Dupont Imron paint. Santa Fe lettering and numbers will be added well before the Open House.

The tender before removal from Coronado Park: It experienced abuse from natural elements and vandalism, but New Mexico's high, dry climate saved it from more severe deterioration. Come to the October 18 Open House and see what it looks like now.

The restored tender represents many hours of hard labor by Society members. First, it was completely disassembled. The 19 ton wheel trucks were placed on panel track. The 11 ton fuel bunker and 24,500 gallon water tank were placed on cribbing.

The separate components were thoroughly cleaned of caked grease, rust, dirt, and trash. About 3000 pounds of calcium was scraped from inside the water tank. Fifty year-old oil was dug out of the fuel tank. Once cleaned, all parts were either reconditioned or replaced.

Work by members is impressive, but all of that work could not have been done without the support of many organizations and individual rail fans. For instance, lifting heavy components required large cranes. Many other tasks required special equipment and/or materials.

The support included cash contributions, donated services, and donations of specialized tools and equipment. Support came from local, state, national, and even international sources.

See list of contributors on page six.

HOW POWERFUL IS IT?

In the 21st Century, with only a few large superpower steam locomotives operating, the most frequent questions asked about the huge machines are: "How fast will it run?", and "How powerful is it?"

That is certainly the case when visitors see 2926 up close for the first time.

Speed can be easily measured. Power is an entirely different and complex issue. The complexity derives from the fact that steam locomotive power can be determined in several ways, under different conditions, and by either measurement or calculation.

In this article, NMSL&RHS Board Secretary, Steve Bradford steps up to try to clarify an issue that has seen wildly differing published power ratings for a number of locomotives, including 2926. ——Editor

There are a number of methods for comparing steam locomotive performance. They include drawbar pull, boiler horsepower, indicated (cylinder) horsepower, drawbar horsepower, and rated tractive force (RTF). Also called tractive effort (TE), RTF is the only one that is commonly available for almost all steam locomotives.

Drawbar pull and horsepower data is difficult or impossible to find for the majority of engines, even though it is the most useful measure of power. It measures power at speed available at the tender drawbar to pull a train.

RTF is the one point of comparison not affected by all the variables affecting horsepower measurements and calculations. It is also the one for which data is available for most locomotives Because one can easily compare different locomotives on the basis of rated (starting) tractive effort, it has been a popular and convenient method for comparing the starting power of locomotives for over a hundred years.

RTF is a calculated figure as opposed to a measured figure. And it is relatively easy to calculate if locomotive dimension data is available. However it is a theoretical figure and does not reflect real measured performance data. It was not unheard of for some engines to develop actual drawbar pull measurements when starting, that were greater than their RTF (Santa fe 2-10-4s, for instance). RTF is the force (in pounds) at the driving wheel rim exerted by a locomotive when it starts. With steam this was usually considered to be derived from a complete revolution of the driving wheel, in other words for a full, complete piston stroke. Tractive force is not drawbar pull. Drawbar pull is a measurement usually taken at the tender drawbar.

Shown in Figure 1 is the tractive force formula in the 1939 version of the Locomotive Data handbook (11th edition) published by Baldwin Locomotive Works. It describes rated tractive force as being developed at starting speeds when: ***"A locomotive will develop the rated tractive force, which is calculated from the dimensions of the engine. Rating of a two-***

Figure 1: Locomotive Data

$$T = \frac{0.85 \; P \; X \; C^2 \; X \; S}{D}$$

Where:
T= the rated tractive force in pounds.
C= diameter of cylinders in inches.
S= stroke in inches.
D= driving wheel diameter in inches.
P= boiler pressure in pounds per square inch
.85= MEP at starting with full cut-off

For limited cutoff, modify the MEP to suit cut-off.

When more than two simple cylinders are used, multiply T by $\frac{N}{2}$, where N equals the number of cylinders employed.

Approximately 25% of the adhesive weight can be utilized as tractive force.

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FLUE TUBE REMOVAL

Once Again, A Local Business Gives The 2926 Restoration A Big Boost

NMSL&RHS members take pride in their collective skills and abilities, but sometimes need help. That was the case with flue tube removal.

There are more than 250 flue tubes into which the superheater pipes are inserted. Each tube is over 20 feet long, and is held in place by front and rear tube sheets. (*See generic boiler on Pg. 6 for details..)*

Tubes are welded in place at the rear tube sheet, and swaged at the smokebox end to allow for expansion and contraction.

