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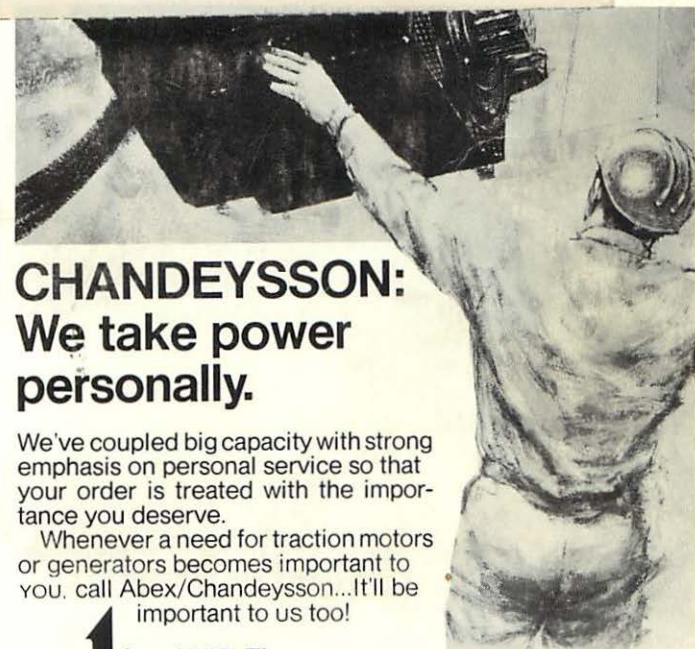
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# MONDAY MORNING SESSION

## September 28, 1981



**R. G. CLEVINGER**  
PRESIDENT  
General Electrical Foreman  
Atchison, Topeka & Santa Fe Railway  
Kansas City, KS 66106

## MONDAY MORNING SESSION

### September 28, 1981

The 1981 annual meeting of the Locomotive Maintenance Officers Association, held on September 28-30, 1981 at the Conrad Hilton Hotel, Chicago, Illinois, convened at 9:10 a.m., Mr. R. G. Clevenger, President of the Association, presiding.

**PRESIDENT CLEVINGER:** Gentlemen, may we begin the meeting. My name is Bob Clevenger, and I am President of the Locomotive Maintenance Officers Association. We would like to welcome all of you to this year's meeting. This is the 73rd annual technical conference, and it is now in session.

Members of the Coordinated Associations, honored guests and friends: On behalf of the LMOA, their Executive Committee and officers, it is indeed a pleasure to have you here this morning. I welcome each of you to this convention.

We will open the meeting with the invocation by the Reverend Daniel Bystrom, Pastor of the Addison Street Baptist Church, Chicago. Please rise.

**REVEREND DANIEL BYSTROM:** Good morning, gentlemen. It is a pleasure to be with you. I was in Israel a month or so ago. They don't have any trains there. I suggest that you all go over there and start building railroads, selling parts, railroad ties, whatever they need. Then after

each war you can go back there and start all over again. It should be a pretty good market.

A newspaper reporter was interviewing Sadat in Cairo, Egypt. On Sadat's desk were two phones—a white one and a black one. The reporter asked, "What are the two phones for?" Sadat replied, "With the black one I run everything that goes on in Egypt. With the white one I talk to God and listen to Him." He picked up the white phone and heard a voice say, "This is the Lord." The reporter was very impressed.

The next day the reporter went to Jerusalem and interviewed Begin. On Begin's desk there were two phones—a white one and a black one. Begin said, "With the black phone I run everything that goes on in Israel. With the white phone I talk to God."

The reporter said, "Sadat talked to God yesterday in Egypt. He said the call cost him \$3.19 and he was glad to pay for the privilege."

Begin said, "It costs me 30 cents. From here it's a local call."  
[Laughter]

Now that I have seen you smile, let's bow together in prayer.

Our Father Who art in heaven, we fully acknowledge that You govern all the affairs of men. Since the sparrow cannot fall to the ground without Your knowing it, keep us from the foolish indifference of thinking You are

unconcerned with what we do during the proceedings of this convention.

Now, before we become caught up in the routine of the business before us, we pause to ask Your help. You know so well the hearts of men. We know so little of the heart of God. We would ask that You turn our hearts and minds toward You. Give us the graciousness to forgive and forget faults and failures from the past, and set us free from them. Forgive us for not individually applying to ourselves the standards we demand from others. In our indifferences may we be gracious and kind in our agreements, that we may be humble.

Lord, keep us mindful that we are praying to the One who has conquered death so that we no longer may be afraid and dismayed by the economic problems that plague us. Grant us wisdom and insight so that we will not view them as threats but as challenges—challenges that You have brought to test us. Help us to overcome in Your Name and Your power, since You have overcome the world. May Your will be done in all the proceedings before us, in all of our lives, in our beloved land. We pray in Jesus' Name. Amen.

**PRESIDENT CLEVENGER:**  
Thank you, Reverend Bystrom.

Because of the close relationship that exists between our organizations and the vital part each plays in railroad operations, I think it is appropriate that we join together at the opening of this meeting.

Before we hear from our honored guest this morning, I would like to introduce to you the gentlemen at the head table. I will ask them to stand as I introduce them. Please withhold your applause until all have been introduced.

Beginning on my right: Mr. R. W. Russell, Superintendent of the Missouri Pacific Railroad Company and President of the Air Brake Association.

Mr. R. L. Sutton, General Mechanical Superintendent-Car, Union Pacific Railway, and President of the Car Department Association.

Mr. A. E. Huston, Retired District Road Foreman of Engines, Southern Pacific, and President of the Railway Fuel and Operating Officers Association.

We were going to have with us Mr. R. P. Herman, President of the Railway Supply Association, but unfortunately he had to keep an appointment with a dentist this morning, so he couldn't be with us.

These, gentlemen, are the presidents of our affiliated Associations. [Applause]

I purposely passed over one gentleman sitting up here whom I am sure most of you know, Mr. Jim Long, Past President of the LMOA, who will introduce our speaker this morning. Mr. Long.

**MR. J. H. LONG** [Manager, Locomotive Department, Chessie System, Cincinnati, Ohio]: Thank you, Bob.

Ladies and gentlemen, it is a real pleasure for me to introduce our

principal speaker this morning, because I have known him and his family for quite a few years. Thinking about how to introduce him, I thought of one little gem. He was our general manager. He was a working general manager, believe me. He went out and rode engines and came back and really put things to the mechanical department.

He liked to use a red pencil when writing notes. To my boss he wrote, "What are we doing to correct conditions on locomotives so we can have better locomotives?" One day my boss said to me, "See what he sent me! I have to get hold of every maintenance instruction, every modification, have copies made, and send them back to him." The bundle he put on Mr. Johnson's desk was almost a foot high. He wrote across the first page, "You asked for it."

I remember one time he was talking about delays on Moore's Hill outside of Cincinnati. I had found a pamphlet put out in 1864. I received a penciled note, "What are we doing to correct delays on Moore's Hill?" Across the top of it I wrote, "They have been trying since 1864 to correct delays on Moore's Hill. Any suggestions?" And I sent it back to him.

Those two little gems will give you proof that this gentleman really is mechanically inclined and oriented.

Mr. Allen W. Johnston is Vice President of Operations and Maintenance for the Association of American Railroads.

The Operations and Maintenance Department is the largest in the AAR, consisting of eight divisions. The various divisions deal with such matters as freight car utilization; communications and signaling; engineering; the design, construction, maintenance, repair, interchange and inspection of railroad equipment; track construction and maintenance; settlement of freight claims; health, safety and security matters; grade crossing programs, and railroad operations generally.

A native of Brunswick, Maryland, Mr. Johnston was General Manager, Western Region of the Chessie System in Cincinnati since 1977 before joining the AAR in 1979.

He began his railroad career with the Baltimore and Ohio Railroad in 1942 in his hometown of Brunswick, Maryland. After serving three years in the U. S. Marine Corps, he returned to work for the B&O as a yardmaster in Brunswick, Maryland.

Thereafter, Mr. Johnston worked in various positions in Washington, D. C., Parkersburg, West Virginia, Wilmington, Delaware, and in Washington again before becoming Superintendent of the Baltimore Division in Baltimore in 1961.

Mr. Johnston served a two-year stint as manager of the Washington Terminal Company in the nation's capital in 1963-64, returning to Baltimore in 1965 as general manager for the B&O's Eastern Region.

From 1966 through 1973 he was General Manager-Western Region

for the Chessie, served as Central Regional General Manager in Pittsburgh, and General Manager of Transportation in Baltimore.

He attended Marshall College, the American University in Washington, D. C., and the University of Michigan. Mr. Johnston and his wife have four children.

It is a pleasure to present Mr. Allen W. Johnston. [Applause]

MR. ALLEN W. JOHNSTON: Good morning, gentlemen. Thanks, Jim. I am not sure I understood everything you said about me.

#### General

It is quite a pleasure to be here today before such a large and distinguished gathering.

When my old Chessie colleagues Nelson Buskey and Jim Long approached me some time ago to address this group, I asked them what I should talk about. Knowing my mechanical aptitude from our past association, they emphatically told me not to discuss anything mechanical and embarrass myself, and furthermore, if I told any stories about engine or equipment failures, that I would never be invited to attend this conference again.

With those guidelines, it promptly reminded me of the morning Jim Long dispatched an office car special—of all places off the engine house ready track and after moving five car lengths the locomotive had a "GPR". One hour later we managed to get off the ready track with the master mechanic, general foreman, three electricians and Jim hanging on the side of a GP-40.



A. W. JOHNSTON  
Vice President of Operations and Maint.  
Association of American Railroads

Some of the things I want to discuss here are things you have heard about before.

But the idea reminds me of the time the Russian Government decided that Joseph Stalin was no longer in favor in that country, so they decided to have him buried elsewhere. They approached the American Government and were turned down. They tried the British, and were told "Well, we already have Karl Marx buried here in London." They tried the French and the Italians, and they said they were having trouble enough with the Communists as it was. Finally, the Russians turned to Israel. Surprisingly, the Israeli Government quickly agreed to have Stalin buried there. But they added: "Don't forget that we have the highest resurrection rate in the world."

"Well, I'm not really "resurrecting" the topics I'll be discussing—

I'm simply bringing you up to date on them.

With the first anniversary of passage of the Staggers Act just around the corner, deregulation is certainly a prime topic. Outside of your own haliwicks, you're probably wondering how it's working in the industry as a whole.

### Summary Of Talk

I also plan to discuss fuel efficiency, some of the new technology that's going on in the railroad industry, the coal and grain situations and some of the legislative problems facing us—such as coal slurry pipelines, the weight and length of trucks, and waterway user charges. Also, I will touch briefly on some of the activities of the AAR as they relate to your day to day problems.

### "Deregulation"

So, let's talk first about deregulation, since not only does that seem to be the topic most talked-about around the industry these days, but it has an effect on some of the other subjects I'm going to discuss.

Deregulation, as you all know, is something the railroads for many years have advocated and worked hard for—and now we've finally achieved some measure of it.

But let me add a word of caution here: The Staggers Act is not the be-all, end-all as far as deregulation of the railroads is concerned. There has indeed been a lessening of regulation. To say we are "de-

regulated" is far from being wholly accurate.

But, for now, the Staggers Act is leading to some improvements in areas where railroads have needed help for years. Why, if you were to go back 10, 15, maybe even 20 years, you'd find the railroads asking for many of the same things they were trying to get last year in the Staggers Act.

Fortunately, our successors 10, 15 or 20 years from now won't be able to say quite the same thing. The Staggers Act is important, and it is a large step in the right direction. And most importantly, it has erased some of the problems we've been trying to solve for so long.

It is also important to mention, before I go into detail, that the predecessor to the Staggers Act—the 4-R Act—paved the way for some of the more dramatic freedoms now open to the railroads.

One of the more visible examples of what has happened as a result of passage of the 4-R Act has been deregulation by the Interstate Commerce Commission of movement of perishables by rail. Within a year of the ICC's action, the rail share of the perishables transportation market shot from 11 percent to almost 15 percent. That may not seem like much until you consider it was the first major increase in rail movements of perishables in about 25 years.

Almost any increase at all was bound to be significant.

This is just one example, however, of a continuing ICC trend

toward less interference in railroad industry affairs. This trend, started a couple of years ago, was encouraged by the 4-R Act and has continued since that time.

When the Staggers Act came into being, even more important things began to happen.

### Contract Rates

Let's start out with contract rates—an area that's very critical for the railroads. It's entirely possible, for example, that some day a third or more of all rail traffic may move under contract rates. In terms of 1980 traffic, that would add up to the equivalent of all coal carloadings, all grain and all motor vehicles and equipment. That's a lot of traffic!

So you can see, right away, how important contracts can be to the railroads.

### Coal

I mentioned coal a moment ago. Already a number of railroads have entered into contracts involving coal movements. Generally, these involve railroads providing certain guaranteed rates, while utilities commit themselves to accept certain volumes of coal. This, of course, allows railroads to forecast their income and equipment needs, and the utilities can depend on the coal rolling in without their having to worry about their supplies.

And while I'm talking about coal, I'd like to remind you that in late August the railroads moved more coal in one week than ever

before. They moved more than twelve-and-a-half million tons during the week ended August 29, topping a record set back in 1926—and while they were doing it, there was still a surplus of some 13,000 open top hoppers.

This just points up the fact that railroads are continuing to expand their car and locomotive fleets and spending more on track maintenance and improvements than ever before, and these elements have made a big contribution to the industry's ability to move efficiently and economically.

Furthermore, projections indicate that coal traffic will continue to increase—both for domestic use and for export. Over the last couple of years, coal traffic has leaped more than 30 percent.

But back to contract rates.

### Contract Variants

There are many variations on the contract rate theme; and I'm sure that as railroads and shippers work together there will even be more innovative ideas. Already, contract tariffs have been filed for shipping such commodities as canned or preserved foodstuffs, sand, corn syrup, furniture, lumber and so on.

Contracts can also be used—as at least two railroads are proving—to eliminate empty backhauls for unit trains. With the growing use of unit trains, this becomes more and more important.

Many of these contracts will, of course, apply to grain movements, many of which will involve use of unit trains, as do most coal move-

ments. Although grain loadings are down so far this year from 1980—which was the best grain year for the railroads since 1973—we anticipate that 1982 will be another banner year. Grain loadings in 1980, for instance, posted the highest increase of any single commodity carried by the railroads, including coal.

### Individual Rates

Since I have been discussing contract rates, perhaps it is appropriate now to mention individual rates. The ICC, of course, has been trying for several years to channel us away from general rate increases and to direct the industry toward selective rate changes.

The Staggers Act did the same thing—encouraged railroads to make more rate changes on a case-by-case basis.

And although many shippers feared the worst—that rates would zoom suddenly through the proverbial roof—their fears have been allayed somewhat, because lots of rates have gone down. It is true, of course, that some rates have gone up. They needed to. And the marketplace is, generally, accepting valid rate increases.

But common sense should tell us that railroads, in the difficult financial bind they have been in for several years, would not do something that would drive business away.

It didn't happen in Canada, when deregulation took place there, and experience so far indicates that it is certainly not going to happen in this country either.

The Canadian experience was that when both carrier and shipper suddenly got into a face-to-face situation—actually sitting down and working out rates between themselves—they suddenly found they could do just that. They found they could work together and could work to each other's advantage.

Again, I think we see a similar situation developing here in the United States.

### Piggyback

Take, for example, piggyback traffic. You all know that piggyback is the area of railroading most recently deregulated by the ICC. This has already led to the reduction of a lot of piggyback rates—many, of course, occurring in vigorous competition with over-the-road heavy trucks.

The rate reductions a visible trend toward speeded-up service and other improvements in piggyback, have evidently pleased quite a few shippers at this point. For instance, in the first quarter of this year—before piggyback was deregulated—traffic was down about 6 percent from 1980. By mid-August, cumulative traffic for the year was more than one percent ahead of 1980—a jump of some 7 percent, and the line on the chart is still angled up in spite of a depressed economy.

It certainly is good to see piggyback start another comeback, since movements were down slightly last year for the first time since 1975. As you are all aware, piggyback has been the big mover in rail

freight traffic over the past few years, and it remains second only to coal as a source of railroad traffic.

If piggyback continues to climb as it has over the last few months — especially in view of last year's slight slump — I think we'll have positive evidence of some of the good things that can happen — and are going to happen — under this new deregulatory climate.

It is also important to keep in mind — and to point out at every opportunity — that we, the railroads, are keeping those monster trucks off the highways every time we load a piggyback flatcar.

### The "Monster" Trucks

Speaking of Monster Trucks, Congress is now considering a bill which would allow bigger trucks on all Interstate and designated Federal-aid highways. S.1402, sponsored by Senator Cannon of the Committee on Commerce, Science, and Transportation, would require all states to permit twin trailer trucks at least 65 feet in length, trucks up to 102" side (an increase of 6" over the current limit) on all roads with lanes at least 12 feet wide, and single trailer trucks at least 60 feet long. This bill would permit the nationwide operation of twin 27-foot trailer combinations, now prohibited in most eastern states.

This bill would increase the costs of maintaining and repairing the highway system at a time when highway budgets are increasingly tight. It contains no provision for

raising user fees on the heavy trucks which would benefit from higher limits. The obvious result would be more highway deterioration and a bigger highway budget shortfall — both at the expense of other motorists, who are traveling on bad roads and are being asked to pay higher fuel taxes to cover the shortfall.

Recent studies by the Federal Government and several states have found that the heaviest trucks, the five-axle tractor-trailers that weigh over 50,000 pounds, should pay much higher user fees to cover their share of highway costs. The Federal Department of Transportation is conducting a study to determine how much each class of vehicles should contribute to the Highway Trust Fund. In its Second Annual Progress Report, issued in January 1981, the DOT found that user charges on trucks registered at 50,000 pounds or more should be increased by 81 percent — without considering the added costs of increased size or weight, which would certainly increase that figure.

These preliminary findings from the Federal study are consistent with the results of many state highway cost allocation studies. Studies in Mississippi, Georgia and Florida have recommended that user charges on the heaviest trucks be increased by amounts ranging from 70 to 129 percent.

DOT will complete its highway cost allocation study by January 15, 1982. At that time, Congress will have the information it needs

to consider the closely related questions of truck user charges and weight and size limits. Any action on truck weight or size limits before that time can only worsen the highway finance crisis.

### Slurry

Another battle that seems to be much closer at hand is the one over coal slurry pipelines. Already hearings have been held and more are in the works.

So far, legislation introduced on the House side—and written by the coal slurry people—is worse than last session's bills. For one thing, the new bill does not contain provisions that would protect the financial integrity of railroads. Furthermore, it totally disregards the rights of states that have legal interests in water that would be flushed away by the proposed pipelines. And it would grant the broadest possible eminent domain authority to pipeline operators.

One of the new Senate bills would prohibit the granting of right-of-way across Federal land unless the affected states agreed to the use of their water. This bill does not address the eminent domain issue.

Water, of course, is going to be the big issue once again; and it's a matter—if you'll pardon my saying this—that just won't wash with a lot of people. Congressman Williams of Montana—one of the more seriously affected states in terms of water—called the House bill—and I quote—"A bulldozer with which to plow through any

state laws—including water laws—that might stand in the way of building a coal slurry line."

So, you can see we do have some backers on Capitol Hill on this matter, but its going to be a tough battle.

### Water User Charges

And there's still another issue where the railroads have lots of friends—waterway user charges. The Reagan Administration wants to recover one hundred percent of inland waterway costs through user fees. In other words, they believe the barges—not the general taxpayer—should take care of paying the bills for the barge industry's right-of-way. The Administration's position was voiced before a Senate subcommittee by none other than David Stockman, director of the Office of Management and Budget. (I'm sure that name is a familiar one these days.)

### Fuel

I told you earlier I was going to discuss fuel efficiency. To many of you here today, that's a subject of great concern: And I must add that it is because of your efforts that the railroads are—have been—and will continue to be—the most fuel-efficient way to move freight.

I know that a lot of our fuel-efficiency figures are being challenged nowadays, but I don't think that should bother us greatly—as long as we continue to improve our methods, as long as we keep coming up with new innovations.

It's very difficult to challenge results, though, and I have some results I'd like to share. Going back 10 years, revenue ton-miles have increased from 740 billion in 1970 to 919 billion last year. Fuel consumption per ton mile, however, has decreased. We used to get only 202 ton-miles per gallon; last year's figure was 236 and that's a very dramatic increase.

With increasing fuel costs, expenditures for fuel have become a major portion of any railroad's operating costs. The AAR Research and Test Department has focused in on this problem by studying fuel consumption, waste, and the use of alternative fuels. To gain a more accurate definition of the problems, the R&T Department conducted an industry-wide fuel audit. The report of that audit is in the final stages of preparation.

The Safety and Special Services Division of the AAR O&M Department is assisting in that effort by an examination of the problem of loss of fuel oils through theft and pilferage and a look at effective security measures. Safety and Special Services Division has found, through the cooperative efforts of member railroads, that losses occur throughout the entire fuel cycle. Believe it or not, delivery trucks have actually removed fuel from railroad storage tanks while making bogus deliveries, and prudent thieves have devised ways to bill railroads for fuel which was not actually delivered. Most of these thefts are preventable and the Di-

vision plans to disseminate prevention methods to member railroads. The actual format of this dissemination of information has not yet been determined, but at this point, it appears that symposium will be conducted wherein the efforts of R&T and O&M will be reported to interested members of the industry.

### Safety

Another area where railroads take a bad rap is safety. It is often said railroads aren't safe—that they don't pay enough attention to safety. Well, as our advertisement says, that's a myth.

Just look at the figures: The Federal Railroad Administration shows a drop of nearly 25 percent in railroad accidents and a drop of almost 15 percent in injuries over the last three years. And in the 15 years from 1966 through 1980, railroad fatalities were down by 60 percent.

But even that was not as dramatic as the 66 percent decrease in fatalities at railroad-highway grade crossings during that same 15-year period. As a matter of fact, there were fewer grade crossing deaths in 1980 since record-keeping began back in 1920—and this was despite more than a 40 percent increase in exposure.

The significant decrease in grade crossing accidents can be attributed to the Federal funding provided for in Section 203 of the Federal Highway Bill of 1973 to improve safety at crossings. The Operation Lifesaver Program adopted by 29 states and implemented by the rail-

roads has also played an important part in alleviating grade crossing accidents.

### Track-Train Dynamics

In another area close to home for many of you, the Track-Train Dynamics Program—now in its 10th year—continues to be responsible for new developments in such areas as train make-up, train handling and equipment design. A manual developed through the program has led to formulation of comprehensive guidelines for improving operating practices. An Implementation Officers Committee enables railroads to report both successes and failures to the Track Train Dynamics staff, helping keep the program in tune with industry needs.

I'd also like to report that the AAR Car Repair Billing Seminars—which the AAR started in the Spring of 1979—will continue. These seminars have been extremely successful, with 300 participants attending the first year, 430 the second year and 500 last year. And I might add that freight car repair billings this year should approach the 700-million dollar mark.

The Open Top Loading Rules Committee developed an audio-visual training program that has been well received by the industry and shippers and will be presented at the Car Department Officers Association during their meeting. I urge those of you that are interested to attend. The next training program under consideration will

show the proper securement of pipe and related steel products.

I am also pleased to report that periodic attention (COT&S) for ABD type brake equipment has been extended from 14 to 16 years effective October 1, 1981. Recently, the period for COT&S attention to AB type brake equipment was extended from 6 to 8 years. The unnecessary removal of brake equipment from a freight car, disassembly, cleaning and testing before reapplication to the car, is a prime example of non-productive work which has been eliminated at considerable saving to the railroad industry.

Among the current problems under consideration by the Mechanical Division is the subject of thermal damaged wheels. The Mechanical Division Technical Committees, with the support of the FRA, have established an Ad Hoc Committee, and the Research and Test Department is cooperating with several railroads in a test program to better understand and identify thermally damaged wheels which are unsafe to continue in operation. Two railroads have requested waiver of Freight Car Safety Standard Rule requiring wheels with plates discolored by heat, in excess of four inches, be removed from service. Other railroads have agreed to saw-cut wheels, with plates discolored by heat in an effort to better understand this problem.