Since pulling the superheater pipes, there has been much head scratching about tube removal. A key question among the members was: "Can we do it ourselves?

At that point, a local business owner stepped up to help. He was Charles Williams, owner of Chardans Mechanical, Inc. His company has specialized in industrial boiler work for more than 25 years.

Williams offered the services of his boiler specialists to teach a collection of volunteer workers to remove the flue tubes.

Standing in the smokebox next to the front tube sheet, a Chardans Mechanical boiler specialist begins tube removal instruction. The tubes are swaged or crimped at this end. Each tube must be collapsed at this end, cut free at the rear tube sheet, and pulled out through the smokebox.

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cylinder simple locomotive arranged with conventional long cut-off may be expressed as follows:"

Using the relevant 3765/3776/2900 class "dimensions" which are identical in this regard and plugging the numbers into the formula yields a "rated tractive force" figure of 79,968 lbs. But the3765/3776/2900-classes were not *"arranged with conventional long cut-off"*. They and the 5001/5011 2-10-4 engines all were equipped with a limited cut-off feature to artificially limit cut-off when starting in full forward gear.

The reason for this can be inferred by comparing the 79,968 lbs tractive force with the adhesive weight (weight on the drivers). According to Baldwin, and most steam locomotive design practice, primary concern regarding tractive force was to avoid very poor adhesion characteristics and a have very "slippery" engine when starting. Nobody wanted to design "slippery" engines.

With that as background lets look at the 3765-class. With an adhesive weight of 286,980 a tractive force of 79,968 lbs results in an unacceptably low factor of adhesion of 3.59. The 3776-class with 281,900 lbs on the drivers would have had a factor of adhesion even worse at 3.53. The heaviest of the three classes were the wartime 2900s with an adhesive weight of 295,000 lbs which would produce a factor of adhesion of 3.69.

Clearly something is wrong with the 79,968 lb tractive force number; it is simply too large for the adhesive weight. Undoubtedly that is why limited cut-off was specified in the design of these engines. It has the effect of reducing tractive force when starting without reducing power at speed (where it counts) and where cut-off is normally reduced anyway.

Figure 2: THEORETICAL MEAN EFFECTIVE PRESSURES FOR VARIOUS CUT-OFFS
Single Expansion Engines

	Mean Effective Pressure %		
		Franklin Ry. Supply Co.	
Cut-off	B.L.W.	Without A.P.*	With A.P.*
50	68	60	75
55	71	64	76
60	73	68	77
65	76	71	77
70	80	74	78
75	82	77	79
80	83	80	80

*A.P. stands for Franklin Railway Supply Co.'s Auxiliary Steam Port

Maximum cut-off when starting in full forward gear affects one formula input, namely MEP. It stands for **m**ean **e**ffective **p**ressure *on the piston face in the cylinder for an entire stroke cycle* when the locomotive is starting. The use of 85% of boiler pressure to simulate this is an approximation only, in the absence of any engine-specific test measurements. It is "close enough for government work" but hardly precise. And it does not apply in the case of limited cut-off, so some other percentage must be used.

And true to form the Baldwin handbook provides the table (Figure 2) for this purpose. The only question that now needs to be answered is at what point was the cut-off limited on the 3765/3776/2900-class engines? It appears to have been approximately 60%. According to The Santa Fe's Big Three by S. Kip Farrington Jr. (page 154), the 3765-class locomotives were "limited to 60% maximum cutoff". Using the Baldwin handbook conversion data, this would yield a tractive force of 68,678 lbs and a factor of adhesion for 3766 of 4.18, really good solid adhesion. For a 2900 it would be 4.3.

However, Farrington's "60%" appears to be a rounded-off figure. Farrington quotes later (page 224) from the test report on #3766 (Report 87312) that during testing "indicator cards taken while starting showed a mean effective

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BANGING ON A 2900

Is she steam or is she diesel?

At ground zero for the colonies' industrial revolution in Woonsocket, Rhode Island the infant Bradford was christened Steve in 1945. Shortly thereafter the family moved to Wrentham Massachusetts as his dad followed a management path in the textile industry. Later in 1953 they moved to Philmont, New York before a final move south when his dad took a job as researcher and professor at north Carolina State's School of Textiles.

All this movement put the impressionable little Steve in a position to watch Steam disappear from lines like the New Haven, New York central, and Boston and Maine. As near as he can remember he was hooked while eating ice cream in a hospital room after his tonsillectomy watching New Haven steam roll by with clouds of steam in the winter air. His dad took the toddler to the South Station in Boston to watch trains and meet a New Haven fireman on a Pacific. The hook was set deep.

Steve's first train, a Lionel Scout, Christmas. 1951 Young Steve and sister on Christmas morning in Wrentham.

Steve got a ride behind a Norfolk and Western J-class 611 on Saturday, October 24, 1959 from Roanoke to Williamson West Virginia and back. It was Norfolk and Western's last steam passenger run. In Williamson, he saw long lines of steam locomotives. Some were on layover, but most of them were lined up to be scrapped. In the scrap lines, Steve was seeing the end of an era.

In Williamson W Va, 14 year old Steve poses in the engineer's seat of Norfolk & Western 2143, 2-8-8-2 Mallet as it sits in the scrap line.

Despite daydreaming about steam he graduated form Needham Broughton High School in 1963, started college at NC State and took a major in history as an Air Force ROTC cadet.

That made him a 2nd Lieutenant in 1967 but he was deferred to study more history——the history of Bosnia and events leading up to WWII. He grew tired of that, and the Air Force put him on active duty. He was sent to Intelligence training at Lowry AFB in Denver.

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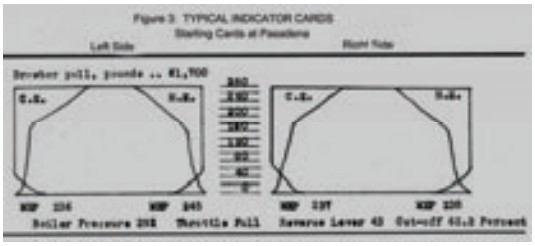
pressure of 240 lb. per sq. inch which is 80% of boiler pressure. This sounds like an average of the MEP noted when starting during all the test runs. It gives a maximum calculated tractive force of 75,200 lb. based on 61.5% cutoff with factor of adhesion of 3.8. It is to be expected that the tractive force will decrease to 75% of boiler pressure expressed as mean effective pressure, after the first few revolutions which gives 70,400 pounds tractive force with a factor of adhesion of 4.1. Drawbar pulls between 64,000 and 68,000 lb, were observed when starting without taking slack, which substantiates the calculated tractive force given."



Saving the best for last, there is actual measured M.E.P. On page 227 Farrington published copies of "typical indicator cards" taken during testing of 3766. The card in Figure 3, taken when starting at Pasadena is of interest. Although it records only one data point, it is consistent with average M.E.P readings demonstrated by a number of starts in the test series. It records M.E.P. for left and right sides, crank end and head end of a single stroke (presumably the first complete driver revolution).

Boiler pressure at the instant of these readings was 292 psi Throttle was full, reverse lever at detent 43 and, most importantly, cut-of registered as 62.2 %. The drawbar pull measured at the tender drawbar was 61,700 lbs, less than calculated tractive force, as would be expected. The average M.E.P during this one stroke was 239 psi, entirely consistent with the 240 psi noted for all starts by Farrington.

This data is directly transferable to 2926. It means that all published tractive force figures for 3765/3776/2900-class engines are incorrect. The figure used by the railroad and all steam age publications well into the 1980s was 66,000 lbs. This is the correct figure for #3751, as delivered in 1927. But it was never modified to account for major upgrades and changes to 3751 as a result of rebuilding and upgrades over the years. SBRHS publishes a corrected figure of 71,719 which correctly accounts for these changes. The railroad and the railroad community continued to use 66,000 lbs for years for all its 4-8-4s. It was "close enough" for their purposes such as calculating tonnage ratings and such.

Based on the above analysis it appears that

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the tractive force of the 3765/3766/2900 classes must fall between 68,000 to 75,000 lbs. The railroad figure of 66,000 lbs understates tractive force, while the currently popular 79,968 figure overstates it and doesn't take limited cutoff into account or the need for adequate factor of adhesion. Tractive effort between 68,000 to 75,000 lbs yields good to acceptable adhesion.

Using the formula, and properly applying Baldwin's conversion table data for 60% cutoff yields a tractive force of 68,678.4 lbs, and can be rounded up to 68,700 lbs. That provides a reasonable calculated tractive force figure for 3765/3776/2900-class engines but it appears a little low. This may be because the conversion table data is generic and not engine-specific.