One indication of the extent of this problem, as well as the bigger problem of wheels removed from

service prematurely, is recent figures from the CRB Program to show that less than 20% of wheels removed from service are worn to condemning limit. That means 80% of the wheels are removed from service prematurely for reasons other than wear.

As many of you are aware, at the invitation of the new Secretary of Transportation, railroads were asked to furnish a list of regulations that they felt were under the guise of safety, but were more of economic in nature to the FRA Administrator for review. A task force from the industry was formed and made up of mechanical, engineering, signal and transportation officers to coordinate an industry response through the AAR. This was accomplished and a number of meetings have been held with the FRA to review our request.

Revisions of the Power Brake Law was given first priority. Hopefully, in the not too distant future, we will see a Notice of Proposed Rulemaking giving the carriers relief of the 500-mile inspection, extension of piston travel from ten inches to eleven inches and elimination of the necessity to perform an initial terminal test at interchange points on other than run-through trains that have been certified. An extension to in-date testing is also being considered.

As you can appreciate, this is a very sensitive subject to Labor. However, we feel with the technology and improvement in brake equipment over the past decade,

we can support our request when given an opportunity.

### Summary

Earlier, I mentioned technological advances. Today, that's very much the name of the game. I like to think a whole new world is going to open up to us very soon. It won't be love at first sight, where one moment it's not there and suddenly it is. It'll come upon us slowly. Technological change in railroading must come incrementally in order to avoid premature obsolescence of what we've already got.

These things are going to happen to this industry because we are going to make them happen. We will make deregulation work, and we shall meet the challenge of the truckers and the challenge of the barges. We shall continue to look for — and find — new and more efficient ways to conduct our business to remain competitive in a free market environment.

The decade of the eighties promises to provide an exciting opportunity for all of us. While impending legislative changes and the Staggers Rail Act of 1980 will open up a whole new era in marketing and pricing, the real challenge lies with railroaders like yourselves who make it all happen. There is no industry whose people have more dedication to their profession than railroad officers and its employees. We are a great fraternity and I am proud to be a part of it and I know that you are too. [Applause]

**PRESIDENT CLEVENGER:** Mr. Johnston, I am sure everyone in this room will take your words of wisdom home with them and will do a lot of thinking about them. We certainly thank you.

On behalf of the LMOA, its officers and members, we would like to present to you this desk set in honor of your address this morning. We hope when you look at it you will think of the good work that goes on at these meetings, and also of the nice time we had this morning. This is emblematic of an honorary life membership in the LMOA.

**MR. JOHNSTON:** Thank you, Bob. One thing I failed to mention this morning. I had a very unusual experience this morning.

I stopped at our offices on Van Buren Street at about eight o'clock to visit our people for a few moments. Going up on the elevator to the 22nd floor, I was stuck between the 9th and 10th floors all by myself. Unfortunately for me the ventilation was not on, and needless to say I began perspiring. I took off my coat and began to think. I have heard every excuse for train delays, but never have I heard of an engineer being stuck in an elevator delaying a train off the ready track.

Thank you very much, Bob. I have enjoyed being here. [Applause]

**MR. LONG:** I would be remiss if I didn't give Mr. Johnston this red pencil so he can write up that elevator. [Laughter]



Mr. A. W. Johnston, left, accepting General desk set from LMOA Chairman of the Board Jim Long and 1st Vice President Nelson Buskey, center.

# MONDAY MORNING SESSION

## September 28, 1981

### REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS



**B. C. CAIN, Chairman**  
Chemist  
Atchison, Topeka & Santa Fe Rwy. Co.  
Topeka, KS



**R. R. HOLMES**  
3rd VICE PRESIDENT  
Dir. Chemical Labs & Environment  
Union Pacific Railroad  
Omaha, NE

**PRESIDENT CLEVENGER:**  
Thank you for being with us at this session, Mr. Johnston.

We will now adjourn to our individual meetings and carry on the business of the convention.

[Recess]

**PRESIDENT CLEVENGER:**  
Will the Fuel and Lubricants Committee come forward, please.

Ladies and gentlemen, the first paper this year will be presented by the Fuel and Lubricants Committee. I would like to call on Dick Holmes to act as officer of the session and introduce the chairman of the Committee.

[Mr. R. R. Holmes, Director, Chemical Labs and Environmental Union Pacific Railroad, Omaha, Nebraska], introduced Mr. B. C. Cain, Chemist, Atchison, Topeka & Santa Fe Railway Company, Topeka, Kansas, chairman of the Committee. Mr. Cain then introduced the members of his Committee.

[Part I of the paper was summarized by Mr. J. G. Hoffman, Manager Combustion Engineering, General Electric Company, Erie, Pennsylvania; Part II by Mr. D. D. Hudgens, Manager Field Laboratories, Union Pacific Railroad, North Platte, Nebraska, and Part

III by Mr. R. A. Bjorndal, Senior Staff Engineer, Chevron, San Francisco, California.]

MR. CAIN: At this time I would like to open the floor for discussion. If you would like to ask a question or make a comment, please go to the nearest microphone and state your name and affiliation. If you want to direct your question or comment to any specific Committee member, please feel free to do so. If we don't have the answer we will try to get it for you.

MR. G. L. KARNER [Gulf Research, Gulf Oil Corporation, Pittsburgh, Pennsylvania]: There have been numerous publications comparing the properties of shale-derived distillates versus coal-derived distillates. It should be pointed out that the shale material is a very highly refined material. The coal liquid properties represent a raw distillate. I think Jack is very aware of this, but I did want to point it out. Thank you.

MR. FRANK D. BRUNER [Assistant CMO, R&D, Union Pacific Railroad, Omaha, Nebraska]: I would like to ask Jack Hoffman a question. I know GE has run tests on No. 2 and No. 6 combination fuels. I would like to ask what percentage of the No. 6 fuel mixture he has tested.

MR. J. G. HOFFMAN [Manager Combustion Engineering, General Electric Company, Erie, Pennsylvania]: Frank, the majority of our modern experience, although certainly not all of it, is with roughly 10% No. 6. We have op-

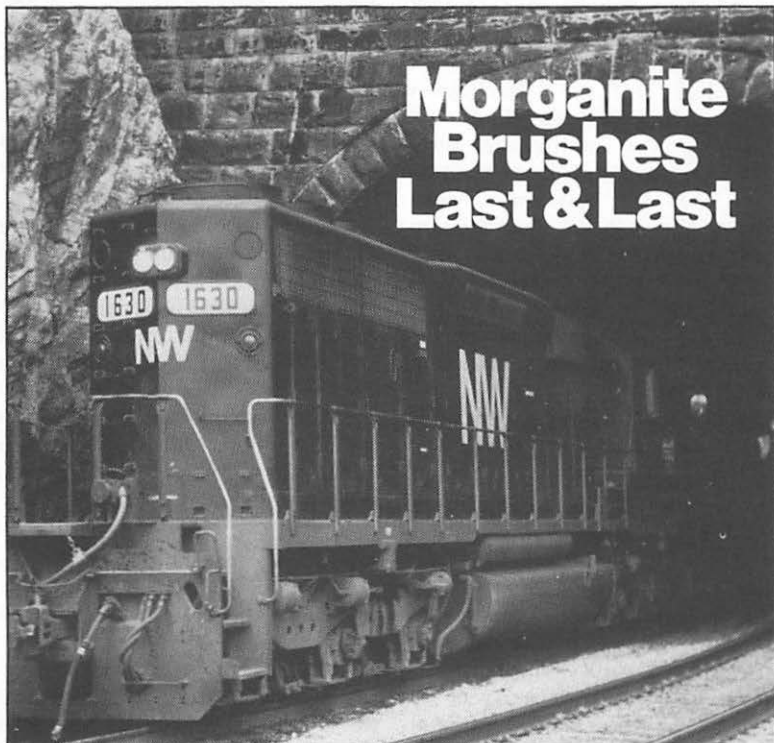
erating experience with considerably higher No. 6 content. But as I indicated in the formal presentation, defining these fuels strictly as a percentage of No. 6 and a percentage of No. 2 is an easy way to talk about it, but is not really the best definition.

We must consider that the No. 6 fuel spec in viscosity alone runs from 900 Saybolt seconds at 100°F to about 9,000 Saybolt seconds at 100°F. Therefore the viscosity is perhaps a better way of defining the fuel, but is hardly perfect.

With a 10% blend one can achieve viscosities, even with the heaviest No. 6, that are still within the range of the G. E. distillate specification of 50 Saybolt seconds at 100°F. We have been operating with a fuel viscosity up to 125 Saybolt seconds measured at 100°F without heating. I hope that answers what I think you are asking about.

MR. BRUNER: May I also ask Mr. Hamilton of the L&N. I understand you people have also run tests with No. 6. Have you had enough experience on the L&N to remark on your tests?

MR. W. C. HAMILTON [Engineer of Tests, Louisville & Nashville Railroad, South Louisville, Kentucky]: We have done some preliminary testing, and the viscosity is one of the things you definitely want to look at. The test we ran did work out very well and was very satisfactory. We actually had no problems with the viscosity or the sulfur. We did not heat the oil. We had a very good



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test on it. I will be glad to talk to you later about it.

MR. DALE H. PROPP [Chief Mechanical Officer, Burlington Northern, Inc., Billings, Montana]: Regarding the multigrade tests that were performed, you mentioned that the tests were done without the use of the friction modifiers. Have any road tests been done with these oils? Also, I would like to know if the 1% to 3% fuel savings were accomplished with or without the friction modifiers.

MR. R. A. BJORN DAL [Senior Staff Engineer, Chevron USA, Inc., San Francisco, California]: I can't address that directly. There are people in this room, however, that can speak to it a little better than I can.

As indicated in the paper, the work we referred to was done as, you might say, a "bug-hunting" expedition. The purpose was to see if there were any operational difficulties on the locomotive as a result of the lower viscosity at low operating temperatures.

A friend of mine sitting right down here is anxious to get up and speak. He can discuss friction modification, and do it better than I. Neill Parkin, would you stand up and chat a bit about this?

MR. NEILL R. PARKIN [Senior Product Specialist, Oronite Additives Division, Chevron Chemical Company, San Francisco, California]: The oil in the field trial he mentioned did not contain a friction modifier, but I am aware of a field test in progress that does

contain a friction modifier. There is stationary locomotive fuel consumption data available that indicates that the majority of the fuel savings is achieved due to multigrading, and only a small portion is due to the addition of a friction modifier.

MR. BJORN DAL: Chevron Chemical has conducted rather extensive work with a stationary full-scale locomotive, with a variety of oil formulations, both with and without friction modification. This work is being reviewed now and has been discussed with some engine builders, and it will be made broadly available to the public shortly.

VOICE: I have a question I would like to address to the engine builders particularly, with regard to the No. 2 and No. 6. As Jack said, the parameters of so-called No. 6 aren't exactly defined. Among the offerings that we are aware of, there are some with cetane numbers as low as 30. I would like to have their advice or recommendations, considering that the other parameters would be acceptable to the use of a product of that type.

MR. HOFFMAN: I am closest to the microphone. I see quite a contingent from LaGrange, including former Committee member Jack Hayden, who may wish to speak also.

The G. E. spec for minimum cetane number, whether it be with a residual containing product or not, is 37. This value does not indicate that it is the lowest possible

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cetane number one could use and get starting under some sets of circumstances. However, it does indicate that, given the normal starting requirements in the United States, 37 is the appropriate value.

Southwest Research Institute is redoing their cetane work on the multicylinder EMD and GE engines. Basically, the number which they find is going to be a value such as 35 to 37. The 37 cetane number will be too low without engine modifications.

The point I wish to make is that engine modifications can be made to affect cetane number minimum requirements. The work we are all talking about, today at least, is the type of fuel that can be used in the existing fleet of locomotives, as opposed to some future fleet of locomotives.

MR. THOMAS PRATT [Electro-Motive Division, LaGrange, Illinois]: I would like to add one thing to Jack's comments in regard to the question asked. Certainly No. 6 residual is going to have a very low cetane number, as you said, in the 30 range. However, I do believe that in the blending we are talking about—10%—the effect is not going to have a major impact on the cetane number. If you start talking about burning 100% No. 6, yes, you have some definite considerations to take care of. But for the small amount, 10% range, that is going to have a minimal impact on the cetane number.

MR. HOFFMAN: Thank you very much. I fully concur with that. I was addressing it as a blend. You are absolutely right.

VOICE: My point for the use of such a product is that the cost would be such (and the other characteristics are such) that you could use it otherwise almost 100%. Could we go to 50% with a product of that type, considering the cetane number, or 25%?

MR. PRATT: I think the main problem you are faced with in the high percentages is how you are going to be able to heat the product, and how you are going to handle it during the wintertime. I believe the viscosity of a No. 6 product is on the order of 3,000 to 6,000 seconds, and it is probably not going to get any better.

When you talk about handling a product of that type, you have to walk before you can run. If you want to handle No. 6 you have a tremendous amount of consideration in terms of pumpability, in terms of cold weather handling, and, in fact, in burning it in the engine. Now you are talking about some rather major modifications to the engine in order to be able to handle that type of fuel.

VOICE: Thinking about true No. 6 or heavy No. 6, which I was thinking about, is something that looks like gas-oil which has a low viscosity. The sulfur is good, and so on. The only thing that is of concern is cetane number. I would expect maybe we should have to do

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some engine tests to get the right mix with something like that. Or would you have some number or type of proportion in mind, that if you had a cetane number that low and the viscosity was fairly comparable to No. 2 light distillate, and so on?

MR. PRATT: Normally, when you talk about gas-oil it is often associated with marine terminology. Usually, gas-oils are the equivalent of typical grades that you find on the railroad today—the 2-D type grades.

In terms of how much cetane number you can drop below 40, as Jack pointed out, you could certainly go down to 37, maybe even 35. There are products being burned in Canada—the tar sands distillates—which are co-mingled with conventional petroleum in the refinery. I believe these co-mingled products have slipped below 40, and in some cases may actually be in the 39 or 38 range.

One problem that arises with lower cetane range is startability. Beyond that, you get into idle and light load combustion problems. The lower cetane fuels are better burned under full load-rated output conditions. They are more difficult to burn at idle and under very light load conditions. As you start blending fuels you start dropping the cetane number. 35 to 37 is probably a reasonable target to shoot at for operation down the road, and I am sure we are going to wind up with a product like that in the future.

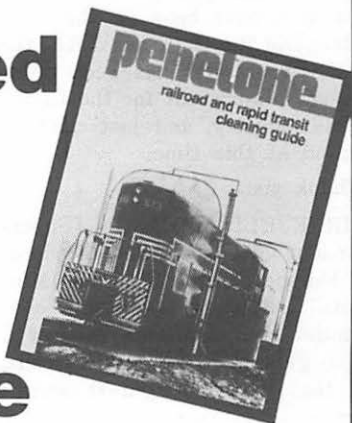
MR. BRUNER: I might remark that in this audience we have a number of members of the alternate fuel group, Mr. Hoffman, Mr. Holmes and myself, Mr. Mike Wall, committee chairman and also people from the DOE, FRA and AAR.

The Phase 2 report is now out on the testing done to date at Southwest Research Institute, funded jointly by the manufacturers, the AAR, FRA and DOE. Most of the preliminary work on alternative fuels has been done with a 2-cylinder EMD engine; however, it has progressed to the 12-cylinder EMD and GE engines at the test facility. That report will be available very shortly from the National Technical Institute located in Virginia. It is very good reading and answers a lot of the questions being asked here.

Also, at the same time I would like to put in a financial pitch because government money is starting to get a little bit tight, with budget restrictions, and so on, and it looks like the private sector is going to have to take up the burden.

I, for one, have already gone to our management to make certain that our Chief Mechanical Officer, vice presidents, presidents, and also the general committee of the AAR are assessed of the need for additional funds. The foregoing tests and tests in the future on the standard diesel engines, 12-cylinder GE and EMD engines, must continue on these alternative fuels to ensure we have the knowl-

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Most certainly I want to thank those who have been on the committee, and the DOE and FRA, for all the work that has been done. It is very important for the future of this industry, and just can't be dropped at this time.

Thank you.

MR. KJELL AXELSON [Superintendent Motive Power, Burlington Northern, Inc., St. Paul, Minnesota]: With the present consumption and depletion rate of 5 billion gallons a year for railroads, and that matched against known petroleum reserves, is there any forecast or guideline to indicate the urgency of the need for finding alternate fuels for railroads in terms of possibly years? This is of much concern to a railroad like the Burlington Northern, because we are using up to 1.8 million gallons a day and it adds up pretty fast.

MR. HOFFMAN: Swede, I don't really think I can answer the question as you stated it—that is, what is the urgency in terms of the rate with which the petroleum reserves of the free world are being used up. Practically every time a forecast comes along, we note that we have additional reserves. I am sure part of that is the result of the change in financial policy in terms of taxes which permits more expensive kinds of product.

I wouldn't want to touch with a 10-foot pole the availability problem. Certainly, though, the cost escalation of diesel fuels and the

competition of the railroad industry for its 1.65% of the total petroleum used affects availability. Competition is going to come in the fuel distillate range that we all presently specify.

The slope of the diesel fuel demand curve is presently going up steeply. The slope of gasoline requirement is going down. When you, and we in the laboratory, compete for that diesel fuel oil that is used for automobile diesels, for truck diesels and all the other newly applied diesel engines, it is going to be tougher to get just on a cost basis.

As far as I am concerned, the urgency today is the urgency of cutting the cost. And those types of engines, whether they be used on railroads or used in marine applications, that can use fuels other than the very fine grade we have historically specified should take advantage of whatever cost incentives there are.

I can only really deal with your question on a cost basis.

MR. AXELSON: I appreciate the cost factor, Jack, but I think right now availability is the most single important factor, and of course if there is no more diesel fuel available the railroads and builders may have to consider planning for another form of prime mover.

I thought possibly, with all the oil companies represented here, they could give us some kind of a feel, possibly, for future planning on which way to go.

MR. CAIN: Gentlemen, I would like to thank you for your attentiveness and interest. We will have to cut the questions off now because we have run out of time. If there are further questions or comments that occur to you between now and Wednesday, I would encourage you to write them down and ask them during the What's Your Problem session at 10 o'clock Wednesday morning.

PRESIDENT CLEVENGER: Thank you, Bill.

At this time I would like to ask Nelson Buskey to come to the platform. He has a little extra-curricular activity to perform. I want to second the suggestion that you save any questions for the What's Your Problem session on Wednesday morning.

MR. NELSON BUSKEY [Assistant General Manager, Chessie System, Huntington, West Virginia]: Gentlemen, at this time the LMOA wishes to recognize a certain individual and his company for their contribution to the success of this Association.

The gentleman we are about to honor was born in St. Louis, Missouri on December 28, 1924. He attended public schools in St. Louis and served as a navigator in the Army Air Corps from January 1943 to June 1946. During this period he attended Haverford College in Pennsylvania. He then attended Washington University, where he received a B.S. degree in Industrial Engineering. In September 1951 he was recalled to service during the Korean war, and

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was discharged in February 1953.

He joined Nalco in 1956 as a field representative for the Industrial Division, and served in various capacities in that Division through 1965. He then became the Manager of Process Chemicals for the Transportation Division. In 1967 he was promoted to Manager of the Transportation Division. In 1972 the Transportation Division was absorbed by the Industrial Division, and he became National Sales Manager for the Specialty Chemicals Group. He has been a member of LMOA since 1966.

He has three children and one grandchild. He and his wife, Marti, currently live in Wheaton, Illinois.

Gentlemen, may I present to you Mr. Nicholas C. Eckerle. Nick, will you come forward, please? [Apause]

Nick, in recognition of all you and your company have done for the LMOA, we would like to present to you this desk set, emblematic of our Association, and also an honorary life membership. [Applause]

MR. NICHOLAS C. ECKERLE: This is absolutely beautiful. Thank you. This is a complete surprise. I was on my way out of the room at the end of Jack Hoffman's talk. I thought I had better get to the room to make sure the tables and chairs were set up for our luncheon today. Dennis grabbed me and said I should come back in.

This is a wonderful surprise. It is a terrible thing for a salesman to be at a loss for words, but I do appreciate it, and I thank Nelson, Bob, and all the other members of



Nick Eckerle, of Nalco Chemical, accepts General desk set from LMOA 1st Vice President Nelson Buskey. LMOA President Bob Clevenger, center, beams his approval.

LMOA. They are the backbone of this organization, and they really do pay all the bills.

Remember, when you visit those rooms, do so only at times other than during the meeting. They will not be open for business during the time meetings are going on. We

certainly don't want to embarrass any of them by showing up while meetings are in progress.

Now let's give the Committee a rising vote of thanks.

[The audience arose and applauded.]

[The meeting recessed at noon.]

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the Association. Thank you very much, gentlemen. [Applause]

**PRESIDENT CLEVENGER:** At this time I will call on Dick Holmes to summarize the Committee's paper.

**MR. HOLMES:** We have certainly had a great paper presented this year by the Committee on Fuel and Lubricants.

I say amen to Jack's comment and to Swede Axelson's question with regard to the urgency of increased availability of railroad product, and also to Jack's comment that the railroad industry and the builders need to coordinate with the oil companies to definitely point the direction to the supply industry that we feel they should work on alternative fuels to ensure supply of our needs. This may result in some degree of inconvenience for us, the users, and may also involve some tradeoff in maintenance requirements. We must jointly address these salient points.

The work with alternative fuels is progressing on the research level, and to a limited extent in the field. I am certain railroad field tests will be expanded during the coming year. Additional field tests will be progressed to determine how changes in visco-metrics, as exemplified by 20W40 oil, fits the appetite of both builders' engines and what positive results are obtained in cost effectiveness.

Greater potential reduction in cost of fuel oil may be found in the use of heavier fuel combinations, as opposed to the No. 2

light distillate which are now common. Prime considerations at this time are the availability and cost of such alternative fuels and what maintenance offset is encountered in their use.

The mixer-divider system is one of the outstanding innovations of recent years to ensure reliability in the engine fuel system and avoid costly down time in winter operations. An innovative method of oil analysis has been presented by your Committee that is known as ferrography. The investigation of the technique by the Union Pacific R&D was brought to your attention.

Gear lubrication is still undergoing change. The practice is not standard, as recommended by the engine builders or as accepted and used by the railroads. The entire Committee is to be commended for this outstanding contribution, as evidenced by their thorough investigations and reporting of recent developments and practices relating to locomotive fuels and lubricants.

**PRESIDENT CLEVENGER:** Thank you, Dick.

We have all listened this morning to words that I know are near and dear to our hearts, and I am sure we will all remember them.

I have one announcement. I would like all of you to look at this year's program and read the Honor Roll of Advertisers shown on the back. If you are visiting any of the hospitality rooms, thank them for advertising with the

# MONDAY AFTERNOON SESSION

## September 28, 1981

The meeting reconvened at 2 p. m., Mr. R. G. Clevenger, President, presiding.

**PRESIDENT CLEVENGER:** This afternoon I think we will start a little differently. This morning I said "gentlemen." This afternoon I will have to say "ladies and gentlemen." I keep forgetting that we have ladies on these railroads now, and I don't want to miss anyone.

Ladies and gentlemen, it is now two o'clock and we will begin our afternoon program. According to the blow-by-blow description of events that our esteemed Secretary puts out each year, I am supposed to give a little talk at this time; so please bear with me.

This morning we opened the 43rd annual meeting of the LMOA with an inspiring talk by Mr. A. W. Johnston, Vice President-Operations and Maintenance of the AAR. Two days from now, when this meeting is adjourned, I am sure all of you will agree with me that this year's meeting has been one of the most informative on record.

I can predict this because, being your President, I have been privileged to attend a number of the pre-convention presentations and can testify to the fine job being done by the technical committee chairmen in developing their subjects for presentation. The hard work that has gone into preparing

these papers certainly deserves your undying interest, and I hope each and every one of you can return to your home point and report to your boss on the excellent information you obtained while here.