On the other hand, the 239 psi figure for the Pasadena start is based on real measured data. Applying it in the formula yields a tractive force of 74,950.6 lbs. This entirely believable. It yields a factor of adhesion of 3.94. It is an adequate factor of adhesion, very close to the customary design goal of 4. However, because the 3765/3776 class engines were lighter, their adhesion, while still acceptable, (3.83 for 3765 and 3.76 for the 3776-class), was not as good as the 3765/3776 classes in freight service.

The late Lloyd Stagner, in an article "Thirty Years of 4-8-4's" (Trains Mag., Feb 1987) noted that the 2900's performed better than the 3765/3776 classes in freight service.

He observed that the heavier weight of the 2900-class engines had *"the beneficial effect of making them better freight power and, after 1949, tonnage ratings were increased from 250 to 400 tons from the 3765/3776 classes on the Middle Division."* This is consistent with all three classes having adequate adhesion charac-

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ORIENTATION AND SAFETY

Safety Officer Sets Safety Training Session

A number of individuals have recently joined the Society and so it is time once again to hold a new member orientation and safety briefing. To that end I have scheduled an orientation session for Saturday, September 6th at the locomotive restoration site.

The session will begin promptly at 9 am and should finish up before noon. New members are required to attend this orientation if they desire to work at the restoration site.

In addition of the original safety training, each member is required to attend a safety refresher training session once each year to maintain working privileges. All training materials used in the training session will be provided.

In addition to the safety training, there are two other requirements for on-site restoration work. 1. Membership status of persons working on-site must be current 2. Anyone working on-site must have current medical insurance.

If there are any questions regarding the orientation or the overall safety program, please feel free to contact me at kc5ntw@sdc.org.

Jon Spargo, CSO

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It was in Colorado that things got interesting. In the singles apartment building where Steve lived there was a cute young graduate from Iowa who caught his eye. That was Mary. Next thing you know she accepted an invitation for their first date. She wore what she calls a "frilly white frock". He took her to the Denver train yards and got it covered with soot.

Where is the locomotive? Young Lt. Bradford gets his first look at one of AT&SFs huge 2900s. In this case, it is 2912 in Pueblo, CO, and much like his first contact with the early NMSL&RHS crew, Steve is on the outside looking through a chain link fence.

Dates after that included chasing trains where Mary learned of Steve's penchant for jamming on the brakes, grabbing his camera and lacerating his belly on the still fastened seat belt as he tried to bail out. It only seemed to happen when there was a train nearby. She also learned that when he did this it was her responsibility to the traveling public to deal with the car he had just abandoned. What young gal wouldn't love a spontaneous guy like that?

One thing lead to another and before long Steve took Mary home to meet his folks in Raleigh, NC. His neighbors remembered well Steve's near obsession with trains. While at home, Steve answered a knock at the door. It was a couple of neighbors. Their first question was "Is she diesel or is she steam?"

Mary doesn't know what he said. He ain't saying. I think he said "steam".

Soon Steve had to leave steam chasing and Mary for an assignment as an Intelligence Officer assigned to the 388th Tactical Fighter Wing in Thailand at Korat Royal Thai AFB. He watched F-4Es, F-105s, and dreamed about racing around hills to find the locomotive under the smoke.

Back stateside at Nellis AFB Steve worked on a Masters in Public Administration. He left active duty in 1975, staying in the USAF reserve system as an intelligence specialist. He kicked around the country in a series of government jobs and briefly tried working for an engineering consulting firm. Along the way Kelly and Katie (who is a NMSL&RHS member) were born.

Steve's reserve work got him noticed and soon he was at Scott AFB and then Kirtland AFB doing what he loved second best——intelligence work. He can't talk much about what he did for a living but if he studied it like he studied the details of steam he must have been pretty good at it.

Then in 1997 he was out for a bike ride when he passed the 2926 in Coronado Park and found a bunch of guys wandering around inside the fence looking her over. He jammed on the brakes and introduced himself to them. One of the inspectors was Doyle Caton who probably tried to talk Steve's ear off about the 2926. Doyle, however, had met his match. Steve joined this bunch of foamers, membership number 5 in what was then a "New Mexico division" of the Pueblo Colorado RR Historical Society (then owners of ATSF 2912).

After the newly named NMSL&RHS acquired 2926, Steve made nearly every meeting when his day job did not have him off briefing someone important. He was elected to the Board of Directors and has been our Board Secretary for years. Before Steve had been with us long, anybody who needed to be brought up to speed on steam was shunted off to the Steve encyclopedia. He should have picked up the nickname "professor". This did not happen.

Seems Steve had another great talent—an ability to get dirtier, easier and quicker than anyone else. As most everyone knows, the 2926 restoration site has several of the dirtiest locations in the city. If there was ever a dirty 2926 job involving oil, grease, dirt, soot, caliche, black rubber, rust, or just plain filth it was tailor-made for Steve. This may have put new stress on Mary-the-steam-tolerant as he brought a lot of it home on his face, hands, boots, overalls and car seat on Saturday afternoon. It also explains why we call him "pig pen". The only award presented by the society bears that name in his honor.

Steve "Pigpen" Bradford in his element. Here he sits at the front of the 2926 firebox ready to blast soot out of the flue tubes with an air hose. There is a reason for the mischievous grin. Steve knows that some other members of the work crew are near the smoke box end of the flues—where a cloud of soot will exit the tubes.

Now that Steve has retired from the intelligence business he has turned more attention to his first love, steam. He has also sprouted a new fascination for wildlife—especially bears and the mountains they live in. This gives him another reason to suddenly brake to a stop and bail out of a car with a camera when there is not a train around.

He has exciting accounts of both bears and steam trains from a recent motor home trip along the Rocky Mountains to Canada. First, there was a closer than expected meeting in Wyoming with a mother grizzly and her cubs. He did get some great pictures.

Then there was the encounter in British Columbia with Canadian Pacific steam engine #2816. He and Mary chased it till it stopped in a small town, and Steve got a cab tour and visited with the crew—more good pictures.

Watch out for quick stops if you are following Steve's car up highway 17 north of Chama! That road has both bear and steam train crossings.

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Several NMSL&RHS members participated in the training. The training went well, and with help from the Chardans boiler specialists, the first tube was removed August 27.

The Chardans and NMSL&RHS tube removal team holds the first flue removed.

Though not experts, the NMSL&RHS crew members are now capable of removing the flue tubes. Tube removal will continue through the next few work sessions.

(See Page 6 for additional pictures)

A WORD OF THANKS

During the past few years, NMSL&RHS and 2926 have been supported by friends near and far. Members of the NMSL&RHS would like to once again extend a sincere word of thanks for all the support we have received since we began the effort to restore 2926.

Collectively, our membership possesses an impressive array of talents and abilities. But in a project such as the restoration of 2926, that internal capability is far from sufficient.

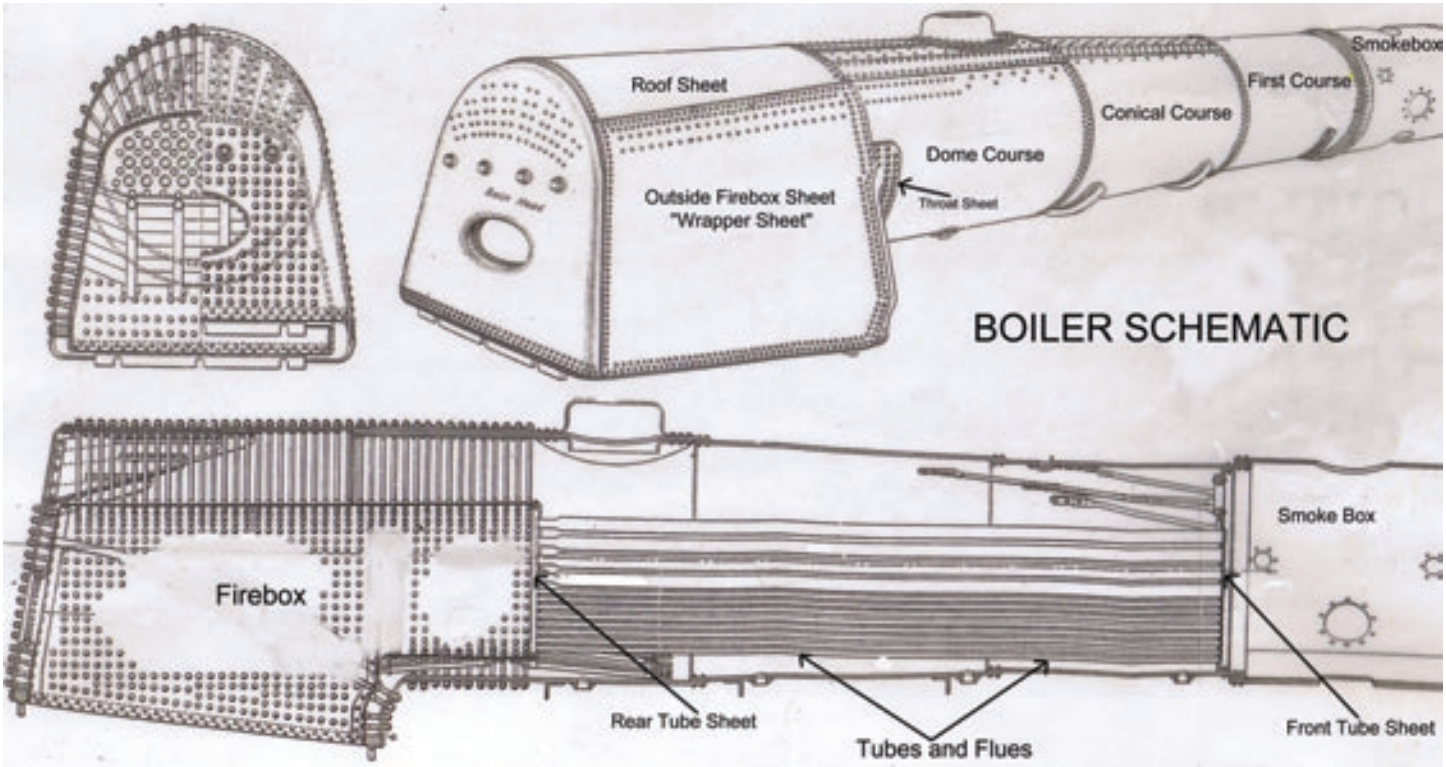
A shiny black completely restored tender now sets on our rail siding. Restoration of the locomotive itself is proceeding steadily. Without the support and direct assistance from a variety of public and private organizations as well as many individuals, we could never have reached this point.