To fully benefit from these reports you must participate in the floor discussions and comment on particular problems that you may be experiencing on your railroad. It is well to remember that the questions that will remain unanswered are questions that were not asked during the floor discussion.

There are many practices that different railroads are using, all pointing to the same result, and the purpose of the Locomotive Maintenance Officers Association is to publicize these innovations through the committee papers so that everyone can benefit, if they so desire, from the tried and tested methods that have been developed. These methods have prompted our locomotive builders to eliminate in some instances redundant maintenance or to improve operating results in other areas.

In my opinion, the LMOA is a great communication system, wherein mutual problems and experiences are exchanged on a free-flow information basis. I am sure many problem areas would not be eliminated without this Association.

Our attendance totals at this time sound good, and promise to get better before the sessions wind up on Wednesday. While we would like to see more people at these meetings, it appears that we are going to have to look more and more to quality of attendance rather than quantity. By this I mean better and more participation by the smaller numbers in the business of the meeting as a whole.

Last year President Jim Long pointed out that the theme for the year 1980 would be "Decade of Progress." Every dictionary I have read defines decade as ten years, and I expect to see ten years of progress by the LMOA. You might say the year 1981 could be called "Decade of Progress, Chapter II."

I know all of you can think back and remember how progress has affected your life as a railroader. As an example, if you happen to have been associated with the electrical end of railroading, try comparing the present-day high horsepower locomotive with the original diesel electric locomotive produced in the 1940s. It is like comparing a new LTD Ford with the Model "T" which I am sure all of you can remember.

Many progressive ideas have been brought forward, such as remote control operation of helper consists, run through and complete interchange of locomotives with other railroads, welded rail, and radio communication between the locomotive and caboose which made it possible to converse with any and all who are responsible for



**R. G. CLEVENGER**  
PRESIDENT

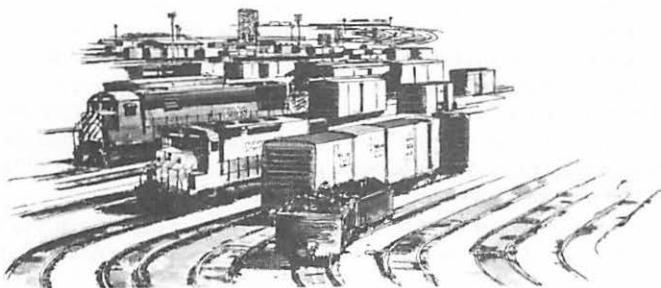
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Kansas City, KS

efficient railroad operation. We have progressed from an industry where each division was a kingdom and each superintendent a king, to an entire industry that works together more and more as a unit.

While railroads as a whole have made progress by leaps and bounds in the past few years, the need for efficient and progressive management is a must. One of the major problems underlying the economic difficulties of our industry, and the United States as a whole, is our dwindling productivity. This message has been forcibly brought home as we find ourselves buying more and more articles produced in a foreign country. Whether they be automobiles, cameras or TV sets, the finger of responsibility for our reduced ability to compete is pointed not just at the business community, not just at the working man, not just at the government, but at the whole fabric of our society.

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GENERAL  ELECTRIC

One of the difficulties in discussing the problem of dwindling productivity is the definition of the illusive term "productivity." Our economic wealth is produced by the coordinated use of labor and capital in the production of our goods and services, and the efficiency of that production also depends upon the contributions made by both machines and the people who operate them. Regardless of which element is the more important factor, we do know that to obtain high productivity requires management skill and training on the part of managers.

Today the railroad industry is classified as a "capital-intensive" industry, meaning that large amounts of money have to be invested in the real property to furnish employment for our people. Where the original investment in the railroad amounted to about \$70,000 per employee, if these assets were revalued at today's cost the figure would probably be closer to \$200,000 per employee.

The great opportunity for improving the use of our facilities is now squarely up to railroad management and employees. Ways to increase our productivity are one of the underlying goals of the LMOA. Efficient and progressive management of our railroads will be one of the reasons we can continue to compete as a competitive mode of transportation in a race that appears to have the cards stacked against us.

We know your management is progressive by your attendance

here at this Chicago meeting. In this way you can pick up the best part of the technical papers and take them home to improve your own maintenance practices. We welcome any contributions from the manufacturers and/or supply people, when their products are being discussed, since we do want all of the facts.

No doubt there will be questions asked that the chairman or his committee do not have a ready answer for. These questions will not be ignored but will be given to the "What's Your Problem" committee who will try to get the facts or answers before the Wednesday morning session. If for some reason the question cannot be answered at that time, the committee chairman will enter it as one of the problems for next year so that he can get a definite solution. While we don't anticipate questions that can't be answered by someone on the committees, or a member from the floor, it is possible this might happen.

Many of you, like myself, have been a part of this organization for a long time and, in fact, for most of our management careers. We realize full well the benefits presented to us over the years by the activities of our various committees and the discussions that have taken place on each of our subject reviews.

The problems facing us for the immediate future, and the problems to be faced by the maintenance officers of tomorrow, make it all the more important that we do

everything possible to maintain this organization to ensure continued progress on the part of all concerned.

Our technical committees have done a fine job in developing their subjects for presentation. The hard work that has gone into their papers for presentation certainly deserves your maximum interest, and I hope you will take part freely in asking questions and assisting with the discussions of these topics for the rest of these meetings.

It has been a great pleasure for me to have served as President of this fine organization for the past year. I have enjoyed my association with my fellow officers, and I know that your incoming President Nelson Buskey will carry on the fine work that has been started here.

Thank you all for this opportunity. [Applause]

At this time I would like all of us to stand in a moment of silence in memory of our deceased LMOA members this past year, especially John Ekin, Past President, who passed away last month.

[Silent standing tribute to deceased members.]

**PRESIDENT CLEVENGER:**  
Thank you.

At this time I would like to call on Second Vice President Frank Bruner, Assistant C.M.O., Research and Development, Union Pacific Railroad, who will serve as officer of this session.

**MR. BRUNER:** Thank you, Bob.  
I would like to call on Fourth Vice President Darrell Walker,

Diesel Superintendent, Southern Railway, Atlanta, to give the membership report.

**MR. D. M. WALKER** [Diesel Superintendent, Southern Railway, Atlanta, Georgia]: This is the membership report as of September 1, 1981:

Active members, 1,022. Associate members, 384. Advertisers (whom we appreciate very much), 114. Total, 1,520. Hopefully with the people who joined in September and here at the meeting we will reach our goal of 2,000.

**MR. BRUNER:** From what I saw this morning, I think we will have a fine turnout of people here today, especially with the economic and travel conditions as they are. It takes a real effort to get here, and we certainly appreciate it.

Now I would like to call on Past President Ky Pruchnicki to give us the report of the Nominating Committee.

**MR. KY PRUCHNICKI** [Retired General Supervisor Locomotive Maintenance, Southern Pacific Transportation Company, Houston, Texas]: Mr. President and members, the report of the Nominating Committee for the year 1981-82 is as follows:

#### LMOA NOMINATIONS FOR THE YEAR 1981-82

Following is the Nominating Committee's Report for the Year 1981-82:

President:

N. A. Buskey, Assistant General Manager, Chessie System, Huntington, WV



**KY PRUCHNICKI**  
(Retired)

General Supervisor Loco. Maint.  
Southern Pacific Transportation Co.  
San Francisco, CA

**1st Vice President:**

F. D. Bruner, Assistant Chief  
Mechanical Officer, R&D, Union  
Pacific Railroad, Omaha, NE

**2nd Vice President:**

R. R. Holmes, Director Chemical  
Labs and Environment, Union  
Pacific Railroad, Omaha, NE

**3rd Vice President:**

D. M. Walker, Diesel Superin-  
tendent, Southern Railway Co.,  
Atlanta, GA

**4th Vice President:**

Kjell Axelson, Superintendent of  
Motive Power, Burlington North-  
ern, Inc., St. Paul, MN

**5th Vice President:**

W. R. James, Chief Mechanical  
Officer-Locomotive, Chessie Sys-  
tem, Huntington, WV

**6th Vice President:**

D. H. Propp, Chief Mechanical  
Officer, Burlington Northern,  
Inc., Billings, MT

**Regional Executives:**

B. A. Cumbea, Manager, Locomo-  
tive Maintenance-Engineering,

Chessie System, Huntington, WV  
Mike Gogol, Chief Quality Con-  
trol Officer, Southern Pacific  
Transportation Co., San Fran-  
cisco, CA

E. R. Hafling, Engineering As-  
sistant, The Atchison, Topeka  
and Santa Fe Railway Co., To-  
peka, Kansas.

J. D. Smalling, Chemical Engi-  
neer, Southern Pacific Transpor-  
tation Co., San Francisco, Cali-  
fornia.

J. L. Kuhns, Manager, Planning  
and Maintenance Family Lines  
Rail System, Jacksonville, FL

D. L. Ward, Coordinator, Shop  
Methods, Burlington Northern,  
Inc., Springfield, MO

This is the proposed slate. Are  
there any other nominations? If  
not, all those in favor of the slate  
please say "aye." Any opposed?  
The slate is approved.

MR. BRUNER: Thank you, Ky.  
I will now call on Past President  
Tom Harley for the report of the  
Treasurer.

MR. E. T. HARLEY [Vice Presi-  
dent-Equipment, Trailer Train  
Company, Chicago, Illinois]: Mr.  
President and gentlemen, this is  
the report of the Treasurer:

MR. BRUNER: Thank you, Tom.  
I would now like to call on our  
Secretary, Joe Koerner, for his re-  
port.

MR. JOSEPH J. T. KOERNER  
[Huntington, West Virginia]: In-  
flation continues to take its toll of  
our Association, while mergers and  
consolidations tend to reduce our  
membership base.

LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION  
STATEMENT OF REVENUES, EXPENDITURES  
CASH BALANCES — CALENDAR YEAR 1980

BALANCES IN FUNDS JANUARY 1, 1980:		
Checking Account — Security Bank	\$ 4,612	
Reserve Account — Security Bank	16,681	
Total		\$21,293
REVENUES:		
Interest on Reserve Account	\$ 679	
Active Membership Dues	9,456	
Associate Membership Dues	7,222	
Registration Fees	1,840	
Advertising Revenues	20,128	
Miscellaneous	176	
Total Receipts		\$39,501
EXPENDITURES:		
Convention, Publication and Travel Expense	\$19,161	
Office Expense, Office Assistance, Payroll Taxes, Supplies, Postage and Stationery	21,344	
Total Expenditures		40,505
Excess Expenditures Over Revenues		( 1,004)
BALANCES IN FUNDS DECEMBER 31, 1980		\$20,289
Checking Account Balance	\$ 2,929	
Reserve Account Balance	17,360	
Total	\$20,289	

APPROVED:  
R. G. Clevenger, President

APPROVED:  
N. A. Buskey — 1st Vice President

Approved this 6th day of April 1981, Chicago, Illinois.



**JOSEPH J. T. KOERNER**  
Secretary-Treasurer

To overcome these twin problems we are proposing a new approach to our railroad membership drive, which will be a fair and equitable approach and hopefully will return the Association to a more stable

condition. The support of all railroad membership chairmen is earnestly solicited in this endeavor. We will advise you further as the plan unfolds.

After twenty years of outstanding service to the Coordinated Associations, Al Schiffers is stepping down as Executive Secretary. While many of you may not know Al personally, he was the man behind the scene—a perfect gentleman and a wonderful person to work with. We will miss him.

W. J. Burrows, who was President of RSA in 1977, is filling Al's shoes, and we pledge him our complete support and wish him every success.

Are there any questions? If not, this completes the Secretary's report. [Applause]

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# MONDAY AFTERNOON SESSION

## September 28, 1981

### REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

PICTURE  
NOT AVAILABLE



**T. L. WESTERFIELD, Chairman**  
Senior Electrical Engineer  
Chicago & Northwestern Trans. Co.  
Chicago, IL

**FRANK D. BRUNER**  
Assist. Chief Mechanical Officer, R&D  
2nd VICE PRESIDENT  
Union Pacific Railroad  
Omaha, NE

**MR. BRUNER:** Thank you, Joe. Will the members of the Committee on Diesel Electrical Maintenance please come to the podium and take their seats.

[Mr. Bruner introduced Mr. T. L. Westerfield, Senior Electrical Engineer, Chicago & North Western Transportation Company, Chicago, Illinois. Mr. Westerfield then introduced the members of his Committee.]

[Mr. Westerfield and Mr. N. Thibodeau, Senior Electrical Engineer, Canadian National, Montreal, Quebec, summarized the Committee's paper.]

**MR. WESTERFIELD:** We will welcome any questions from the floor on any of these subjects.

**VOICE:** What is the cost of the traction motor tester, to the nearest \$10,000?

**MR. NORMAN BECKER** [General Electric Service Shop, General Electric Company, Cleveland, Ohio]: Buying a tester is a lot like buying an automobile. You buy the base unit power and then decide how many gadgets you want to go with it. Some test stands are sold with the Hy-Pot unit, some with the impedance tester, digital tachometer, vibration indicator,

digital bearing temperature indicators and protective devices. These options should be incorporated in a good test stand.

Roughly, the test stand runs around \$48,000, give or take a few thousand, depending on what options you want with us. All of the above options are included except the Hy-Pot.

VOICE: When you run your motors forward or in reverse, how much differential do you allow in current from one direction to the other?

MR. THIBODEAU: It is fairly low. Basically we set the voltage on the field and we try to keep the speed within 10 rpm. Perhaps Mr. Becker or Mr. Eland might be able to answer that question better than I.

MR. STEVE ELAND [General Electric Company, Cleveland, Ohio]: What we are watching for between the forward and reverse directions of the motor is a difference of less than 25 rpm.

The current on the field and the voltage to the armature will be within 2% when reset in the opposite direction. Using this 2% as the variable, a good remanufactured motor will be within 25 rpm in either direction. We are experiencing variances of less than 10 rpm at our Service facility.

MR. MORRIS CHANDLER [Consolidated Rail Corporation, Altoona, Pennsylvania]: On your vibration analysis, what is your recommended condemning limit?

MR. THIBODEAU: The limit we use is .3" seconds on horizontal,

vertical and axial planes, which is the limit recommended by the supplier of the tester.

MR. CHANDLER: Maybe Steve can tell us how that number was arrived at.

MR. ELAND: It primarily was arrived at as to the maximum vibration limit of the motor, as suggested by the manufacturer. We test the motor for vibration on its spin-down cycle with no power applied to the motor armature. The vibration is measured from 2300 rpm on down. We have a strip chart which records the vibration on each of the three axes and use this for accepting or rejecting the motor for vibration failure.

MR. WESTERFIELD: May I add that the answer to that question really depends to a great extent on the kind of vibration equipment you are using, whether you are doing spectrographic analysis, whether total band amplitude, and to some extent you are going to have to work with your equipment supplier plus the school of hard knocks, your own experience with results on your own motors, to set the standards for the type of testing you do. I know in the case of our shops we do octave band analysis, and we have different condemning numbers in different octave bands, depending on whether it is bearings, misalignment, and that sort of thing.

MR. VIRGIL WHEATON [General Electric Company]: You have to watch how you mount the motor. You can wind up with a resonant

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situation on the way you have it mounted on the floor. It can scare the hell out of you and still wouldn't hurt.

MR. THIBODEAU: We have the motor on a steel table, and we have a rubber pad between the steel and the motor. The motor is chained down as hard as we can to the table. The table itself is anchored to a concrete floor.

MR. WESTERFIELD: True, but I personally have trouble believing that something weighing 6,000 pounds can jump around.

Are there any further questions from the floor? One of the things we discussed in preparation for this year's paper was the potential for this Committee to undertake the task of preparing troubleshooting guides or hints or tips in written form for use by various railroads. Would anyone like to address this subject, as to whether you would find this useful?

So that everyone may remain anonymous, may I have a show of hands of those who might be in favor of us undertaking a test like that? Thank you.

I mentioned briefly that we had very limited experience with the new model locomotives of both builders. Is there anyone here who would like to bring up anything for discussion on those models at this time?

MR. BRUNER: I would like to inquire of the manufacturer or anyone else that might be involved, as to their progress or ideas concerning an onboard computer sys-

tem for locomotives. We at Union Pacific feel there is need for utilization of the computer technology in two areas onboard the locomotives. One system would monitor the operational parameters of the locomotive consist and could at the same time monitor some mechanical functions as deemed necessary. A second use of a process type computer could be to simplify control functions and other mechanical functions of the diesel engine and electrical system.

I know there have been at least a few companies involved in various approaches in the past. I recall a few years ago Bendix was involved with one of the Eastern railroads; Harris Controls has been involved for several years with the Canadian Pacific, and there are others that have been involved or are still working on various systems. Would the manufacturers or anyone else care to comment in this regard?

MR. D. I. SMITH [Senior Service Engineer, General Electric Company, Erie, Pennsylvania]: The computer age is upon us, and certainly we are headed that way. At the moment we are using computer analysis in our own laboratory, where the equipment is part of the laboratory and not part of the locomotive or the engine.

The day is not here yet when the computer is as reliable as the locomotive, and until it is we continue to hesitate to burden you with one more piece of maintenance equipment. But the day is coming. One of the biggest headaches will



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be the development of transducers that will accurately reflect the true status of the equipment to the computer, and until we can do that as reliably as we have to do it, we hesitate to bring it to the industry.

MR. T. G. WINFIELD [Assistant Manager, Technical Service, Electro-Motive Division, LaGrange, Illinois]: There are two areas covered by this question. The first is for onboard diagnostics of locomotive problems. We as a Committee have been looking at it, and as a manufacturer we are looking at input from the railroads of what types of onboard diagnostic equipment you would like to see on your future locomotives.

That is one area where the microprocessor, the minicomputer, can aid us in our troubleshooting of a locomotive. The actual control is something that is down the road. As Dave said, it is something that everybody is going to be looking at. It is a matter of getting the hardware and making it as reliable as the locomotives we are accustomed to. It is hard to beat the .1% or .2% of an old relay. We can put it on an airplane, but it is not the environment that we see on a locomotive.

MR. WESTERFIELD: I might add in this regard that there has been some preliminary pioneering work done in this area. The Federal Railroad Administration's LDAP program certainly presented a first-cut approach to this type of equipment. It was quite expensive. It was intended as a demonstration project, and I be-

lieve some of the data was taken on the UP as well as the Boston & Maine. I have seen some of the results of that. I also noticed in the lobby there are a number of suppliers represented here today who are making approaches in this direction in terms of onboard equipment.

In terms of justification or impetus for this kind of discussion, at the Joint Railway Technical Conference in Atlanta last spring the Southern Pacific made an interesting presentation. They had run some tests and had measured the fuel consumed by a locomotive, and measured the drawbar output of the locomotive at the same time it was having its fuel consumption measured. They found differences, depending on the age and condition of the locomotive, as high as 6% in terms of the thermal efficiency. That is, in some of the locomotives as much as 6% of the energy input in terms of fuel compared between one locomotive and another locomotive, as much as 6% more of the energy in the fuel was disappearing between the engine and the drawbar. This would certainly suggest in this period of \$1-per-gallon fuel that there might be an awful lot of our money that is leaking out of the corners of the locomotive due to minor discrepancies in locomotive performance that we can't even measure with our present equipment.

If you talk about 5% to 6% of all our fuel bills, we are talking about some big bucks. I think this is certainly an area that is going



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to justify further research and experimentation.

MR. BRUNER: I think these comments pretty well answer my question. I realize there will be problems involving placing onboard computers in the locomotive environment where it is subjected to a severe mechanical, electrical, and temperature problem.

I, for one, have been very much interested in adapting microprocessors into the locomotive control functions in areas such as the engine governor, excitation system, wheel slip system, temperature control, and other lesser tasks. This microprocessor could greatly simplify the function of power contactors sequencing and interlocking, reduce the engine speed control to a single wire operation, provide more exacting control of transition, reset ground relays, and provide better protection to the diesel engine under varying operating conditions.

One of the problems involved with the computer monitoring or control is in the area of transducers which are reliable and can also live in a locomotive environment. Having been involved in railroad testing for several years, we find that measuring devices that provide accuracy of less than 1% and have good resolution and sensitivity are hard to come by. This is particularly true when the environment or use of these devices must be capable of at least half life of the locomotive without failure. There has been progress in some areas; however, other areas are

still deficient in their reliability and accuracy.

In spite of this, there is need to keep investigating, testing, and working toward simplifying the locomotive system in order to increase its availability, reliability and efficiency by utilizing microprocessor systems to our advantage.

One of the items I had mentioned concerned the replacement or improvement of the present governor of our locomotives in the fleet today that utilize a hydraulic governor that is good in many respects and provides several functions. However, on a fleet average and in day-in-day-out operation, it is subject to operating the diesel engine from 30 to 100 horsepower above or below the locomotives' rating. I believe this to be one device that could be improved upon by utilizing a microprocessor system.

Are there any comments from the manufacturers in this area.

MR. WINFIELD: I am not really prepared to talk intimately about this kind of thing that could be done. I wonder if there is anyone here who would like to address that. Someone from our Engineering Department might be able to fill us in a little more on this.

MR. BRUCE R. MEYER [Electro-Motive Division, La Grange, Illinois]: We have started the initial work for microprocessor control of a locomotive. We have not progressed to an actual prototype unit yet. Microprocessor control of a locomotive will be a reality in the

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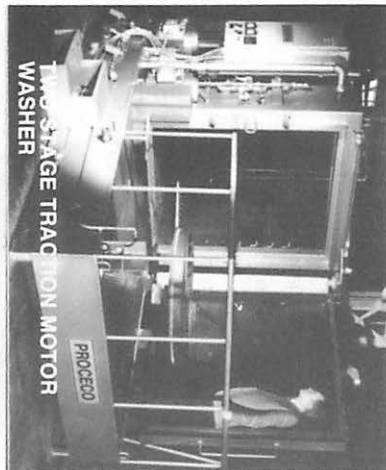
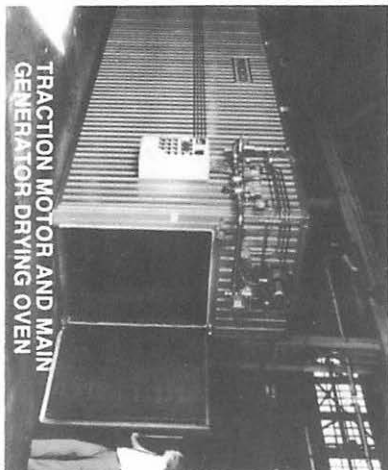
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future. It is not going to happen as quickly as you might like, because there is a lot of work needed to perfect it. When microprocessor control arrives, there will be various degrees of diagnostics. This is basically all I can say at the moment.

**MR. SMITH:** We have much the same response to this question. The day is getting nearer and nearer, and the problem is getting bigger and bigger. We are looking at it now. A lot of smart people are trying to solve this problem of adapting the microcomputer to the railroad environment. It is going to happen, and it will be a better locomotive.

**MR. WESTERFIELD:** Is there anyone else who would like to speak? If not, I will call on Mr. Cumbea to summarize the paper.

**MR. B. A. CUMBEA** [General Manager, Locomotive Maintenance-Engineering, Chessie System, Hunt-

ington, West Virginia]: First of all, congratulations to Tom and his Committee for an excellent job. Perhaps they were a little too thorough in their coverage, because they didn't leave much room for questions. Discussion is the heart of our meetings. We would like to see more discussion of papers in the future.

Traction motor problems and failures are one of the very high contributors to annual budgeted dollars and, as such, offer a continuing area for improved policies and repair techniques. It is reassuring to have this Committee keep us abreast of new procedures and their potential impact on improved performance as well as the economies which may be realized. We hope that the Committee will continue its efforts in future papers, and particularly would like to see the continued use of survivorship curves as a statistical approach to monitor potential benefits of changing design and repair practices.

Today's locomotive electrical systems or circuits have become more and more complex, requiring ever-increasing needs for re-educational programs. The troubleshooting guides offer mechanics a useful tool in locating the source of a problem when a malfunction occurs or is reported. One approach in using these guides which has proven beneficial is to have them printed on pocket-size paper and encased in plastic so that they can be carried and be readily available as needed.

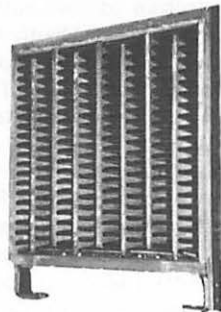
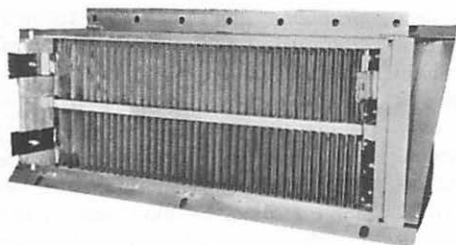


**B. A. CUMBEA**  
Gen. Mgr. Locomotive Maint.-Engineering  
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We are pleased to see that the Committee has presented a follow-up on batteries and battery-charging systems which was generated by the floor discussion last year. One new problem in this area concerns the frequent shutting down and starting up of engines for fuel conservation. This may offer the Committee a challenge and a topic for future papers.

In the final section, devoted to selection of locomotives for major repair or overhaul, there is a continuing need to develop the economic life cycle of a locomotive and the intermediate heavy repair requirements before a locomotive is ultimately retired. This not only involved transportation, mechanical and purchasing departments as indicated, but is of major concern to financial planning particularly with respect to cash flow, investment costs, depreciation and taxes. In the future we would like to hear further discussion or recommendations on what to do with locomotives that are 30 years old or older.

In conclusion, I would like to congratulate Tom and his Committee on their preparation and presentation of a very informative

report. Before you show your appreciation to the Committee for a job well done, I will turn the meeting back over to Frank for closing remarks.

MR. BRUNER: Thank you very much, Bud. I can't really fault our Committee on the length of the report. Tom and his Committee did a great job, doing everything extemporaneously. All of you did a very good job. We appreciate the response we have had from the floor, and if you have any more problems don't hesitate to bring them up at the What's Your Problem session on Wednesday.

PRESIDENT CLEVINGER: I would like to suggest that all of you read your Proceedings book when you get back home. If you don't happen to have one, borrow one from a friend. Read the complete report and you will get the complete story.

Again we thank the suppliers who are supporting the LMOA.

Now let's give the Committee a rising vote of thanks.

[The audience arose and applauded.]

[The meeting recessed at 3:30 p.m.]

# TUESDAY MORNING SESSION

## September 29, 1981

### REPORT OF THE COMMITTEE ON SHOP EQUIPMENT



**T. A. KESSENGER, Chairman**  
Senior Engineer-Facility Planning  
Louisville & Nashville Railroad Co.  
Louisville, KY



**KJELL AXELSON**  
5th VICE PRESIDENT  
Manager Motive Power-Mechanical  
Burlington Northern, Inc.  
St. Paul, MN

The meeting reconvened at 9 a.m., Mr. R. D. Clevenger, President, presiding.

**PRESIDENT CLEVENGER:** Good morning, gentlemen. This morning we want to welcome you to the second day of our 1981 meeting. At this time I will call on our Fifth Vice President, Kjell Axelson, Superintendent of Motive Power, Burlington Northern Railroad, to serve as officer of the session.

**MR. AXELSON:** Good morning. It is a privilege and pleasure to be associated with a hard-working, hard-hitting and hard-fact Committee, the Shop Equipment Committee. This Committee ferrets out and attacks the latest available

technology to bring to you the beneficial aspects of using the information for increased productivity and quality control, very important work these days, while simultaneously reducing your maintenance costs.

Just to bring progressive thinking in perspective, I am reminded of a story about a woman and her daughter who were watching a typical romantic movie of the 1930s on television. After it ended, with the usual clinch and fadeout as most movies of those days did, the daughter turned to her mother and said, "Gee, Mom, your movies end where ours begin." [Laughter]

[Mr. Axelson introduced Mr. T. A. Kessenger, Senior Engineer-

Facility Planning, the Family Lines Rail System, Jacksonville, Florida and chairman of the Committee on Shop Equipment. Mr. Kessenger then introduced the members of his Committee.

[The paper was summarized as follows:

[Part I, by Mr. M. G. Marler, Mechanical Superintendent Shops, Union Pacific Railroad, Omaha, Nebraska.

[Part II, by Mr. G. B. Sweeney, General Foreman, Southern Railroad, Atlanta, Georgia.

[Part III, by Mr. T. E. Whitten, Precision National, Mount Vernon, Illinois.

[Part IV, by Mr. J. R. Snowden, Industrial Engineer, Illinois Central Gulf Railroad Company, Paducah, Kentucky.

[Part V, by Mr. P. F. Hoerath, Superintendent Plant Engineering, Conrail, Altoona, Pennsylvania.

[Part VI, by Mr. W. R. Doyle, Diesel Supervisor, Missouri Pacific Railroad Company, Omaha, Nebraska.

[Part VII, by Mr. L. G. Salts, Engineering Assistant, Atchison, Topeka & Santa Fe Railway Company, Topeka, Kansas.

[Shop Equipment, by Mr. T. F. Kelly, Chrome Crankshaft Locomotive Sales Company, Rock Island, Illinois.]

MR. KESSENGER: These are the areas we wanted to cover. I would like to ask you to search your minds and come up with any topics you might want us to cover for next year. If you are bashful perhaps you can write them down

and give them to one of our officers. We need your input to be able to cover the areas that railroads are interested in today. So, if you have a shop facility item or a piece of equipment you are wondering about, or maybe even an area that there is not a piece of shop equipment made for and that you would like us to look into, write it down and give it to any of our officers.

Are there any questions in regard to any of the areas we have covered this morning?

VOICE: I want to thank Mr. Kelly for reading the part of the report covering the D. M. & I. R. Mr. Merle Anderson, author of the report, just became a new father, and that is why he is not here. I think he did a good job on that report, too.

MR. KESSENGER: Thank you. It is always good to have people hear our presentation. We weren't able to put that particular section in the book this year because our slides were not adequately prepared, but our officers have told me they will put it in for next year.

Any other comments or questions?

MR. RICHARD R. STEELE [Peaker Services, Brighton, Michigan]: I have two questions. On the GE power assembly you mentioned a figure of \$750. Do you know what that includes? Is it capital cost, labor, parts, or what?

My second question: On the de-stratification fans, have you had any employee complaints about



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drafts?

MR. SALTS: The \$750 includes all costs, labor and material as of May, 1980. It has increased a little since then, but not a great deal. It does include everything.

MR. KESSENGER: Is that direct labor, shop overhead, fringe benefits?

MR. SALTS: Direct labor involved.

MR. KESSENGER: And the parts that are associated with that?

MR. SALTS: Right.

MR. STEELE: Does it include any of the capital costs for the equipment that was designed and developed for that?

MR. SALTS: I don't believe it does. I am pretty sure it doesn't include those capital costs. The capital costs were recovered in a very, very short time period. This shop paid back in a very short period of time, I believe.

Tom Enns, sitting over here, might want to elaborate a little on that, because he was involved in putting this shop together. Both of us were, but there was a very short payback on that.

MR. THOMAS ENNS [Atchison, Topeka & Santa Fe Railway Company, Topeka, Kansas]: Yes. The \$750 does not include the initial cost of getting the shop going. We are looking at an investment of about \$130,000 to get the shop going. The \$750 does include labor, payroll and additive cost for that labor. The \$750 does include all material that went into the assembly. The \$750 does not include shop overhead.

MR. SALTS: I believe that payback came back within less than two months; right?

MR. ENNS: Yes. Prior to that we were unit exchanging all our power assemblies with GE, and the shop calculated out to pay for itself in about 43 days. In other words, we recovered our initial investment using 1978 usage figures.

MR. KESSENGER: It is hard to get everybody to agree on what shop overhead is. Some shops figure the total points and divide by the total labor, and others figure on each installation. We have run into this problem. It is hard to put down an actual cost.

Would you please repeat your second question?

MR. STEELE: The shop becomes drafty when the destratification fans are running. I wonder if anyone has had any employee complaints because of drafts in the shops.

MR. HOERATH: The fans have not been installed in that particular area as yet. We have them in another building similar to that, where our engineering department is working. They are proving very satisfactory.

MR. KESSENGER: Any other comments or questions from the floor? If not, I would like to call on Mr. E. R. Hafling, Engineering Assistant, Santa Fe, to summarize our paper.

MR. E. R. HAFLING [Engineering Assistant, Santa Fe Railway, Topeka, Kansas]: The Shop Equipment Committee's paper, entitled "Tools and Training for Productiv-

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ity," covering such items as Training Aids, Testing Devices, Some More Tools, Shop Supply and Service Facilities, takes in a broad spectrum of shop operations that can help improve production by doing a better job because of increased know-how with the use of more efficient tools in an upgraded work area. This is a very timely paper because it shows what is being accomplished in plant facilities to conserve energy and maintain conservation-oriented equipment. This indeed has been a very good presentation, and I think the Committee should have a big vote of thanks. [Applause]

Now I would like to turn the meeting back to Swede Axelson.

MR. AXELSON: Thank you, Elmer. I think you will all agree with me that this Committee gives full measure. I believe they used the psychology of the salesgirl in the candy store who always had customers lined up waiting for her, while other salesgirls just stood

around doing nothing. The owner of the store noted her popularity, and asked for her secret. She said, "That's easy. The other girls scoop up more than a pound of candy and then start taking it back. I always scoop up less than a pound and then add to it."

Let's give the Committee a vote of thanks and excuse them. [Applause]

PRESIDENT CLEVINGER: I would like to tell you about something new that we have started this year in the LMOA, for you people who received your Proceedings book in the mail and were a member prior to coming to this meeting.

We have started a five-year index on each committee presentation, which will make it easier for you to refer back to articles that have been written in the previous five years, in case you want an answer to some particular situation.

A couple of years ago we were involved in providing a standby power supply for the Ford Motor Company in St. Louis, using some of our GE engines, and we had to go through all the books to find the instructions on how to hook it up. Now this book has a five-year index in it. For example, in connection with the Shop Equipment Committee that just presented its report, on page 288 of the 1981 book there is a recap of what they have presented over the last five years. This is something we have added, and we hope you will be able to use it.



**E. R. HAFLING**  
Assistant Mechanical Engineer  
Atchison, Topeka & Santa Fe Rwy. Co.  
Topeka, KS

# TUESDAY MORNING SESSION

## September 29, 1981

### REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL



**D. L. WARD, Chairman**  
Engineer Motive Power  
St. Louis-San Francisco Railway Co.  
Springfield, MO



**F. D. BRUNER**  
2nd VICE PRESIDENT  
Asst. Chief Mechanical Officer R&D  
Union Pacific Railroad  
Omaha, NE

The second report this morning will be presented by the Committee on Diesel Material Control. I will call on Second Vice President Frank Bruner, Assistant C. M. O. - R & D, Union Pacific Railroad, Omaha, to serve as officer of the session.

[Mr. Bruner introduced Mr. D. L. Ward, Coordinator Shop Methods, Burlington Northern, Inc., Springfield, Missouri and chairman of the Committee on Diesel Material Control. Mr. Ward then introduced the members of his Committee.

[The report was summarized by

Mr. L. C. Showers, Manager Cost Control, Union Pacific Railroad, Omaha, Nebraska; Mr. W. R. Powell, Material Supervisor, Atchison, Topeka & Santa Fe Railway, Topeka, Kansas; Mr. Ward, and Mr. M. L. Wall, Superintendent Motive Power, Missouri Pacific Railroad, St. Louis, Missouri.]

MR. WARD: This completes our 1981 paper, and I would now like to open the floor to any questions anyone might have. If there are no questions, may I say that this is my last year on this Committee, and I will be turning it over to Mike Wall beginning next year.

I would like to take this opportunity to thank all the members of this Committee. They have been on the Committee for a number of years, and have done a terrific job. Everybody has contributed to our paper. It has been a real pleasure to work with all of them, and I would like to personally thank all of them at this time.

I would now like to call on Mr. J. J. Gregory, former Project Manager, Heavy Repair Shop, Conrail, Altoona, Pennsylvania, to summarize our paper. However, before doing that I would like to mention that due to ill health, Mr. Gregory was forced to end his 22 years of continuous service with the LMOA, and I am very happy to say that Jim was honored at the Altoona pre-convention presentation in April, and was made at that time an honorary life member of the LMOA and also received his blazer. It is a great pleasure to see Jim here, and I will call him to the

podium to summarize our paper. [Applause]

MR. J. J. GREGORY [Retired, Consolidated Rail Corporation, Altoona, Pennsylvania]: Thank you, Don. I was fortunate to be assigned to this Committee at its inception. This Committee brought to the forefront some very interesting items. First, the in-shop warranty which some railroads have followed, units held for material and, to some extent, projected life of materials.

In the discussion today it was interesting to note that much of the material we throw in for scrap does have some value. I didn't realize you could sell scrap brush holders or brushes, and I thought that was a very interesting topic.

The second topic listed is the importance of planning material-handling facilities. I believe the one that was presented in its computerized system would probably be worthwhile for some other rail-



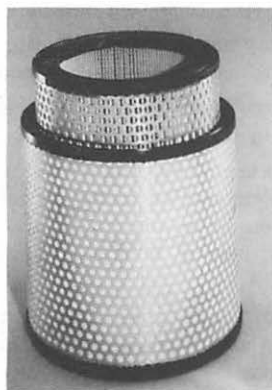
Above is copy of snapshot of Jim Gregory accepting his LMOA blazer and General desk set from LMOA Vice President Swede Axelson.

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roads to look into, because there is really no need for each railroad to reinvent the wheel.

The third topic was somewhat dear to my heart, because it took us five years on the Committee to get all the railroads to decide what is the definition of a unit held for material. On our first inquiry we got only six railroads, and needless to say the units held for material were significantly higher than the latest inquiry. In fact, I would say on some railroads there has been a 90% reduction. Whether that indicates close cooperation between the mechanical and stores departments and/or computerization, I think you will find both are factors.

In the fourth part of the paper, in which the lexicon used in industry is "value engineering," I think the railroads are looking deeper and deeper into whether we unit-exchange and "make-or-buy." All the items considered were brought out very well in the paper.

I think Mr. Ward and his Committee, which I have had the pleasure of serving for so many years,

should be commended for their excellent presentation. Thank you. [Applause]

MR. BRUNER: Thank you very much, Jim. We are certainly glad you could be with us today, and we are looking forward to your coming back any time you can.

PRESIDENT CLEVINGER: I have a few announcements. First of all, be sure to correct your transcript immediately and return it to the reporting company.

Stay out of the hospitality rooms while meetings are in session.

Enroll any supply members you can in the LMOA.

Remember the What's Your Problem session tomorrow morning. If you have any questions, please turn them in to any officer of the LMOA.

Now let's give Don Ward and his Committee a rising vote of thanks.

[The audience arose and applauded.]

[The meeting recessed at 11:40 a. m.]

## TUESDAY AFTERNOON SESSION

### September 29, 1981

The meeting reconvened at 2 p. m., Mr. R. G. Clevenger, President, presiding.

**PRESIDENT CLEVINGER:** This afternoon we are going to have the Diesel Mechanical Committee's presentation, but before that we have a short matter of business. At this time I would like to call Nelson Buskey to the podium.

Nelson, it is with great pleasure that I turn over to you the gavel that represents the Presidency of

the LMOA. Good luck. [Applause]

[Mr. Nelson A. Buskey assumed the Presidency of the Association.]

**PRESIDENT BUSKEY:** Thank you, Bob, for those very kind words. I, very much like Bob Clevenger, have had the privilege of being a member of this Association for seventeen or eighteen years, working actively with the Mechanical Committee since 1963, and sometimes on occasions I have had too much to say from the floor and from the platform at these



Newly elected President Nelson Buskey, left, accepts gavel from retiring President Bob Clevenger. Center is 1st Vice President Frank Bruner.

annual meetings. It has been a long and sometimes rocky road, but I have enjoyed every year and every mile of it. This is indeed a distinct honor for me, gentlemen, to become President of the Locomotive Maintenance Officers Association, and one that I accept most humbly, as, I believe, it is the largest and most active organization of its kind in the country.

Locomotive maintenance, our prime prerequisite, will always be a thorny problem, as it is now and ever has been. Are we over-maintaining or under-maintaining our locomotive fleet? I believe that while there seems to be as many problems facing maintenance officers today as ever, today's problems are of a different type, of a different magnitude, because many of yesterday's problems have been solved; but to solve current problems, individual railroads will have to continue interchanging ideas and information freely, and will have to continue pressing the locomotive builders for a greater reduced maintenance and fuel-efficient motive power as well as improvements and retrofits to reduce maintenance on our existing fleets. This organization and these types of meetings are the very vehicles to accomplish these objectives.

LMOA's 1981 year is almost over. Bob Clevenger has had a successful year as President. His is a difficult act to follow.

The success of the LMOA in 1981 and past years has been due not only to excellent support of our leadership by our Executive Com-

mittee members but also our good associate members in the supply industry, our friends of the railroad news media, our hard working technical committee chairmen and their members, our able and conscientious officers and our hard-working, reliable keeper of the keys, our Secretary, Joe Koerner.

Gentlemen, all of the supporting ingredients are still here. No one could possibly ask for better support than Frank Bruner, Dick Holmes, Darrell Walker, Swede Axelson, Bill James and Dale Propp.

Our technical committee chairmen have shown their ability to coordinate their committees effectively and produce constructive conclusions to their many problems.

With this support, we can meet any reasonable goals we choose to set for 1982. The specific goals of each of our Vice Presidents in their areas of responsibility will be defined at our planning meetings for 1982 in November.

In the meantime, I would like to set forth two general objectives for all of us as members of the LMOA to look toward in our support of this organization in the coming year:

1 — Membership. The Locomotive Maintenance Officers Association was first organized in 1939, at which time there were 27 associate and 60 active members, for a total of 87. The organization rapidly grew to 1953, its peak year, when it reached a membership of

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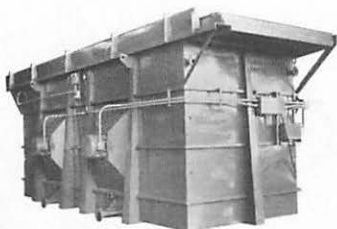


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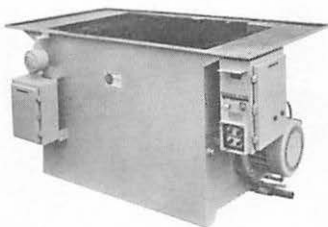
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4,003. Since then, there has been a steady decline in membership, mainly due to railroad consolidations and mergers, decline in business in some areas of the country, and the resultant reduction in employees.

It is unrealistic to think that our membership will increase if attendance and participation is not encouraged and sponsored to a much greater degree than it presently is by some of our roads. Gentlemen, we have set a membership goal for the year 1982 at 2,000 members. We solicit your help to reach this goal. There is some consideration being given to another approach to membership subject to Executive Committee approval.

2—We should continue to encourage our young officers to par-

ticipate and become active members on our technical committees. Not only will the railroads profit by encouraging such participation directly, but they will profit more indirectly by the development of these young committee members. These young men are the leaders of tomorrow—not only of our railroads but of our Association.

I appreciate the confidence you have expressed in electing me your President. I am looking forward to a year of real progress, and I know we will have such a year with the continued support of our officers and members.

Thank you very much. [Applause]

At this time I would like to call Bob Clevenger and Tom Harley to the podium, please.



Bob Clevenger's years of LMOA service, culminating in the presidency for the year 1980-81, are rewarded as he receives the General desk set from Jim Long. Looking on is 2nd Vice President Dick Holmes.



Past President Tom Harley, right, welcomes Bob Clevenger to the "club" as he presents Bob the attractive past president's pin. 4th Vice President Swede Axelson looks on.



Past President Ky Pruchnicki, right, presents outgoing president Bob Clevenger with leather-bound history of Bob's year as president. In center is 3rd Vice President Darrell Walker.

MR. E. T. HARLEY [Vice President-Equipment, Trailer Train Company, Chicago, Illinois]: Bob, I have the pleasure of presenting to you the LMOA desk set. It is something all of us Past Presidents are very proud of, and I know you will revere it in the future as a remembrance of your years of service to the LMOA. [Applause]

PRESIDENT BUSKEY: Mr. Taggart, will you come forward, please?

MR. J. TAGGART [Retired, Canadian National Railway, Hull, Quebec]: I have been away from the LMOA for a few years, but not very far away. I have always watched with interest how the LMOA is pursuing its goals and achieving them. I must say I think you have gone a long way in the past year to help achieve those

goals. I would now like to present to you, Bob, the LMOA Past President's pin. [Applause]

PRESIDENT BUSKEY: Now may I call on Mr. Ky Pruchnicki.

MR. PRUCHNICKI: Bob, for the good work you have done as President of the LMOA, we wish to give you this book of Proceedings, which you can refer to for many years and which we trust will bring back good memories. [Applause]

PRESIDENT BUSKEY: First of all, gentlemen, I want to remind you that we need a lot of response from all of you. We need input for next year's meeting. We need input for committee topics and subtopics. Please don't be bashful. Stand up at the microphone and ask questions. In that way we can get an idea of what your problems are.

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# TUESDAY AFTERNOON SESSION

## September 29, 1981

### REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE



**J. L. KUHNS, Chairman**  
Superintendent-Motive Power Maint.  
Louisville & Nashville Railroad Co.  
Louisville, KY



**D. H. PROPP**  
7th VICE PRESIDENT  
Director of Energy Conservation  
Burlington Northern, Inc.  
St. Paul, MN

Now I would like to call on our Sixth Vice President, Dale Propp, Chief Mechanical Officer of the Burlington Northern, Billings, Montana, to serve as officer of the next session.

**MR. DALE PROPP:** Will the Committee on Diesel Mechanical Maintenance please come to the podium.

[Mr. Propp introduced Mr. J. L. Kuhns, Manager, Planning & Maintenance, The Family Lines Rail System, Jacksonville, Florida and chairman of the the Committee on Diesel Mechanical Maintenance. Mr. Kuhns then introduced the members of his Committee.

[Mr. R. W. Diamond, Master Mechanic, Missouri Pacific Railroad, North Little Rock, Arkansas, summarized Part I of the paper.]

**MR. KUHNS:** Are there any questions on this part of the paper?

**MR. TAD H. VOLKMANN** [Assistant Diesel Supervisor, Chicago and North Western, Chicago, Illinois]: Are the builders making any progress toward the development of a roller bearing support bearing to do away with a lot of maintenance in that area?

**MR. A. C. HILLHOUSE** [General Electric Company, Erie, Pennsylvania]: We have put some out

on test right now, but nothing for production. Everything looks like it is going pretty good. We are still running some lab tests on it.

MR. KUHNS: I might comment that there was a demonstrator GE had out a few years ago. They ran for quite a while on the L&N Railroad that did have roller bearing in the traction motor suspension bearings.

MR. D. W. CHIRIKOS [Manager Technical Section, EMD, La-Grange, Illinois]: Many of you may be aware that in 1975 EMD put out GM6C Electromotive type running on Conrail. We have never really offered it since then. I think it is cost that is one of the hangups. It has been under that particular locomotive, and that is the only one that has had it.

MR. D. G. GOEHRING [Manager, Equipment Maintenance Planning, National Railroad Passenger Corporation, Washington, D. C.]: Amtrak has 26 E60C electric locomotives that were built by General Electric in 1975. These six-axle locomotives are equipped with roller bearing suspension bearings and are in service on the Northeast Corridor.

MR. HILLHOUSE: We think it is a cost factor on the railroads, because it is quite a bit more expensive.

MR. KUHNS: Cost enters into it. You have to draw a line somewhere as to where you want to make the sacrifice. Suspension bearings have been equipped with roller bearings, as we said.