Messer Construction moved 2926 from the park. BNSF Railroad relocated it to the current site. The current site was provided by the Bureau of Indian Affairs and the U.S. Government General Services Administration.

Individual contributions have come from around the United States as well as from rail fans in England, Germany, and other countries.

Donations of services, and contribution of tools, equipment and materials have come from a variety of sources. It seems that when we get to the point that we desperately need equipment, direct assistance or just some good advice, there is always someone to step forward and help.

Page six has a partial list of contributors businesses, organizations, and individuals who have stepped forward to help bring an icon of New Mexico's rich railroad history back to life.



This schematic is similar, but not an exact representation of the 2926 boiler. However, it is close enough to be used here to depict the challenging job of pulling the flue tubes. The pictures below show the removal process.

Tube removal steps: 1: Working in smokebox to collapse swaged tube at front tube sheet. 2: Working in cramped firebox space and using internal cutting tool to cut firebox end of tube. 3: Using forklift and cable to pull tube. 4: First tube removed from smokebox.

Assistance to the 2926 restoration effort actually began when several Albuquerque City Departments, and city employees showed confidence in our capability by helping NMSL&RHS acquire 2926. Since then, many businesses, organizations, groups and individuals have contributed in one way or another. Donated or discounted service, tools, equipment, and materials, along with assistance in acquiring support have contributed to our restoration work. Cash donations ranging from a few dollars from a German rail fan to $5000 sent by an anonymous British rail enthusiast, have supplanted dues and contributions from the NMSL&RHS membership. Here are a few of our supporters. Others will be named later.

Electric Motor Company, Albuquerque	Crane Service, Albuquerque	NM Governor, Bill Richardson
R&R Heavy Equip. & Sandblasting, Albuquerque	Bond Paint Co. Albuquerque	NM Lt Governor, Diane Denish
Albuquerque Bolt & Fastener, Albuquerque	Rust Bullet, Reno, NV	U.S. Rep. Heather Wilson
H&P Hydraulics & Pneumatics Inc, Albuquerque	BNSF Railway, Albuquerque	NM Rep. Rick Miera
A Reliable Engine Rebuilder, Albuquerque	Wells Fargo Bank Albuquerque	U.S. General Services Administration
RPC Machine Shop, Albuquerque	Jamin Electric Albuquerque	U.S. Bureau Of Indian Affairs
Grancor (Asbestos Removal), Albuquerque	Thomas L. Popejoy, Albuquerque	NRAO Very Large Array, Socorro
Messer Construction, Hereford, TX	Artist, Gayle Van Horn Albuquerque	WHEELS Museum
Blaylock Industries Inc., Forth Worth, TX	Johnny Plath, Elect Ser. Albuquerque	City of Albuquerque