MR. MIKE MOSS [Shop Superintendent, Illinois Central Gulf Railroad, Paducah, Kentucky]: I have a question concerning the involute profile on ring gears and pinions. EMD recommends .010" and GE recommends .015" during gauging process. I would like to know the difference between the .005" variation among the two manufacturers, because of the cost involved when qualifying ring gears and pinions. A re-profiled ring gear costs around \$300 and around \$1,000 for new. This is a very critical dimension when qualifying ring and pinion gears.

MR. KUHNS: I see two representatives who regrind gears, and maybe they can comment. Would GE or EMD like to make a comment? They both are shaking their heads.

MR. FORREST MITCHELL [General Electric Company, Erie, Pennsylvania]: Historical performance is where the tolerances we have developed came from. We introduced re-profiling of bull gears back in 1959 and 1960 in the Alco-GE locomotive days. The gear had to be pressed off the axles and returned to our Lynn, Massachusetts plant to be re-profiled and shipped back to the railroad. That introduced a cost factor which didn't prove to be economically feasible at that time.

What we did then was to work on the traction motor, because at that point in time we knew that vibration of the motor was deteriorating the then micromat insulation in the 752TM. We went to

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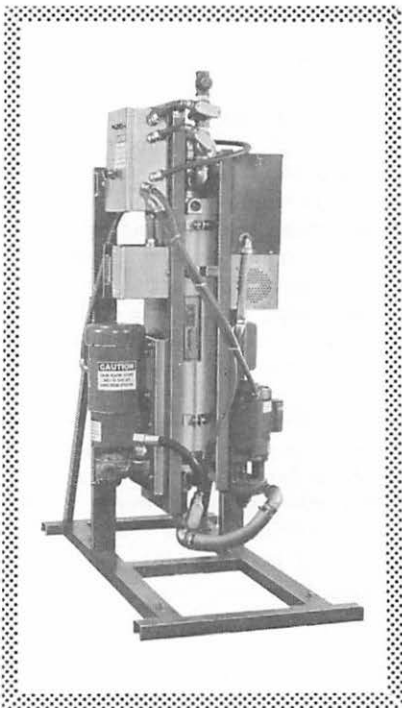
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great lengths to redesign the motor to improve mechanical integrity and minimize the impact of vibration on the insulation system.

The deviation from involute profile was established at .007 for re-use without any work being done, and at .015 maximum based on our data that says our motor will survive with that kind of profile deviation. The wear limit was also established at the same time as 1/8" because, as pointed out by your Committee, you can have wear and still retain the original involute profile. It will only increase the backlash of the gears.

So, I don't think we can precisely say where the .007 and .015 come from, except on history of our experience in the traction motor business going back to the early Alco-GE days, and we believe with those limits we have established satisfactory motor life especially with the current insulation systems today which are not as susceptible to vibration damage as our previous insulation systems were. I hope that clarifies it somewhat.

MR. F. I. BURCHETT [Mechanical Assistant - Locomotives, Atchison, Topeka & Santa Fe Railway, Chicago, Illinois]: I would like to add to Mitch's comments slightly.

You may want to establish two limits of outer profile wear. Particularly at the outset of your program you may find that your gears are worn so badly that you can't afford to change all of the gears that are worn out of profile. The other reason you may want to have two limits is that the first

limit would be a wheel that you remove at your running repair shop. You might want to establish an .008 to .010 out-of-profile wear at the running repair shop where the wheels are not worn out. You go ahead and put the wheels back in without having to pull the wheels and gear for re-profiling.

The other limit you would certainly want to establish would be for your wheel shops, where you will dismount wheels anyway. Certainly you would want to re-profile any gear that comes into your shop that is going to set up the vibrations Mitch talked about and the vibrations we talk about in the paper. What you are really trying to do is eliminate those traction motor vibrations that are so detrimental to other equipment.

MR. KUHNS: I believe we had better stop the questions at this point, otherwise we won't have time to complete the other three parts of the paper.

[Part II of the paper was summarized by Mr. W. A. Brown, Assistant Manager Motive Power, Burlington Northern, St. Paul, Minnesota.

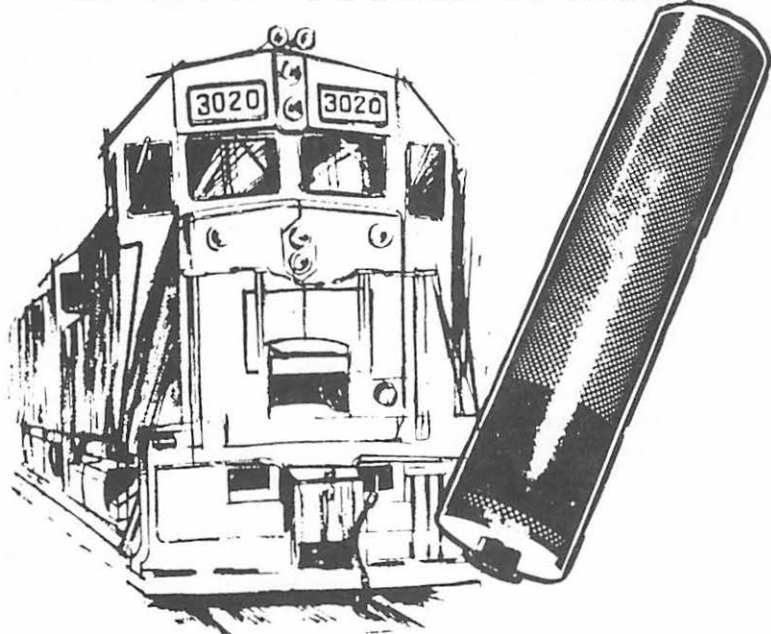
[Part III was summarized by Mr. M. G. Dinius, Superintendent Locomotive - Mechanical, Illinois Central Gulf, Chicago, Illinois.

[Part IV was summarized by Mr. Kuhns.]

MR. KUHNS: This concludes our report. Are there any questions on these parts of the paper?

MR. C. W. DIETERICH [Manager, Production Planning and Control, Southern Pacific Trans-

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portation Company, San Francisco, California]: I have two questions concerning gear cases. My first question deals with the extended capacity gear case. At Southern Pacific we use polyethylene bags filled with lithium that we apply to the gear cases when they are serviced. What we are finding is that the polyethylene bags themselves are not dissolving, and are causing a build-up of plastic residue in the bottom of the gear case. I wonder if the panel has any information on this problem.

The second question is, what has the Committee found as to the advantages or disadvantages of the new fiberglass gear case?

MR. KUHNS: As far as polyethylene bags dissolving in the gear cases, does anyone on the Committee want to answer that? I can't help you there at all, and it doesn't look like anybody else can either.

As far as the fiberglass gear case is concerned, we had a little conversation about that in our meeting today. A couple of us seem to be of the opinion that maybe we have been approaching the gear case problem in the wrong way. Maybe we ought to make gear cases a throwaway item, so instead of trying to repair them you throw them away and put a new one on.

As for the fiberglass itself, I believe that is quite a bit lighter than steel. We have a couple of people on the Committee who can probably offer more on that than I can. The Canadian National has adopted that as a standard up in

Canada. I believe Bombardier also uses it in their locomotives. Len, would you like to add anything?

MR. L. M. DANIEL [Senior Mechanical Assistant - Motive Power, Canadian National Railways, Montreal, Quebec]: Basically we have gone to fiberglass gear cases for the matter of safety. There have been instances of steel gear cases dropping in service and causing derailments because of steel gear cases becoming jammed in switches. There was also ease of handling. There is someone here from Railtech who might want to add something to that.

MR. CLARY GINN [Railtech, Ltd., Dorval Quebec]: We manufacture fiberglass gear cases. They weigh about 47 pounds. We consider this light weight a very distinct advantage. One of the reasons is that since 1974 the Canadian National Railway has cut their support bracket failures in half. We like to think it is because they are using the lighter gear case. At least we hope that is a large part of it.

The fiberglass gear case will hold about one quart more lubricant than the steel one. This is measured, naturally, without the gear being in place.

MR. KUHNS: Is this the increased capacity gear case or the old standard?

MR. GINN: This is the standard configuration. They are manufactured on a die or press and are pressed at 1200 PSI. They are heated to 280 to 300°F and cured for about 30 minutes. They are a



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standard gear case; by this I mean every case has the same dimensions. You can interchange tops and bottoms in all cases. You don't have to match them and keep them in pairs.

We also feel that because they are so light, the mechanic on the floor thinks they are a tremendous improvement. You can cut down the number of people handling them. One man is sufficient. We feel that if a man can handle it that easily and is happy with it, he will do a better job.

MR. KUHNS: What is Canadian National's experience?

MR. DANIEL: We have gone to fiberglass gear cases too, for the same reasons Clary mentioned.

VOICE: And you have verified that to your satisfaction?

MR. DANIEL: Yes. The primary reason we first went to fiberglass gear cases was the safety factor, when we had instances of steel gear cases falling off in service. I am sure American railroads have had the same problem. Bombardier has had fiberglass gear cases for many years.

MR. K. R. MANSON [Director Customer Service, Bombardier, Montreal, Quebec]: The fiberglass gear case has been our standard for five years.

MR. KUHNS: It looks like Canada uses fiberglass and we use steel.

MR. DANIEL: We used steel gear cases up to five years ago. It is essentially the same gear case bought from EMD.

VOICE: Washing is done in both cases, but is the advantage that of safety and ease of handling?

MR. DANIEL: Yes. Safety is the basic reason for replacing steel gear cases with fiberglass gear cases. A mechanic will readily change out a damaged fiberglass gear case due to ease of handling same, whereas when he sees a damaged steel gear case he is apt to overlook it. It is a heavy job to change out a steel gear case in place under a locomotive.

MR. MITCHELL: I have a question. In looking at fiberglass gear cases, one of the concerns of the engineers was the heat transfer through the fiberglass gear case itself. As you know, oxidation of the gear lube in the case itself will create gear scuffing and gear wear. With the five years of experience they have had in Canada, which I believe is at lower ambient operating temperature, have they had any experience with heat transfer or gear wear?

MR. DANIEL: I am not aware of any problems with heat transfer or gear wear with the use of fiberglass gear cases.

MR. L. L. LUTHEY [Assistant Chief Mechanical Officer, Atchison, Topeka & Santa Fe Railway Company, Topeka, Kansas]: Do I understand that the suspension bearing problem has all been corrected with the new double seal and drainback holes? In the higher speed operation we are seeing grooving of the axle and cracking of the suspension bearings. Cracks

start at the drainback holes. This has been prevalent in some Amtrak engines.

MR. KUHNS: This came up at our meeting today. We don't have to run as fast as some other roads. We are just as wide as most of them, but we don't run as fast. Mr. Chirikos might comment.

MR. CHIRIKOS: In regard to what you are seeing on the axle for the wear where the seal sets, we have radius of the surface of that seal where it seats on the axle with chamfering the grooves so that it will rotate relative to the axle instead of being on the axle. That has been a rather recent change.

I don't know if the Santa Fe has any out there that would be part of the evaluation. I think what you have been seeing is the former seal that is more square at the bottom edge.

As far as cracking through the bearing, I have no good input on that at this point in time. If anybody from EMD has any input on that, I would welcome the opportunity to hear about it. That is the wear you are seeing on the axle itself where that seal seats.

MR. LUTHEY: Cracks in the hole occur on both GE and EMD. Groove wear on the axle occurs on the GE, EMD and Magnus bearing. I wonder if we have the wrong material in that seal.

MR. CHIRIKOS: I will find out for you. I will be glad to follow up on it and give you an answer.

MR. KUHNS: I have not seen it on our railroad, as I said. Do

you have anything you would like to add, Andy.

MR. HILLHOUSE: I haven't heard anything about cracking in the oil holes. I will look into it when I get back.

MR. LUTHEY: If we get the answer we will be glad to share it with anyone.

We have so many fuel filters out there now that we never know which ones to apply particularly at the intermediate points. We ought to get one good one and use it on all locomotives.

MR. KUHNS: Amen! I believe GE is going to use a different element that is a two-stage element, so to speak. Fred made the comment that it will be so heavy the crews can't take it out and throw it away. That might be something on the positive side. You are right, we do have too many elements. I would like to see everything standardized.

MR. CHIRIKOS: I hope you know that on the EMDs the primary paper filter for fuel is the same filter as the air filter for cabinets, so there is some standardization. You have the spin-ons on the engine-mounted filter.

MR. LUTHEY: We have spin-ons and we have lube oil filters, and we have lube oil filters of all kinds too, and sometimes a fellow doesn't know the difference between one filter and another. It is what he has available.

MR. CHIRIKOS: Are you talking about lube oil filters between the two builders—two different types?

MR. LUTHEY: Yes: I don't know why they can't all use the same filter.

MR. CHIRIKOS: Our recommendation is a 13-micron filter. That is the red outer wrap filter. It gives maximum protection for the bearings. If you go to the higher micron size filter you will see wear in the overlay. You can tell the main bearings a block away. They are black. The black is dirt that is embedded in the bearing. I don't believe they have had that many problems.

One area that may help the situation is that we have an increased overlay main bearing and if the railroads are on a 3-year changeout of main bearings that is also another help. So, to maximize bearing operation we recommend the 13-micron primary lube oil filter being installed.

MR. KUHNS: I agree with you, Mr. Luthey, there should be one standard filter for both of them. EMD says they have the same primary fuel filter as lube oil. That is true. GE is now coming out with a double-stage filter element, plus I think they are also trying to come up with a secondary filter arrangement. Hopefully we will have a standard between primary and secondary.

Do you want to comment on that, Mitch?

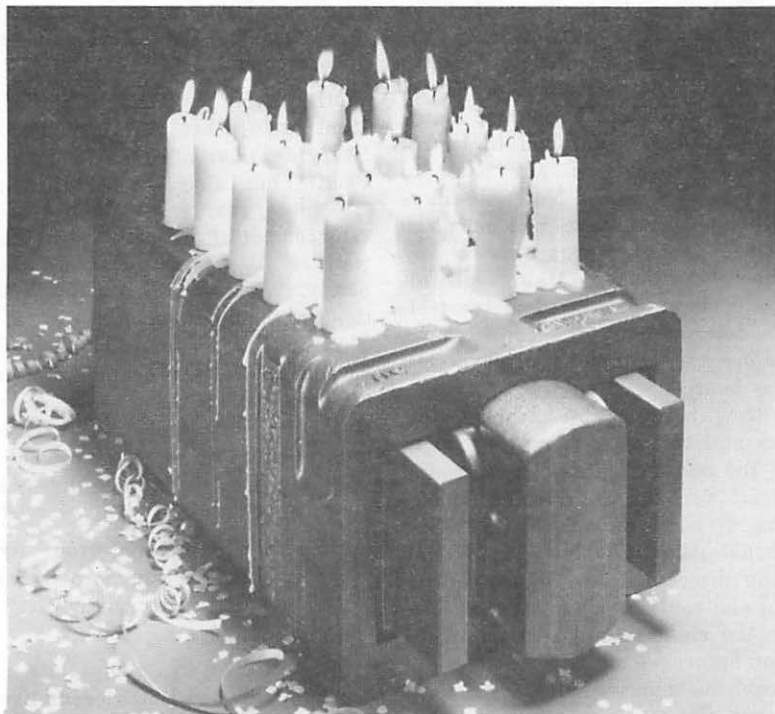
MR. MITCHELL: This is an area where you can get yourself in real trouble. Standardization is something we all work toward, and there have been various committees working toward it. But in

deference to the competitive spirit of the market place when there are competitors, there will be different products requiring different maintenance. We would love to standardize, and I am sure others would also.

When an engine design requires a 13- or 15-micron filter, that is what you ought to be using. Our engine, with a different design and bearing and cranks and speeds, requires a different filter, and we would be wrong to tell you to use our filter in their engine, or vice versa, because it will cause problems. The industry can't just jump in the bathtub and maybe drown through standardization on items that will get you in trouble.

Last year we talked about standardization of gear case lubricants. It's great, and we would love to have a standard lubricant. We said we still recommend Arco Jet Lube TM-sodium base that we have used for years because it works. It has some channeling problems in cold weather, but it provides longer gear life.

The industry jumped into lithium based gear lubricant. We are now looking at three different viscosities of the lithium based, and GE is testing the higher viscosity lithium on a continuing basis in Erie. We still observe some scuffing with the lithium base lube. It is nothing that can't be resolved, but before we standardize as an industry on a particular filter or a particular lubricant we must be sure it is compatible and works in all cases before the decision is made.



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That is a long dissertation on standardization, but some of the differences are necessary. We have found in the past that when we jumped too soon there were many, many failures that had to be resolved before you got back to where you were. Now we have instituted and have had in place a field testing program on any change we make, working with all the customers involved in the test, to determine if it really works before the change is made across the board.

Now, between the various builders and various different products in the market place, it is more difficult for the railroads to make the decision on which way they should go. My only point in this long dissertation is, let's be careful and cautious, and make sure we do the right thing on standardization before we actually create more problems than we solve.

MR. KUHNS: Thank you, Mitch. It would be nice if we had standardization on some items.

MR. AXELSON: Mr. Brown pointed out that it was the Committee's belief that a secondary fuel filter and visual fuel flow indicator system is needed to improve injection equipment operating reliability, and to extend component changeout intervals. Has any developmental work been done on this?

MR. KUHNS: I think they are ready to come up with a standardization on spin-on fuel filters, maybe equal between both engines. GE has a problem with the seals

on them, but they are trying to make headway, and feel this can be overcome.

MR. LAURIE HUNT [Railtech, Montreal, Quebec]: Going back to fiberglass gear cases, the Canadian Pacific has also standardized on fiberglass gear cases. This is for replacement of the existing pool as well as for specification on new power. We are making a presentation to the Southwestern Railway Club on October 22, and we have 25 slides covering the manufacturing aspects of these gear cases. If there is any interest we will be happy indeed to answer any questions and/or show the slides at your convenience.

MR. KUHNS: Thank you. Are they supplied on new locomotives of both Bombardier as well as GM?

MR. HUNT: No. The Railtech case is applied to EMD locomotives only. The last order from Canadian Pacific was for seventy-five 3000 HP locomotives, and the Railtech fiberglass gear case was mounted by GM on each locomotive.

MR. C. A. NOBLE [Assistant Reg. Mechanical Officer, Canadian Pacific Ltd., Montreal, Quebec]: Our last order was for EMD locomotives. Our standard was that fiberglass gear cases were supplied with those locomotives. This has not been the case with units using GE traction motor. We have not been successful with fiberglass gear cases for the GE motor, I guess because of a difference in the supporting arrange-

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ment. Perhaps someone can comment on this.

MR. KUHNS: Are you saying it is not successful with the GE motor?

MR. NOBLE: That is correct. It is our standard for the General Motors motor only.

MR. KUHNS: What traction motor do you use, Ken?

MR. K. R. MANSON [Director, Customer Service, Bombardier, Montreal, Quebec].

MR. KUHNS: Isn't that GE?

MR. MANSON: Yes.

MR. KUHNS: It looks like we have a slight difference here. Mr. Noble said he didn't know of any problems with GE fiberglass gear cases; correct?

MR. MANSON: It has been our standard for five years. We ran into some production and manufacturing problems, but I think they have been corrected.

MR. NOBLE: All I can say is that we have tested one type of GE traction motor gear case on our MLW locomotives. We have experienced problems with the type of gear case we have tested, and it is not our standard to use it.

MR. L. M. DANIEL: The lube oil and fuel filters are identical on Bombardier 4-cycle engines. This has been Bombardier standard for many years.

MR. B. J. TRIPOLI [Assistant Manager, Amtrak-Wilmington Maintenance Facility, Wilmington, Delaware]: In reference to compressors, which were previously discussed, I would like to bring to

your attention that Amtrak has been operating E60 Electric Locomotives with "Joy" 150 CFM rotary compressors. These locomotives have been operating for approximately eight years with many compressor problems, most commonly oil seals and shaft bearings.

I do not want to give a dissertation at this time; however, if any of you are interested you can contact Amtrak and we will be happy to inform you of the problems that have developed through the years.

The thirty AEM7 Electric Locomotives recently purchased are equipped with Gardner Denver rotary compressors. At present they are in their infancy, and successful operation has not been determined. Perhaps in time we will be able to answer this question.

The Gardner Denver rotary compressors are rated at 150 CFM at high speed and 75 CFM at low speed.

Oil leaks or oil vapors in these compressors can create many electrical problems in the enginerooms due to penetration into electrical lockers.

MR. M. SALIDAS [Ontario Northland Railway, North Bay, Ontario]: I have a question for Mr. Daniel and Mr. Hunt concerning gear cases. I have been led to believe there is a possibility of mixing a fiberglass gear case made by Railtech with the steel gear case, providing the fiberglass case is on the bottom. Are you doing this, or can it be done?

Secondly, I would like to know about the effect of cleaning fiber-

glass gear cases with cleaning solvents. How do you clean them?

MR. DANIEL: I am in the engine department but will obtain this information for you, which is as follows: Mating fiberglass bottoms with steel tops is a definite possibility. However, due to the frequency of steel gear case damage in service, it is not recommended that the method of replacement be used. Stress build-up in the part line location of fiberglass gear cases due to improper mating would lead most definitely to fiberglass breakage.

Fiberglass gear case cleaning was originally done in the degreasing vat, but because of distortion caused by high temperatures this procedure was discontinued. Cleaning of gear cases is now accomplished by high pressure jets using hot water and detergent as a cleaning agent. In our case we use a Proceco cleaning machine.

MR. J. A. NUNNS [Assistant Mechanical Officer, Canadian National Railways, Toronto, Ontario]: We have had five years' experience with the fiberglass gear case. We do mix them, using fiberglass on the bottom where necessary. One of the features is that we Huck bolt them. If you ever try to burn a Huck bolt off out in the field, take a gas mask with you. Your fiberglass gear case does not stand up very well with Huck bolting.

MR. HUNT: Fiberglass gear case is Huck bolted, and we recommend that the Huck bolt cutter be used whenever it is necessary to disassemble. A blowtorch can be

held on our fiberglass case for ten minutes and the resin will burn. After the flame is removed from the fiberglass it will self-extinguish in 20 seconds, but burning off bolts certainly isn't recommended practice.

MR. KUHNS: Any other questions? At least we have had a lot of discussion on gear cases.

I will now turn the meeting back to Dale Propp.

MR. PROPP: Thank you, Jack and your Committee, for an excellent presentation. You certainly generated a lot of interest by everyone. I would also like to thank the people in the audience for doing an excellent job of responding to the questions.

Just a couple of things in summary. Obviously, in this era of reduced budgets we are all looking for ways to save dollars and provide a good locomotive maintenance program to the railroad industry. The questions that have been asked today were certainly directed toward that approach.

Gear tooth and pinion wear is still a problem, and I believe within the next year it will be resolved. The AAR, NRLC, and the lubrication industry are utilizing all technology possible to improve the gear lubricant. Whether the result is lithium or sodium, we will have something that will solve the problem. Hopefully, if we can maintain the gear cases to a better level, all the problems will be solved.

Filtration of lube oil, fuel oil and air still demands continued improvements in all new products.

Filters with extended service life will certainly be a benefit to all of us.

The 92-day maintenance cycle is bringing on many changes. We must look at filtration products that will last through the 92-day cycle.

Again, Jack, thanks and congratulations to you and your Committee for a job well done.

PRESIDENT BUSKEY: Thank you, Dale.

Just a few comments before we recess. Wherever possible, encourage new memberships. When you visit the hospitality rooms this evening and tomorrow, thank them

for advertising with us. We need them. We need input from all of you for next year's papers. Our committee chairmen meet tomorrow afternoon with their committees, trying to develop topics and subtopics for next year's papers. This Committee is one of six, and it is really a good cross-representation of the nation's railroads and also Canada's railroads. This Committee is blessed with two Canadian members.

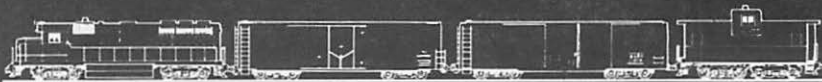
Now let's all stand and give this fine Committee a rising vote of thanks.

[The audience arose and applauded.]

[The meeting recessed at 4 p.m.]

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# WEDNESDAY MORNING SESSION

## September 30, 1981

### REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS



**D. G. GOEHRING, Chairman**  
Manager Maintenance Planning  
National Railroad Passenger Corp.  
Washington, DC



**D. M. WALKER**  
4th VICE PRESIDENT  
Diesel Superintendent  
Southern Railway Co.  
Atlanta, GA

The meeting reconvened at 8:30 a.m., Mr. Nelson Buskey, President, presiding.

**PRESIDENT BUSKEY:** Gentlemen, this is the final session of our 1981 convention. It is most gratifying to see so many of you here so early.

I would like to call on our Fourth Vice President, Darrel Walker, Diesel Superintendent of the Southern Railway, Atlanta, Georgia, to act as officer of this session.

**MR. WALKER:** Thank you, Nelson. Good morning, ladies and gentlemen. I would like to ask the Committee on New Developments to come to the platform.

[Mr. Walker introduced Mr. D. G. Goehring, Manager, Maintenance Planning, National Railroad Passenger Corporation, Washington, D.C. and chairman of the Committee. Mr. Goehring then introduced the members of his Committee.

[The paper was summarized by Mr. T. C. Whittle, Manager Product Planning, General Electric Company, Erie, Pennsylvania; Mr. T. D. Enns, Assistant to Manager - Locomotive, M&P, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas; Mr. A. A. Chacon, Assistant General Mechanical Engineer, Union Pacific Railroad,

Omaha, Nebraska; Mr. G. W. Caulton, Assistant Manager - Technical Services, Electro-Motive Division, LaGrange, Illinois; Mr. R. M. Campbell, Diesel Supervisor, Belt Railway, Chicago, Illinois; Mr. M. A. Coles, Road Foreman of Engines, Missouri Pacific Railroad, Falls City, Nebraska; and Mr. T. L. Scott, Assistant Manager, Southern Railway, Chattanooga, Tennessee.]

MR. GOEHRING: This concludes our paper, and I would now like to open the meeting for questions and discussion. There have been a lot of things thrown at you in a very short period of time. Those of you who have your Proceedings book can cover all this information or review it, and if anything has come to your mind that you would like to ask about, we will try to take care of it right now.

Are there any questions or comments?

MR. N. RICHARD DUNTEMAN [Electro-Motive Division, LaGrange, Illinois]: I would like to commend the Committee for their analysis and explanation of the AAR fuel economy specification. In particular, in sorting out the different builder recommendations with regard to the over-the-road testing, I do have one clarifying question with regard to the recommendations that I would like to direct to Mr. Chacon.

This question is in regard to the over-the-road comparisons. It has been our experience that there are

occasions in over-the-road testing when fuel temperature variations are significant. I would ask Mr. Chacon if the recommendations would include one minor correction in the comparisons to take into account any differences among the locomotives with regard to fuel temperature.

MR. A. A. CHACON [Assistant General Mechanical Engineer, Union Pacific Railroad, Omaha, Nebraska]: Basically we intend on doing that by making the comparison based on constant BTU. We did intend to look at the data and evaluate whether the temperature difference was significant enough that we would have to make a correction for it. The only corrections we intend to use are to ensure that comparison is made using constant BTU.

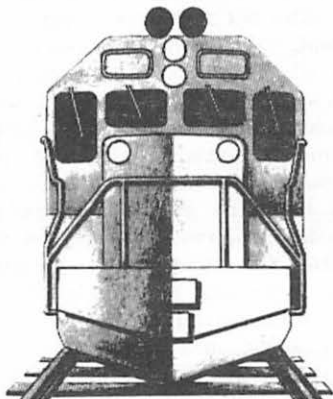
MR. DUNTEMAN: Thank you. On occasions we have seen differences of 10 or 15 degrees depending on ambient, and the volumetric factors would be significant at that point. Thank you.

MR. GOEHRING: Are there any other questions? There has been a lot of discussion during the past few years about gear and lubricating problems. What you saw here today, of course, is still not actually available at the moment. Do you feel this is going to be an answer to some of your problems? I guess you don't have gear case problems.

Any other comments or questions? If not, I would like to ask Mr. Cumbea to come to the platform and summarize the paper.

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MR. CUMBEA: Hardly a day passes that we are not offered a new approach or procedure for fuel conservation. If all prove to live up to their alleged potential, we no doubt will in the future start to pump excess fuel out of locomotive tanks rather than refill them at servicing locations.

There is certainly a strong and continuing need to make every effort to conserve as much fuel as possible not only from a cost standpoint but from future availability of oil. This makes it necessary to have the capability of accurately measuring consumption and evaluating potential fuel-saving procedures. The accuracy should exist in both the static and dynamic modes, and results should be uniform for comparative purposes. We commend the Committee for their presentation and efforts in promoting such uniformity.

Gear case design and leakage problems have been a topic for discussion within the LMOA for as long as I can remember. We hope that the new gear case seals offered by EMD will be a positive step toward needed improvements.

The Farr "Slammer" offers an interesting approach in minimizing

secondary damage when an engine abnormality is detected. We concur with the Committee remarks concerning the need for additional test experience before endorsing this device, particularly in light of the high initial cost.

We are always pleased to hear from the builders and their pitch for the virtues of their new line. We are particularly impressed with the potential fuel efficiency offered by both EMD and GE in their new models.

Use of Pulse and other electronic speed indicating and recording devices is expanding. The discussion presented on calibration procedures and problems with this equipment is certainly timely and informative.

Dave and the New Developments Committee are to be congratulated on their efforts to put this very informative paper together, and I would like to suggest we give them a vote of thanks for a job well done. [Applause]

MR. WALKER: Gentlemen, at this time I would like to ask the members of the What's Your Problem panel to come forward. I will turn the meeting back to President Buskey.

# WEDNESDAY AFTERNOON SESSION

## September 30, 1981

### WHAT'S YOUR PROBLEM PANEL



**E. R. HAFLING, Chairman**  
Assistant Mechanical Engineer  
Atchison, Topeka & Santa Fe Rwy. Co.  
Topeka, KS



**R. R. HOLMES**  
3rd VICE PRESIDENT  
Dir. Chemical Labs & Environment  
Union Pacific Railroad  
Omaha, NE

**PRESIDENT BUSKEY:** I would like to call on our Second Vice President, Dick Holmes, Director of Chemical Labs and Environment, Union Pacific Railroad, to serve as officer of this session.

**MR. HOLMES:** Now is your chance to ask any questions that still haven't been answered, or ask for clarification of any points. We have all the experts up here, the chairmen of all the LMOA committees, and to field your questions we are going to call upon Elmer Hafling, Engineering Assistant, Santa Fe, Topeka, Kansas. Elmer has had 33 years of service.

**MR. HAFLING:** Thank you, Dick.

I was approached last week to help out with the What's Your Problem session today. As you all know, this is the highlight of our convention, where we bring together all the committee chairmen and solicit solutions to problems that the audience might have.

In order for me to follow the format set up by Mr. Smalling, who couldn't be here, I thought of a brief article in one of Ann Landers' columns a few years ago, to give one a lift. It went like this:

"One night I dreamed I was walking along the beach with the

Lord. Many scenes from my life flashed across the sky. In each scene I noticed footprints in the sand. Sometimes there were two sets of footprints, other times there was only one. This bothered me, because I noted that during the low periods of my life, when I was suffering from anguish, sorrow or defeat, I could see only one set of footprints.

"So I said to the Lord, 'You promised me, O Lord, that if I followed You, You would walk with me always. But I have noticed that during the most trying periods of my life there has been only one set of footprints in the sand. Why, when I needed You most, were You not there with me?'

"The Lord replied, 'The times when you saw only one set of footprints, my child, were when I carried you.'"

So, I hope today we will retain at least six sets of footprints besides mine, and these should be of the following:

Mr. R. C. Cain, Chemist, Santa Fe Railroad, and chairman of the Fuel and Lubricants Committee.

Mr. Tom Westerfield, Senior Electrical Engineer, Chicago and North Western, and chairman of the Diesel Electrical Committee.

Mr. Tom Kessenger, Senior Engineer-Facility Planning, The Family Lines Rail System, Jacksonville, Florida, and chairman of the Shop Equipment Committee.

Mr. Don Ward, Coordinator Shop Methods, Burlington Northern, and chairman of the Diesel Material Control Committee.

Mr. Jack L. Kuhns, Manager Planning and Maintenance, The Family Lines Rail System, and chairman of the Diesel Mechanical Maintenance Committee.

Mr. David G. Goehring, Manager Maintenance Planning, National Railroad Passenger Corporation, and chairman of the New Developments Committee.

Before we open the floor for discussion, I ask that when you ask or answer a question you give your name and the company you represent. This will help our recorder. We also ask that you avail yourselves of this opportunity to stand and make your problems known so that the members of the LMOA, locomotive manufacturers, and the supply fraternity can benefit from what appears to be a problem, in the hope that solutions will be found that will be beneficial to all of us here today.

I would like to open the question session. I want to ask a question submitted by Swede Axelson at the Fuel and Lubricants Committee presentation which they didn't have enough time to answer before time ran out. The question is quite lengthy and is in two parts:

"With the present consumption or depletion rate of 4 billion gallons of diesel fuel per year equated against known petroleum reserves, have timetables or forecasts been established to emphasize the urgency and need to make alternative fuels available, and/or does the future of diesel fuel dictate that other forms of prime movers

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should be considered for future motive power planning?"

Mr. Hoffman, can you help us out on that?

MR. HOFFMAN: Someone asked me to repeat the question. [Laughter]

MR. HAFLING: The gist of it is this: Do we have any alternative fuels for locomotives in case our fuels run out? If we don't have alternative fuels, do we have a different type of motive power service to take its place in the future?

MR. HOFFMAN: The question was passed to me on Monday. It covered when and if petroleum fuel resources might run out. There is no way in the world that I can answer that question. I think some of the fuel-supplying fraternity may wish to address it.

The forecasts which one sees (and I subscribe to quite a number of them) decidedly show that the presently held reserves in the free world have increased in recent years. A substitute for petroleum is dictated by a great deal more than just when supplies run out. There is a fantastic economic question that I don't pretend to be able to address in the depth one would like to hear. It involves payments outside of the United States which directly affect the economy of the country. It certainly involves directly how much one has to pay for their annual fuel bill. So, in terms of when an alternative to petroleum is required, as I said on Monday, I think the need is now—some alternative for that which is being

used, and it appears to be dictated by plain economics.

The second half of the question that Swede asked on Monday, that we didn't address at all, seems to paraphrase the question, "Do we need an alternative to the main power plant, namely, a diesel engine or something that uses other kinds of fuels?" In my personal view, the diesel electric locomotive is first an extremely efficient piece of equipment. There isn't much of anything I know of that will really challenge it. It can be made even more efficient, as all studies have shown.

In terms of adaptability to fuels, any report that has been written usually starts off with the assumption that the diesel engine is extremely versatile in the fuel which it can use, ranging all the way into some solids (which I addressed on Monday) to liquids that bear hardly any resemblance to present-day diesel fuels.

How well those alternatives really work with today's engines, or whether it is wise to modify engines to deal with extreme alternatives, such as alcohol, begs the question of availability of the alternatives. It would seem unwise to optimize an engine design to use a fuel which is even less available than petroleum, and thereby decreasing its efficiency when petroleum is used.

So, to summarize the need for an alternative to present fuels now appears to be dictated by economic reasons for the most part. Secondly, the diesel engine prime power

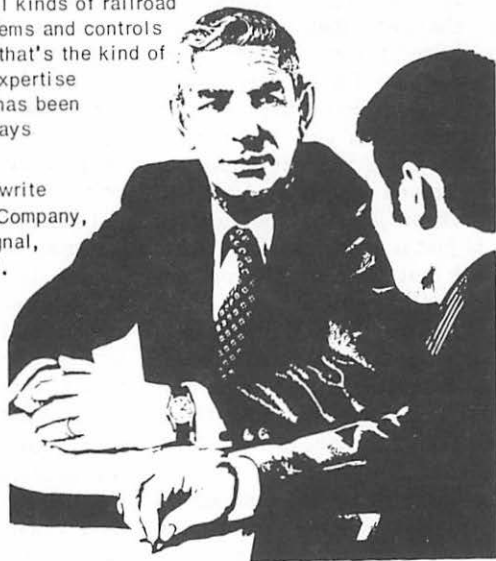
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source of today's locomotive is (a) extremely efficient, (b) can be made more efficient, and (c) is extremely tolerant of fuels.

MR. GILBERT MARTINSON [Brooks Technology Technical Service Manager, Cleveland, Ohio]: First, I would like to say that the American Society of Lubricating Engineers last May, at their convention in Pittsburgh, addressed this very issue. Some thoughts came to my mind while I was sitting here, and I thought about the other day when the question was originally raised.

First of all, you have to consider that say, 50 years ago the petroleum industry had a set procedure for refining diesel fuel, and they were using certain crudes at that time. In the last 50 years they have changed their procedures. They have become much more sophisticated. They are using crudes today that they couldn't even touch years ago. I am talking about crude when it comes out of the ground and is so hard you can walk on it until you heat it. This is just a prime example. Also, the fact that they are finding new oil fields all the time.

The next point: Say the oil does run out. There is a fixed amount of crude in the ground, and that is a fact. We may not have found it all yet, but the idea is that there is a fixed amount.

The next thing to consider is that we believe there is a lot more coal in the ground than there is crude. They are doing tremendous things with coal gassification, and

there are some awfully smart chemical engineers working for petroleum companies, and I believe they have already succeeded in some respects in coming up with a diesel fuel-like substance. If that is not satisfactory to the industry as far as volume is concerned, we can go one step farther and a few years down the road we can start working with biomass. The same material that made crude is the stuff we have on top of the ground right now in the way of biomass.

Thank you.

MR. GOEHRING: I would like to address that part of the question which refers to alternative types of prime movers other than the diesel engine. What I propose is not the answer for all railroads.

It should be realized that Amtrak and the commuter railroads in the Northeast Corridor operate an estimated 80% of their passenger operation without consuming a drop of diesel fuel. We use electric power.

I think one of the answers to alternative fuels in the United States is electrification. Electrifying selected portions of a railroad would supplement diesel motive power and reduce that railroad's dependence on fuel oil.

PRESIDENT BUSKEY: Gentlemen, I apologize. Our hard-working Secretary reminded me that I overlooked something I should have taken care of a few minutes ago, and that is to honor and recognize a man who has been Secretary of the RSA for over 20

years, and of which our organization is one of four. At this time I would like to perform this honor.

**SECRETARY KOERNER:** Thank you, Nelson.

Superlatives are sometimes freely dispensed from these microphones, but in this instance they are well deserved. We are about to recognize a man who has been the heart of the Coordinated Associations for over 20 years. It is a pleasure for me to have been selected by our officers to make this recognition, for no one is more aware of the job this man does than the secretaries of these Associations. This man has performed admirably, has always been most willing to be of help, and is always a gentleman. It gives me a great deal of pleasure to ask Al Schiffers to come to the podium.

Al, on behalf of the officers and members of the LMOA we want to present to you this dsek set which is emblematic of honorary membership in the LMOA. [Applause]

**MR. A. SCHIFFERS, JR.** [Secretary, Committee of the Coordinated Associations, Chicago, Illinois]: Thank you, gentlemen. It has given me great pleasure over the years to work with you people. Although I started on the railroads in the purchasing department, I have always had a soft spot for the mechanical people. I wish you the best of luck in the years to come. Thank you. [Applause]

**MR. HAFLING:** While we are still on the fuel category, I would like to direct this question to some of our locomotive manufacturers:

"Fuel gauges on diesel units are still inaccurate. We need a better design that will last longer and be more accurate. The cost of fuel is again extremely high, and there is too much inaccuracy in readings taken during interchange. I wonder what the locomotive manufacturers are going to do about it. Are there any better prospects for better type gauges?"

**MR. WALTER WECK** [Electro-Motive Division, LaGrange, Illinois]: The subject is fuel gauges on diesel electric locomotives. Fuel gauges are the choice of the purchasing railroad. They are considered to be an extra; in fact, I believe they have always come in as an extra, and they are provided to us by someone else.

Your statement is well put. There have been problems and there continue to be problems, and the accuracy of the gauges is really not what it should be. But we have to have assistance to make these things right. I don't know if any gauge manufacturers are here to speak to the subject. Our only function is to apply the gauges as supplied.

**MR. HAFLING:** This year's presentation of three of our papers was oriented toward traction motor repair, gear wear, lubrication, and gear case maintenance. Although yesterday's session of the Diesel Maintenance Committee had a good discussion on this subject, I received some more questions that some people want to have answered. They have to do, first of all, with the lubricants.

"What is the EMD and GE recommended traction motor gear case lubricant?"

MR. MITCHELL: As we stated last year and again this year, Elmer, the recommended lubricant we have had for the traction motor gear case has been the original Jet traction motor sodium base. We have tested, and are in the process of testing now in Erie, the lithium based lubricants. Particularly on test now is the Arco Jet TM-SLH which is a lithium based lubricant. It is a resin base rather than an asphalt base, and we believe that will give us the gear life we have had in the past, and will also overcome some of the problems that have been introduced with water due to washing the wheels off to inspect for cracks.

It is premature at this time to say that that is good, but it is in the right viscosity range, it has the right EP performances for the gear teeth pressures, and we have great hopes that it will become our standard lubricant. However, the current lubricant we recommend is still the Jet TM which has been very successful in maintaining gear life in the history of our apparatus.

MR. THOMAS WINFIELD [Electro-Motive Division, LaGrange, Illinois]: You will remember that last year this subject was discussed at quite some length, and we addressed it with a white paper, so to speak, on gear lube. We still maintain the Texaco TMGL 7500 as our recommendation for gear lube. We are looking at some of

the other products, but to date we have not found anything that matches the performance of the Texaco product.

MR. HAFLING: It seems all the questions this morning are directed to manufacturers.

I have another question: "What is the cause of premature galling or pitting of traction motor pinions?"

MR. STEPHEN BAREIS [Electro-Motive Division, LaGrange, Illinois]: There are a number of things that can cause galling or scoring on traction gearing. One would be if you are using a sodium base lubricant and water enters the gear case. Our experience at EMD has shown that sodium base lubes are very easily stripped off the gear teeth in the presence of water.

Another reason, of course, could be marginal lubrication, either due to improper maintenance of the lube level in the gear case or due to improper maintenance of the sealing arrangement of the gear case. A common problem is the failure to utilize the removable gutters on the EMD gear case.

Another factor that could enter into this would be the EP properties of the grease that is being utilized. Extreme pressure additives in the grease can help the gear set during a period of marginal lubrication or when starting up cold under heavy loads.

MR. KUHN: I think you hit the nail on the head. Whether it is sodium as GE recommends or lithium as Walter recommends, if

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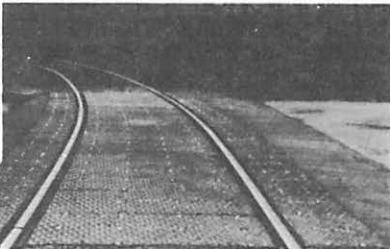
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you don't put it in that is when you have the problem. That has been our experience.

I believe one of the things that leads to whether we create the problem of whether you use sodium or lithium is that you can't get the thing open to put it in. I don't know how you can put some of it in in the wintertime. It is extremely difficult to open up the gear case so you can add it. If you can get the gear lubricant into the gear case you will be all right. It will be a lot better than what we have right now.

**MR. BURCHETT:** We are talking about putting the gear lubricant in the gear case. We had a young fellow on our railroad who came up with a theory that I think needs to be pursued further. He has been promoted twice since he had the idea. [Laughter]

He looked at locomotives that had been over our pits and had been lubed with the recommended lubricant by both manufacturers, and gear cases equipped with overflows, and he had a theory that needs to be developed, namely, that possibly this lubricant does aerate to the extent that you will see excessive amounts of lubricant running out of the overflow. He believes you can pump the lubricant out through the natural overflow and still not be able to maintain a proper level to lube the gears.

I think that needs to be pursued a little farther. We would like to pursue it, but our man has been promoted a couple of times and we haven't been able to get

back to it. It is still something that needs to be looked at. Some of the lube manufacturers ought to look into this subject, too.

**MR. HAFLING:** Maybe the Lubricant Committee could deal with that in the coming year, or Diesel Maintenance.

**MR. KUHNS:** We don't have that for a topic. Maybe Bill Cain has it for his paper next year.

**MR. MARTINSON:** We manufacture gear oil and grease. We come up against the topic of aeration of oils or greases, semi-fluid greases or oils periodically. You are looking at one of two things: Either you don't have a defoamer in there, a defoamer additive you can put in oils to eliminate the problem of aeration. However, a little bit does a good job. If you put too much in, all of a sudden you look on the gear teeth and you see what is known as fisheyes. There is nothing there. It looks like a clean surface. What you have there is a silicone deposit. This can be very unnerving to a mechanic or someone who is inspecting those gears.

Secondly, you can eliminate foaming by correct choice of base oils. There are some base oils that build up surface tension that will not release the air bubbles, and there are other base oils that don't have that problem, and they maintain a low surface tension of the oil, and the air bubbles never have an opportunity to form once the air rises to the surface of the oil.

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that. Take a 1000 ml graduated cylinder, put a diffusion stone on the end of an air line, stick it down to the bottom, and diffuse up through the oil for a period of time and then shut it off, and see how long it takes for those bubbles to dissipate. Most of your new oil will not give a problem. If the oil is used for a while and is tested again, you will see whether or not the oil in question will dissipate the air bubbles.

MR. HAFLING: I have a question directed to EMD: "Is EMD about to introduce a new design pinion for the D77 and D87 traction motor?"

MR. BAREIS: We are not going to be releasing a new pinion or gear for the D77 motor. We will continue with the 62:15 gear ratio. We have released a new gear set with the "50 series" locomotives which has a 70:17 gear ratio and incorporates a finer diametral pitch for improved scoring resistance, a higher pressure angle for improved pitting fatigue resistance, and increased surface hardness levels on the pinion and gear for reduced susceptibility to pitting fatigue and wear.

MR. WESTERFIELD: Would Mr. Bareis care to comment about the possibility of retrofitting those gears into D77 traction motors for logistics purposes in fleets that are running in the same territory?

MR. BAREIS: The gear sets are interchangeable. You can put a 70:17 gear set into a locomotive with a 62:15 gear set. The ratios

are essentially the same, within 0.5%, so there is no problem with wheel slip systems. The big difference, of course, is in the gear set cost. The 70:17 gear set is quite a bit more expensive than the standard 62:15 gear set. These increased costs are primarily associated with machining time. The machining speeds and feeds are considerably slower on the higher hardness materials utilized on the 70:17 gear set. In addition, the basic materials utilized are more expensive.

MR. HAFLING: "A large problem exists at the present time on GE units with gear grease migration into the pinion armature bearing. How can this problem be rectified?"

MR. VIRGIL WHEATON [General Electric Company, Erie, Pennsylvania]: We have a new seal design which we are testing on the Santa Fe and other properties, so far only about 45,000 miles. We have not found any migration whatsoever. Some other types we have tested have had some migration, as well as the old E8 seal, but so far it looks really good. We want more miles under our belt before we say "That's it," but we are quite pleased with it so far.

MR. HAFLING: "What effects, if any, have been observed on traction motor commutators and brushes from use of 'fuel saver' devices?"

MR. WESTERFIELD: As I am sure most of the people here are aware, the film which forms on a traction motor commutator is the

function of a number of factors, but one of those factors is the current density, the current that is flowing through the brushes onto the traction motor.

All of us have gone to a great deal of painstaking effort over the years to run tests of various brush grades and to optimize the brush grade and the film-forming capabilities for the service that our fleets run in. Fuel saver devices, by causing the locomotive to operate for extended periods of time at very low current densities, are going to change those average conditions, and there is no question that the extensive use of fuel saver type devices will cause some change in the film quality on the traction motor, and along with that in brush wear.

Obviously, the extent to which that happens is going to depend upon the extent to which the fuel saver device is used, which is something not all of us have good ways of measuring at this time. It is going to depend on the atmospheric and climactic conditions that you are operating under, and I don't think there is any clear-cut answer. I know this question has been brought up before our Committee, and we know there are some ongoing tests underway on several railroads, trying to get some concrete data as to the degree of effect.

We have seen several places in the country where there have been some commutator problems that may be attributable to fuel saving devices. We have had tests where

there has been no effect shown. Nobody to this point, that I am aware of, has done enough detailed collection to give an answer as to how much is too much, and at what point do you begin to have to worry about changing the brush grade to make up for the use of the fuel saver. I hope by this time next year we will have a little more information on that.

MR. HAFLING: Does anyone have a question on any of the Electrical Committee's report about diesel material, given yesterday?

VOICE: I am not quite sure whether your Committee would care to tackle this question: Has anyone got a good automatic control system for turning exhaust fans on and off in diesel shops (a) to minimize energy and not exhaust heated air, and (b) to maintain proper air quality in the shop?

MR. WESTERFIELD: I would think those suppliers who deal with heating and ventilating systems in large buildings or large industrial plants such as the steel industry, which have similar fuel and vapor problems, would be in a position to sell you a marvelous package that would do anything you want, provided you are willing to pay for it.

I would think there would be so many variations in the kind of system you had, and the exact shop layout and air flow, that it would almost have to be custom-designed to fit each shop. I can't give you the name of any specific supplier in that area.

VOICE: I would like to go back

to the question about locomotive fuel tank gauges. It seems the locomotive manufacturers have thrown the ball into the lap of a gauge company.

Looking back to yesterday's meeting and the type of devices that were presented from \$300 to \$3,000 to measure the work atmosphere, all a gauge company has to do is to say, "What kind of specs do you want me to make?" Therefore, it looks like going to the gauge manufacturer and saying, "I would like a gauge with such-and-such accuracy," and giving them the price range you are willing to pay for it.

MR. HAFLING: I think that is true, because on our railroad we are searching for good gauges, and we have to search out manufacturers that do make gauges, and we have to see what kind of accuracy they can give us.

VOICE: I have a question for the Fuel and Lubricants Committee. During the late 1950s, when diesel fuel cost approximately one-tenth of what it costs now, many railroads, notably the New York Central and Southern Pacific, did extensive research on cheaper fuels. Twenty years have passed. Did we learn anything, or are we doomed to reinvent the wheel? What are the plans on future tests?

MR. HOFFMAN: I wasn't on those railroads but I am certainly from that generation. The question is twofold: First, did we learn anything back in the '50s and '60s? The answer is yes, we did learn a lot in the '50s and '60s. In last

year's paper on this topic there is at least some reference to the fact that the railroads in that era did use some very, very bad fuel oil in terms of alternatives, with the view of saving money in some cases.

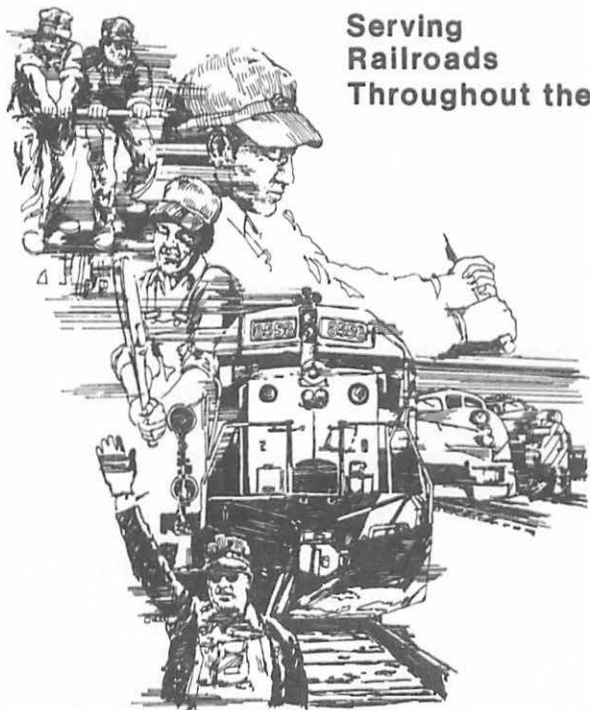
I can go back a little farther than that and point out that shortly after World War II there was a very extensive test to determine the broadest properties of distillate fuel that could be used in the event of national emergency. So, the railroads are far beyond most of the other industries that use portable liquid fuels in searching for alternatives.

Concerning the question of whether we are reinventing the wheel, I would say no, we are not. Particularly, one must remember that the horsepower of the locomotives in the '50s and '60s was substantially lower than at present. In some cases the design changes which have been made to both the 2-cycle and 4-cycle engines have been changes which could make the utilization of some of the fuels that were pretty bad in the '50s and '60s, possible today.

For example, some of the problems in the very heavy residual blends would not be problems now. Some of the problems developed were broken parts on cast iron pistons which are now steel. Some of the potential problems for those types of fuels are burned valves, and cracked valves because of corrosion. Valve material has changed.

It remains to be seen whether those design changes are sufficient

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to take care of the whole gamut of alternative fuel possibilities. One would think it is not; therefore, the job today is to establish what limits are practical in terms of handling, practical in terms of reducing costs. And that is the direction of the work that the rail industry, DOE and FRA are sponsoring at the Southwest Research Institute that Frank Bruner talked about.

I hope that answer will help you, sir.

MR. HUGH WILLIAMS [Electro-Motive Division, LaGrange, Illinois]: I would like to comment briefly on the last question. The question was whether anything was learned from the testing that was done in the late '50s with respect particularly to heavy fuels. The answer is that definitely we learned, and we learned quite a bit. Some railroads were involved in the testing of such fuels to a much greater extent than others. At the risk of being incorrect, I think the Southern Pacific Railroad had the largest scale test of any of the domestic railroads. I think they had approximately 100 locomotives operating on residual distillate fuel blends.

What was learned from some of the tests that were conducted? First of all, a dual liquid fuel system has to be installed on a locomotive. Secondly, that the heavy fuels burn much better in the upper half of the speed load range of the locomotive. The dual liquid fuel system automatically provided for switchover from the distillate fuel

in the lower range of operation to the heavy fuel in the upper range.

Another thing that was learned was that wear rates were greatly accelerated, and I don't mean by a small margin. I mean they were accelerated sometimes 100 times greater than with distillate fuel.

There is a vast difference today in the lubricating oils which are available for operation—if such tests were to be run today. The lube oils today are of much higher alkaline content, and they can neutralize the acidity that is formed from the sulfur in the residual fuels.

These are the comments that I think show a difference between what we had in the late 1950s and what we have today, and what was learned. Thank you.

MR. HAFLING: "EMD super series locomotives have a bewildering number of different versions of the modules. How can we tell which are interchangeable?"

MR. CHARLES OLSON [Electro-Motive Division, LaGrange, Illinois]: I guess the simplest way to answer that question would be that you have to read the designation below the module. There are different ones. For example, the LC module which controls power, depending upon various extras, matching older power, and so on. You do have different LC modules for different models and within the same model line. So, you really have to go by what the module compartment says.

MR. WESTERFIELD: We run into the situation where in the

same order we have had four different versions of the same module in exactly the same model locomotive as various engineering changes have been introduced, and the question comes up from time to time: What happens if somebody tries to put one of the old ones in one of the new slots? The old one will work and the new one won't.

MR. OLSON: In most cases you can't interchange. We would put on a dual nameplate in a case like that, which might say, for example, "DR10/12," or something like that, indicating you could use one or the other. The general rule is that you have to use the module that is designated.

MR. HAFLING: I have a question for the Diesel Maintenance Committee: "What is the latest assessment of the test on air-cooled air compressors as outlined in the Committee's report?"

MR. KUHNS: I can only speak for my own railroad, The Family Lines. We have adopted air-cooled compressors as standard. In the report as stated, EMD and GE have shipped new locomotives with air-cooled compressors. EMD shipped new locomotives to the Clinchfield Railroad with air-cooled compressors two or three years ago that have operated satisfactorily.

As mentioned in our paper, the pendulum swings in both directions. We went from water-cooled to air-cooled and back. We have decided to go to air-cooled as a standard.

Maybe the builders would like

to comment. Do we have anyone here from Gardner Denver or Wabco who would like to comment on this?

MR. MITCHELL: Jack, you are exactly right. We have shipped locomotives with both models of air compressor on them, the Gardner Denver as well as the Wabco. Our records indicate that the Wabco performance has been superior to the Gardner Denver performance in our locomotive.

On the other side of the coin, in order to improve the Gardner Denver compressor, we are working with Triangle Engineering in developing ring and liner configuration which we believe will reduce the pumping of lube oil up past the cylinder in the Gardner Denver compressor. We are testing some of the compressors with those techniques encompassed in the design, and believe they will show a significant improvement in performance. We are doing this with the full knowledge (not necessarily the support) of Gardner Denver, because we believe both compressors should be in the picture.

As you pointed out, historically 10 or 15 years ago compressors were air-cooled; then they were switched, and now we are switching back. Both should be in the picture, and I believe both show merit. Our locomotive is different. The air compressor does run faster, and because it does share a heavier load it operates at different temperatures than the other builder's application of the same compressor.

We are actively involved in this program with both air compressor builders. Right now the Wabco is more expensive initially than the Gardner Denver. We hope to retain that cost saving, not throw it away.

MR. HAFLING: "I would like to comment about air working up into the top of the air cylinder when the unit is shut down. I have worked in a number of areas with a stationary air compressor where we have staged loading. This more or less would keep positive air pressure on top of the cylinder, because most times the air compressor that is stationary never actually shuts off. I wonder why in locomotive service they don't go to staged loading on air compressors. It might help conserve consumption of oil."

MR. ENNS: I would like to go back to the question regarding modules. Could someone from EMD address the MS module as it relates to the GP50s? What is your current status and thinking on the MS module, its availability, and so on?

MR. WINFIELD: At the present time we have made a decision that MS modules will be installed on all of the 50 Series locomotives. The Santa Fe has some on test that were installed as delivered. We have also installed some on the North Western and some on the Southern for testing.

It will be an MS101 module which supersedes the previous MS100 which was on the GP40X locomotives. The MS101 also in-

cludes the circuitry to provide the simulation of traction motor heating during dynamic brake, which the MS100 did not have.

As to availability, we are gearing up to start producing the nearly 200 modules we will have to produce to retrofit all of the GP50 locomotives. I can't give you a date for sure. We hope within the next month or two we can start shipping to some of the customers for application on their GP50s.

MR. HAFLING: Any other discussion on modules? Any other discussion on air compressors? Do we have a Gardner Denver or Wabco representative here? Evidently not.

"On those railroads that have compressor crankcases directly connected to the diesel engine lube system, are they having any contamination problems in the air system?"

MR. KUHNS: We have a representative on our Committee from the Southern, who I believe has more experience along these lines than anybody else. During some of our meetings he has said no, they have not had a problem. Is Bill here? Evidently not. According to his information, he said they are not experiencing any trouble at all.

MR. WALKER: We have been doing this for 15 years on Alcos, GP7, GP9, and SD24. When we had an air compressor oil problem we piped to the engine crankcase against the builder's recommendation, without a problem.

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MR. KUHNS: Are you still doing it today?

MR. WALKER: Yes.

MR. AXELSON: Bill is unable to be here. Speaking for Bill Brown, on the Burlington Northern we have set up some compressor lube systems from the crankcase on GP7s, SD7s, switch engines, and it is working out very well. We are trying to overcome some of the lack of maintenance because the compressor oil level doesn't get much attention, especially on switch engines and locals. We have not experienced any carryover of oil. Also, I think, that helps out due to improved filtration of the engine which supplies the engine oil to the compressor, plus the fact that we now have a fourth generation oil which is suitable for air compressor operation.

MR. HAFLING: Do we have any FRA representatives here today? I guess not. Maybe someone here can give us some information regarding this question:

"We have to apply FRA type 1 and type 2 windows to locomotives. In 1979, GM released locomotives with FRA type windshields and side windows, but the windows were not marked as such. They are supposed to have a stencil on the corner relating to that type of glass. What are the railroads supposed to do with these windows?"

You see, you can't stencil them yourself because you will lose your warranty on the window. What does EMD recommend?

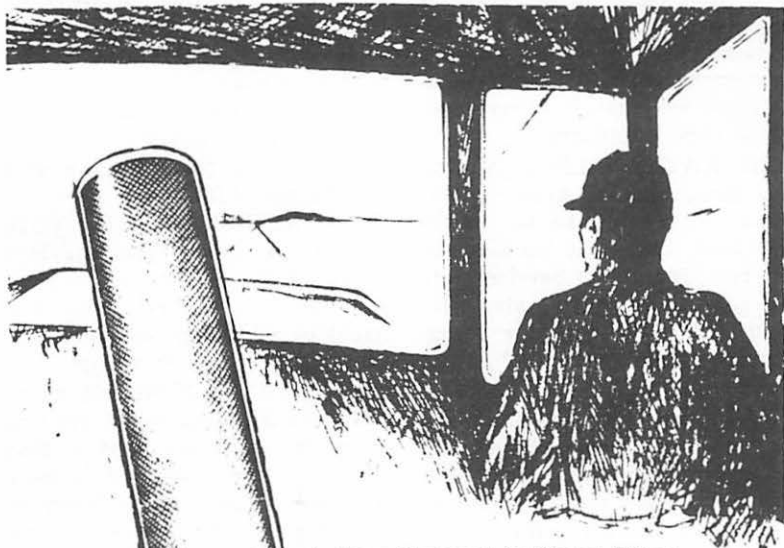
MR. M. B. CAMPBELL [System

Shop Superintendent, Chicago and North Western Transportation Company, Oelwein, Iowa]: I can't speak for the FRA, but I can tell you that we got some glass we knew was type 1 and had been marked in error. The FRA took the position that we had to change all of that glass, and that is what we finally did.

MR. WALTER WECK [Electro-Motive Division, LaGrange, Illinois]: I hope I understand the question. Any glass that left EMD that met the specifications of the FRA rulings was marked. I know we have had several occasions when the glass was inadvertently turned around. We were able to determine that from the marking on the glass itself. I am not aware of shipping glass that met the spec that was unmarked.

MR. M. G. DINIUS [Superintendent Locomotive - Mechanical, Illinois Central Gulf Railroad, Chicago, Illinois]: We had some locomotives in 1979 and 1980 with the original blue dot/blue square to get ahead of the program. FRA has taken exception to it. We have talked to the manufacturers. The glass has to be stenciled. The manufacturers have come up with a metal plate and a small sandblast machine. You hold the metal plate up to the window and etch the manufacturer's name and type of glass, type 1 or type 2, or apply a decal.

MR. HAFLING: I understand that in marking these windows you have to be careful, because this is tempered glass and might fracture.



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I understand the manufacturers mark these signs on the glass by acid etching only, and if you put anything else on the outside the instructions from the glass manufacturers are that it is no good, that it doesn't conform.

MR. WAYNE EWING [Altoona Gear Company, Los Angeles, California]: I would like to compliment Jack Kuhns and his Committee on "Increased Service Life Through Technology," also this group assembled here for recognizing that going to a 7/32 tip width on EMD gears is feasible.

We in the gear recycling business have been feeding the system a few gears at a time that have been down below the 1/4" limit as a test, and to this point I have not heard of any significant failures. We are doing this partly from a cost standpoint and partly from a technological standpoint. We are laying gears on the floor at 25% of new price. We are testing welded gears that will be, if they work (and they are working thus far), 50% of new cost. We will be refurbishing pinions for 50% of new price.

Since the book was written five years ago a lot of things have happened to costs, and now it becomes more feasible and economical for us to do these things. We appreciate the support of those railroads that have allowed us to feed these items into their systems and give us the results.

If there are any contributions that can be made for the good of this subject, I want to go on rec-

ord as saying that I am dedicating the rest of my life to recycling bull gears and pinions, and I welcome any comments, good or bad, on that subject.

MR. HAFLING: I have a couple of questions on gears:

"How many times can an axle gear be reprofiled?"

MR. KUHNS: I would think that is like asking how long is a string. It all depends on how much you take off the first time. You might be able to grind one several times, and another only once.

MR. EWING: If we follow the EMD and GE specs, which are fine specs, we could say that a gear should be reprofiled if it is more than .008 out of profile. When we go to the 7/32nd tip we are taking off up to .060 a side. If we catch this at the .015 increment, then we can go four times. Most of you don't do that, and it gets about two or three grinds.

What we are saying here is that we have proven that we can go to 7/32 which means only 1/32 narrower than the original condemning limit of 1/4." This means that there are 130,000 gears out there that are candidates for reprofiling.

MR. HAFLING: Maybe the person who asked that question had this next one in mind:

"Does profiling an axle gear remove any hardness or finish which will shorten the life of the gear?"

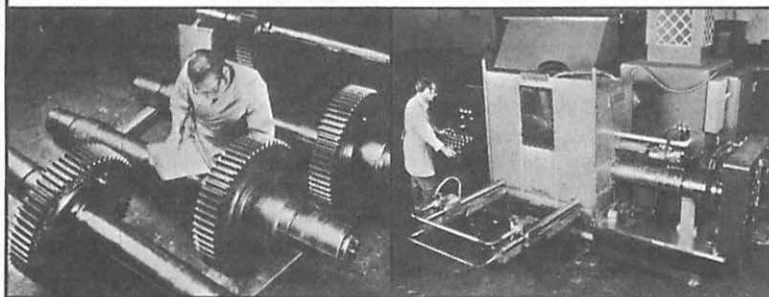
MR. KUHNS: No.

MR. BAREIS: As far as reprofiling gears is concerned, the primary thing you have to watch out for is the case depth of the

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hardened surface of the gear. Our gears are nominally 55 Rockwell C at the surface, 50 Rockwell C minimum at 0.050" below the surface, and 40 Rockwell C minimum at 0.100" below the surface. We normally recommend that the gear tooth thickness not be reduced more than 0.064" during reprofiling; 0.032" stock removal per side.

You can reprofile below those limits, but the material will be softer in those ranges and consequently you will not get the same life out of the reprofiled gear as you would with a new gear that is at the new print specification. On gears utilized in heavy duty service, reprofiling below these limits may result in tooth breakage due to higher tooth bending stresses. In summary, it can be done, but the gear life will definitely be shorter.

MR. EWING: I agree with about half of that. It is softer to the center but not that soft, and you can go to the limits that I pointed out, without danger. We have been doing it for five years and they are holding up.

MR. BAREIS: A little rebuttal to that. [Laughter] When you are in the range between 50 and 60 Rockwell C, a couple of points of hardness can make a very significant difference in fatigue life and wear life.

Testing has been done by some of the people at Detroit Diesel, Allison, showing that, for instance, if you raise the hardness level of the gear from 55 to 60 Rockwell C you will get about a 7-fold im-

provement in pitting fatigue life. So, as you go under the 55 Rockwell C hardness level, which is a new print spec on a standard 62 tooth gear, you will be sacrificing life. However, I can't say that gears reprofiled beyond EMD recommended limits won't run in certain types of service. The life of these gears, of course, will not be the same as that of a new gear.

MR. MOSS: Recently EMD has distributed different types of gauges for different types of ring gears and pinions—that is, a particular type of gauge to measure the profile of a 60, 62 tooth ring gear and also 17 and 18 tooth pinions. Why was this done? Why were the gauges changed when we were using one standard gauge to check all involute profile?

My second question pertains to EMD rods. Recently we have found stress cracks on 1977 blade and fork rods. Are any other railroads encountering this problem?

MR. KUHN: I can't answer the question concerning gauges; maybe EMD can. As for cracked rods, no, I can't say we have experienced any problems. I don't mean we haven't had broken or cracked rods, but nothing of any consequence. Do you want to comment about the gauges, Walter?

MR. BAREIS: There have not been any major changes in the pinion gauges. They are still the contour type gauge that you put on the tooth and utilize small diameter wire feeler gauges to determine what your involute profile deviation is and what your total wear is.

A new type gauge was made for the bull gears that was a little simpler. We at EMD were in a large gear remanufacturing program, and our people in the shop were having trouble using the standard type gauge. As a result, one of our engineers designed an improved gauge that took a little of the judgment out of the use of the old type gauge. The part numbers and instructions for the use of these gauges are detailed in MI #1518.

MR. WECK: A question was raised on 77 connecting rods and finding cracked rods. We have had brought to our attention connecting rods where customers are now going through an engine overhaul period, and at magnaflux they are finding indications. Almost without exception the indications brought to our attention are forging folds, things other than true cracks.

We do not approve of a connecting rod with a forging fold; however, some have found their way into the field. We have representatives on the IC and we would be only too pleased to take any of the rods these gentlemen have that they think are cracked, and do a lab analysis and find out whether they are good, bad, or contain indications that are of no consequence.

MR. RICHARD FARR [Farr Company, El Segundo, California]: In the discussion on the slammers, it was mentioned that we had trouble with our early sensors. We had a sensor that would open when subjected to heat, and then under

vibration would close again, and you couldn't recognize it had failed. We have changed that, and are retrofitting Electro-Motive units equipped with the slammer with a solder loop. When it is overheated it melts and consequently can't reset. We believe we have the problem of false shutdown behind us.

One other thing I don't believe was brought up about the slammer is that one of the main reasons for the development of it was to limit the amount of damage in case of electrical fire. Today, on the present locomotive, in case of an electrical short, if it doesn't burn free you maintain a 3000 HP electrical fire until the engine or the generator stops rotating. We have sensors located in an area that might be subject to electrical short, that recognize an elevated temperature, and immediately shut the engine down and limit the damage due to an electrical short.

MR. AXELSON: I don't have a question, but I would like to make a comment.

Last year on the floor in this session there was much concern expressed about the basement of the locomotive which has received very little attention over the years—the running gear. In a negative way we keep beating engine builders and suppliers over the back for improvements, and in many cases rightfully so, but I couldn't help notice a shift of emphasis and attention given to running gear this year, and the tremendous amount of improvements that have been

made in a year's time.

On a positive note, I think the LMOA ought to go on record as commending the builders and suppliers for helping out in the basement problem area so that we are in a better position to take advantage of the economies of extended maintenance provided by the recent FRA rule changes. Thank you.

MR. HAFLING: If there are no other questions, the What's Your Problem session is closed and we would like to thank all of you for your attention. I will now turn it back to Dick Holmes.

MR. HOLMES: Gentlemen, this was the What's Your Problem session for 1981. We appreciate your cooperation and participation. Our thanks to the LMOA and all those connected with the program, the committee chairmen, and Elmer for handling it so ably.

Now I will turn the meeting back to President Buskey.

PRESIDENT BUSKEY: Thank you, Dick.

I want to publicly thank Mrs. Charlotte Emmons for her patience and kindness to us for so many years. Those of you who receive transcripts of your remarks are asked to correct them and return them to her promptly.

The Executive Committee will meet immediately after adjournment in Room 418. That includes all Vice Presidents, Regional Executives, the new Chairman of the Board, and committee chairmen.

With that, gentlemen, in recognition of the fine work this year's What's Your Problem panel has done, I would like to call for a rising vote of thanks.

[The audience arose and applauded.]

PRESIDENT BUSKEY: We are adjourned until September 20, 1982.

[The meeting adjourned sine die at 11:50 a. m.]



Pictured at start of 1981 LMOA Annual Technical Conference. Left to right seated: 5th Vice Pres. K. Axelson; 2nd Vice Pres. F. D. Bruner; President R. G. Clevenger; 1st Vice Pres. N. A. Buskey; Chairman of the Board J. H. Long. Standing left to right: 7th Vice Pres. D. H. Propp; 4th Vice Pres. D. M. Walker; 3rd Vice Pres. R. R. Holmes; and Secretary-Treasurer J. J. T. Koerner.

PRE-CONVENTION  
PRESENTATIONS

# INDEX

## LOCOMOTIVE MAINTENANCE OFFICERS ASSOCIATION

### MONDAY, SEPTEMBER 20, 1982

- 9:15 a.m. **Joint Meeting** — ABA, CDOA, LMOA and RFOOA  
Keynote Address: John T. Collinson, President and Chief Executive Officer, Chessie System
- 10:00 a.m. **Diesel Mechanical Maintenance Committee** — Chairman W. A. Brown, Assistant Superintendent Motive Power, Burlington Northern. **Topic:** "Quality Maintenance - The Key to Fuel Conservation" ..... 137
- 2:00 p.m. **President's Address** — Nelson A. Buskey, Assistant General Manager-Locomotive, Chessie System
- 2:15 p.m. **New Developments Committee** — Chairman David G. Goehring, Manager Equipment Maintenance Planning, National Passenger Corp. **Topic:** "Quality Maintenance - Improvement Through New Developments" ..... 169

### TUESDAY, SEPTEMBER 21, 1982

- 9:00 a.m. **Diesel Electrical Maintenance Committee** — Chairman Thomas L. Westerfield, Senior Electrical Engineer, Chicago & North Western Transportation Co. **Topic:** "Quality Maintenance - Assuring Thorough Repairs" ..... 203
- 10:30 a.m. **Shop Equipment Committee** — Chairman Thomas A. Kessenger, Senior Engineer Facility Planning, The Family Lines Rail System. **Topic:** "Quality Maintenance Through Modern Tools" ..... 227
- 2:00 p.m. **Fuel and Lubricants Committee** — Chairman Donald D. Hudgens, Manager-Field Laboratories, Union Pacific Railroad Company. **Topic:** "Quality Maintenance Through Fuel and Lubricants" .. 271

### WEDNESDAY, SEPTEMBER 22, 1982

- 8:30 a.m. **Diesel Material Control Committee** — Chairman Michael L. Wall, Superintendent Motive Power, Missouri Pacific Railroad Co. **Topic:** "Maintaining Product Quality Through Improved Material Handling" ..... 303
- 10:15 a.m. **What's Your Problem Panel** — Chairman Jack L. Kuhns, Manager Planning & Maintenance, The Family Lines Rail System. This Panel is composed of the chairmen of LMOA's six technical committees. It is a free-wheeling question and answer session resolving remaining questions from previous papers, as well as an opportunity for anyone to pose any question they may have on locomotive maintenance.

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1947	101	284	937	1321
1948	113	295	1183	1591
1949	134	595	1789	2521
1950	123	595	2101	2822
1951	125	626	2912	3663
1952	135	510	2747	3392
1953	118	597	3288	4003
1954	118	545	2943	3606
1955	81	434	3235	3750
1956	110	419	3257	3786
1957	100	423	2678	3201
1958	82	350	2320	2752
1959	90	387	2395	2872
1960	98	393	2302	2793
1961	101	348	2201	2650
1962	118	316	2291	2725
1964	138	273	2345	2756
1965	155	289	2372	2816
1966	163	464	2368	2995
1967	180	408	2327	2915
1968	200	321	2575	3096
1969	192	335	2173	2700
1970	184	345	1929	2458
1971	140	283	1621	2044
1972	132	343	1777	2252
1973	108	345	1563	2016
1974	124	384	1735	2243
1975	103	326	1579	2008
1976	109	314	1610	2033
1977	114	317	1508	1939
1978	125	363	1367	1855
1979	120	391	1251	1762
1980	112	405	1200	1717
1981	114	445	1143	1702

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# Monday, September 20, 1982

10:00 A.M.

## REPORT OF THE COMMITTEE ON DIESEL MECHANICAL MAINTENANCE

Pre-Convention  
Presentation  
Southwestern  
Railway Club



April 22, 1982  
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### 1982 TOPIC:

**"QUALITY MAINTENANCE — THE KEY TO FUEL CONSERVATION"**

## PERSONAL HISTORY

### WILLIAM A. BROWN

Born in St. Paul, Minnesota, October 12, 1937. He attended public schools in the St. Paul area, graduating from high school in 1955.

Mr. Brown served in the U. S. Navy as a Radioman and in the Seabee Reserve. He attended various trade schools, De Vry Institute, and Northern Montana College.

He entered service on the former Great Northern Railway as an Electrician Apprentice in August, 1957. Assigned various positions, including Assistant Roundhouse Foreman, Roundhouse Foreman, Diesel Supervisor, Power Maintenance Controller, Assistant Manager Motive Power, Manager Engines, and presently position of Assistant Superintendent Motive Power.

Mr. Brown has been a member of LMOA since 1976.

He is married to the former Patricia Crooks and they have five children. His hobbies are hunting and woodworking.

## INTRODUCTION

Prior to the mid 1970's the cost of railroad diesel fuel amounted to less than 2% of freight revenues, thereby having little direct effect on railroad profitability. Only temporarily during the 1973-1974 oil embargo did spot shortages produce some significant effects on rail

operations. Consequently, with some noteworthy exceptions, concentrated efforts to effect fuel conservation were neither undertaken nor warranted.

However, during the 1970's, fuel prices started increasing drastically, experiencing nearly a 1000% escalation within the decade. With this economic transformation, locomotive fuel suddenly became a most significant factor in the overall financial evaluation of railroad operations. Presently, with the annual North American locomotive fuel bill totalling almost \$5 billion, minimization of fuel consumption becomes a necessity for economic survival. Although not commonly realized, with fuel costs approaching approximately 15% of revenues, this formerly unimportant item has become equal in magnitude to all train and engine crew wages combined. Each 1% increase in diesel fuel price costs the North American rail system about \$50 million annually. Conversely, each 1% decrease in the gallons-per-ton mile consumption saves these railroads approximately \$50 million each year.

These large dollar figures have spurred management into seeking and exploring every avenue available to decrease fuel consumption. These endeavors have created changes in train operation, as well as Mechanical Department procedures. Any major procedural change or new program will have expenses related to it; thus our review of fuel economy, its cost and effects on maintenance.

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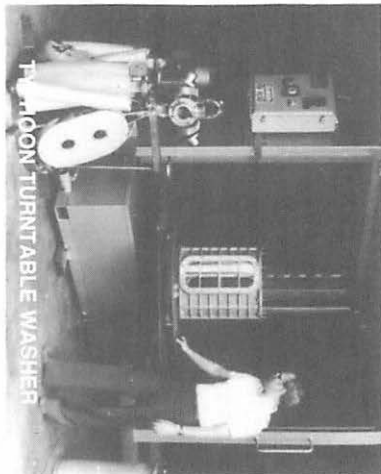
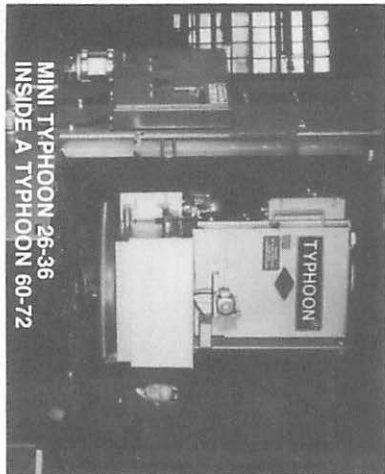
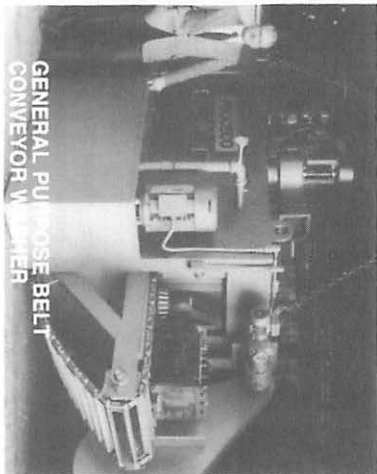
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## I

**FUEL CONSERVATION —  
EFFECTS ON MAINTENANCE****1. Engine Component Life**

Most components on the diesel locomotive affects fuel consumption to varying degrees. It is, therefore, essential that proper established maintenance programs be followed.

Locomotive maintenance officers must continue to review maintenance programs to insure that everything possible is done to promote fuel conservation. Some of the areas to address are fuel and lube oil filters, faulty injection equipment, air and exhaust leaks, air compressor loading, governors, pumps, temperature switch calibration causing unwanted fan operation, air, oil and fuel leaks. Each affects the operation of the locomotive and could increase fuel consumption.

Each of our railroads has fuel conservation programs in effect. The approach may vary but the end result is to have locomotives operating effectively at reduced fuel consumption. Some are experimenting with blended fuels, hybrid fuels and various additives to decrease diesel fuel cost. The results of these tests on engine component life are yet to be fully measured. A method to accurately assess engine wear must be developed. Presently, spectrographic wear analysis and tests are being used. The use of radioactive tracer methods is being explored.

Low idle and engine shutdown are effective fuel conservation practices, but can have an adverse

effect on locomotive component life if proper procedure is not followed and enforced. It is essential that all functions of a locomotive are operating properly when unit is at low idle. Engine temperature, oil pressure, air pressure and charging rate must remain normal. Mechanical instructions for starting procedure must be followed when units are restarted.

**a. Bearings**

At the writing of this paper no member of the committee can furnish information concerning accurate wear of bearings; therefore, no conclusion can be drawn. Governors, water pumps, oil pumps, compressors or gears show no increased usage or wear that can be related to low idle.

**b. Assemblies**

Again no accurate measurement of wear can be assessed. One member railroad reported increased wear of valve and valve seats.

**c. Low Idle**

Being a relatively new feature, low idle must be monitored for possible future effects.

**d. Starters and Batteries**

Engines shut down for long periods of time allowing unit to cool places additional load on starting motors and batteries when prolonged cranking is necessary. Unless starting instructions are adhered to, starting motor damage on EMD locomotives will occur. A thermal overload device has been developed to protect starting motors from damage from prolonged

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or repeated cranking. Batteries must be inspected routinely for electrolyte level, faulty connections, cleanliness and charging rate adequate to keep fully charged. Auxiliary generator and regular need close inspection also.

EMD has developed a "Second Generation" AC auxiliary generator with VR13 voltage regulator with the capability of maintaining full charging voltage down to 235 engine rpm. "A Third Generation" AC auxiliary generator is being applied for testing at 200 rpm engine low idle using the VR13 voltage regulator. Temperature compensated voltage regulators to provide higher charging voltages in colder weather are contemplated.

## 2. Engine shutdown and Starting Procedures

### a. Engine Shutdown Practice

The maximum fuel conservation is attained when the diesel engine is shut down rather than left idling as fuel consumption is then reduced to zero. An idling engine consumes approximately 3 to 7 gallons of fuel per hour. A typical 3000 H. P. locomotive consumes up to 5.5 gallons per hour (gph) at 315 rpm. Therefore, up to 44 gallons of fuel will be saved when it is shut down 8 hours.

A locomotive idles over 50% of the time under normal duty cycle. In the last few years, a majority of railroads have established a standard policy for shutting down locomotives rather than leaving them idle. The lowest ambient temperatures permitted for locomotive shutdown vary from 33° to 50° F.

The lengths of time that a locomotive will not be used before requiring shutdown vary from 30 minutes to 4 hours. A major railroad estimates that 40% of the total fuel consumed in road service is in idle position and there is a potential savings of up to 80% of that amount through a shutdown policy. The savings in yard service can be even greater; estimates show that 40% of the fuel consumed is in idle position, and there is a potential savings of up to 50% of that amount through an effective shutdown policy.

On EMD turbocharged engines, the main battery switch should not be opened until the engine has been shut down for approximately 35 minutes. This can present a problem in delay or require additional time for the locomotive engineer at completion of tour on duty at locations where no mechanical personnel are presently available. Some railroads do not require the locomotive engineer to open the main battery switch following engine shutdown when the locomotive is left at a shop facility or will be shutdown less than a specified period of time.

### b. Starting Procedures

At the present time, most railroads have a prescribed engine start-up procedure. There was a reluctance prior to the escalation of fuel cost to shut down engines because of the concern that damage would occur when restarting or failure of the engine to restart. (Experience by most roads has proven the need for head to liner

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sealing improvement and limited energy starting system.)

Start-up-procedures vary with different model locomotives. Engines without purge control that have been shut down for a long period of time require opening of cylinder test valves, and the engine must be barred over manually at least one revolution. This procedure is necessary to prevent possibility of damage to engine caused by a hydraulic lock. Many railroads have applied cylinder test valves with easy opening devices; otherwise, cylinder test valve wrenches must be made available to open test valves to purge the cylinders.

### 3. Lube Oil Consumption (Low Idle)

At this time no member of the committee can furnish information concerning lube oil consumption related to low idle. Several members of the committee have raised an issue of diesel units pumping oil out of the stack and want more research in this area to determine if low idle contributes to this condition.

### 4. Pre-lube

GE and EMD recommend pre-lube of a new engine, an engine that has been overhauled or engine which has been inoperative for more than 48 hours as necessary and important practice. Pre-lube alleviates loading of unlubricated parts while the oil pump is filling passageways. It also gives visual evidence that oil distribution is satisfactory. EMD's pre-lube instruction should be followed. GE

and EMD also recommend that units that have been stored using anti-rust compound be washed and flushed with fuel to remove sludge deposits and wiped dry before new oil is added to unit. Strainer housing should be filled before starting the engine. GE does not require pre-lubing of the diesel engine before start-up for normal day-to-day locomotive operation.

### 5. Fuel Filler Devices

There are several fuel filler devices on the market and in use on our railroads. All function well if adequately maintained. Abuse of filler device by mishandling or blocking defeats its purpose, creating leaks and spills. Hoses, gaskets, adaptors and couplings must be kept in good repair to prevent costly leaks. Knowledge of the equipment and proper maintenance are essential to proper operation. To prevent needless fuel spills and overflow in service areas and on elevated curves, one committee member reports units being short filled by 200 to 300 gallons of diesel fuel.

### 6. Eddy Current Clutches and Parasitic Loads

Parasitic loads on diesel units are real and necessary and, if not maintained, will result in loss of efficiency and affect fuel consumption adversely.

Eddy current clutches in use on later model General Electric units are designed to delay engaging of cooling fan until a predetermined cooling water temperature is attained. Fan load can be

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controlled by engine temperature which, in turn, reduces loading on the diesel engine.

Air compressors in typical train service are loaded about 10% of the time. Adverse weather conditions or cold temperatures increase trainline leakage; improper functioning of air brake equipment increases compressor loadings. Improperly maintained compressors, automatic drain valves and compressor controls will add to the on-cycle time of compressors. The difference between normal loading and the abnormal condition of continuous loading will increase fuel consumption about 1%.

Auxiliary generators, alternators and exciters must be clean, free of grounds and well maintained. Pumps, blowers, and turbochargers need routine inspection for lubrication and wear.

#### 7. Air Starters

Low idle and cold engine starting have affected the life expectancy of starting motors and batteries. A need for an alternate method of cranking diesel engines has apparently become necessary. Several railroads are currently evaluating air starters with a goal of reduced maintenance costs and improved reliability. We understand that several air start systems are presently marketed for installation to diesel locomotives. Air starters offer advantages in the areas of low initial cost, maintenance cost reductions, eliminating need for high amperage batteries and charging equipment, and are

safe and reliable. Air starters maintain full power for fast, effective starting under extreme cold or hot weather conditions. Air starters are available in a wide range of air pressure (40-150PSI) horsepower and are applicable to many models of locomotives.

This committee believes that further field testing and use of air starters should be considered as a result of fuel conservation effects on maintenance.

## II FUEL CONSERVATION — WHAT IT COSTS

### 1. Security

Because of the complexity and cumbersomeness of direct fuel use measurement systems and less than desirable industry experience with the reliability of fuel use measurement instrumentation, most railroads do not directly measure fuel consumption by locomotives. Some railroads use printing-type fuel dispensing meters at fuel nozzles and record unit number along with gallons dispensed.

Railroads receive fuel by pipeline, barge or tank truck to storage tank and tank truck direct to locomotive fuel tank. Most railroads require fuel delivery to be signed for by an officer of the company, with reporting system showing quantity of fuel received.

One railroad has installed complete Diesel Fuel Receipt and Disbursement Procedures on the system. Appendix I gives a brief description of this standard procedure.

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## 2. Fuel Tank Gauges

The majority of railroads specify optional fuel gauge arrangement on new locomotive purchases. Generally, one eight-inch fill gauge adjacent to each fuel filler pipe and dial-type float gauge is specified for each side of the locomotive. Until recently, the dial-type gauge was located approximately in the center of the fuel tank on each side of the locomotive. This made it difficult to change out the gauge for repair or replacement when the fuel level was above the bottom of the gauge mounting hole.

In recent years, the dial gauge has been relocated to the top of the fuel tank on each side of the locomotive. The dial gauge now can be changed out without lowering the fuel level in the tank. Dial gauges have poor reliability and are not accurate enough for fuel consumption measurement. It is difficult to measure the fuel level accurately on a locomotive; track conditions can create problems in determining if the tank is level.

A number of railroads experienced problems with one brand of fuel gauge mounted on top of fuel tank, such as defects in the right angle gear mechanism at the hinge point between the float arm and main body of gauge. Another problem was experienced when the rubber bushing came loose from the main body of the gauge, falling down over the float and acting as a weight or interfering with float-rod gearing. The locomotive builder contacted the gauge supplier and

advised of the following improvements in the gauge design:

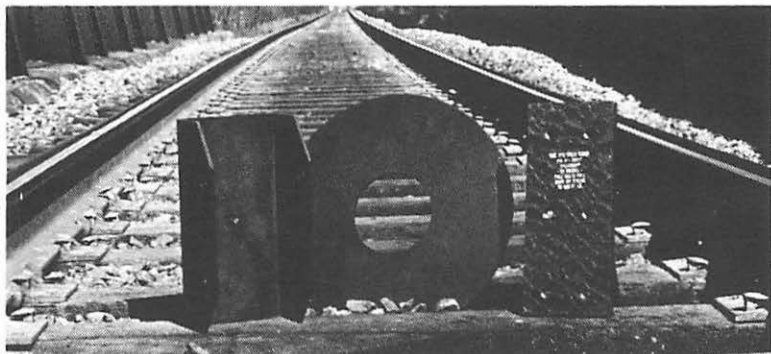
1. A redesigned aluminum float shield to reduce chances of the float catching on the edge of the guide tube during gauge removal.

The float assembly is positioned on the float rod by crimping the end of the rod and at the top of the float shield.

The flat washer surface at the top of the cone-type shield could have caught on the bottom edge of the guide tube during gauge removal, permitting the float assembly to be stripped from the rod. The re-designed cone shield has reduced the area of the float and has provided rounded edges to direct the float into the guide tube.

2. Change in the method of mount the support collar from epoxied to a mechanically clamped assembly.

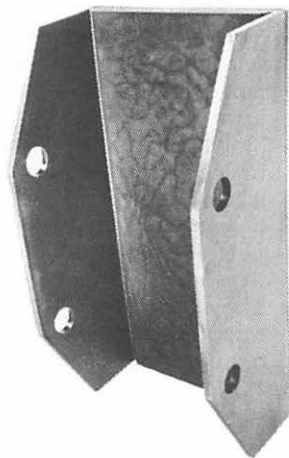
The rubber support collar which provides gauge stability in the guide tube was originally epoxied to the gauge head extension. It was possible to break the epoxy bond, leaving the collar free to move down on the extension until it interfered with the float-rod gearing. The improved method of applying the support collar provides a permanent mechanical bond using two metal rings and the elasticity of the collar to clamp it in place. Applied only in this manner will the collar withstand normal service without becoming loose.



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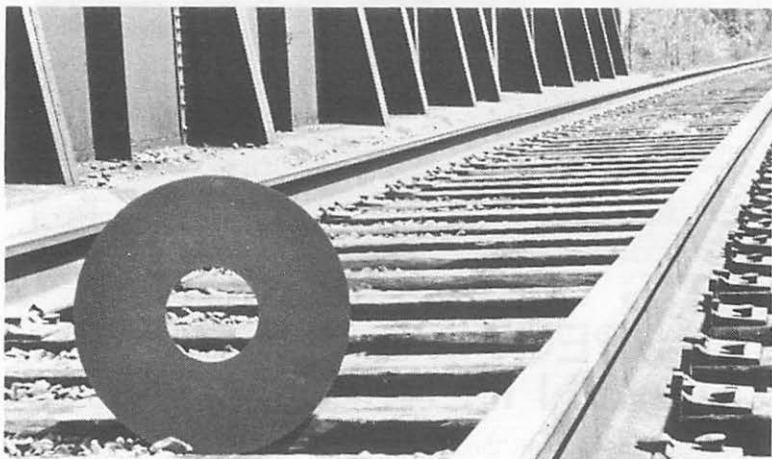
You already know about the premium qualities of Nylatron® nylon pedestal liners. You know they are standard OEM parts on EMD and GE diesel locomotives. You know that they are replacement parts for every major railway in the United States, because

- Nylatron® nylon pedestal liners are cast nylon parts with self-lubricating molybdenum disulfide right in the liner.
- Nylatron nylon liners generally outwear carbon steel 2½-times, and are at least equal to manganese steel liners.
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- Nylatron pedestal liners weigh only 1/7 as much as manganese liners and are easier and safer to install.



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## THE RIGHT PERSPECTIVE IS ON



### Center Plate Liners

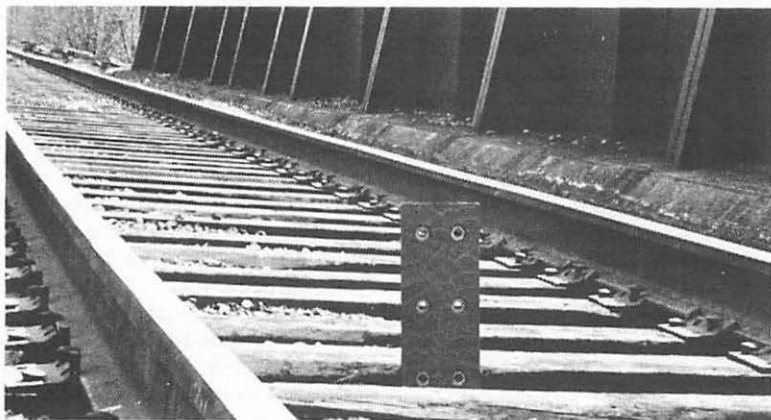
- Nylatron® nylon center plate liners are made of the same self-lubricating and wear-resistant material as Nylatron pedestal liners and are designed for both EMD and GE locomotives.
- Molybdenum disulphide solid lubricant provides Nylatron nylon center plate liners with excellent wear resistance.
- Nylatron center plate liners cost less than the filled phenolic parts you are probably using on your locomotives now.
- The excellent resilience of Nylatron nylon center plate liners enables them to withstand heavy shock loads without cracking.



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## NYLATRON® LOCOMOTIVE PARTS...



### Bolster Wear Plates

- Nylatron® nylon wear plates are made of the same self-lubricating and wear-resistant material as the Nylatron pedestal liners which outperform steel. They also incorporate a witness groove or wear line across the narrow ends  $\frac{1}{4}$ " from the face, which aids in the evaluation of wear.
  - Nylatron nylon bolster wear plates are approved by EMD.
  - Nylatron wear plates feature a unique proprietary insert which permits maximum bolting torque for installation, provides high resistance to pullout, and resists loosening of bolts under vibration. The wear plates are installed using the same procedures as for laminated phenolic wear plates.
  - Nylatron wear plates cost less than the laminated phenolic you probably now use on your locomotive.
  - Nylatron wear plates weigh less than bonded phenolic, which affords savings in shipping, handling and installation. The lighter weight of the Nylatron wear plate also makes it easier to handle and install.
- Join the others who have successfully replaced steel with Nylatron nylon pedestal liners, and ask your Polymer representative for information on our Nylatron center plate liners and bolster wear plates.



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A program was initiated to replace original design top-mounted fuel gauges with the improved design.

The accuracy and maintenance of fuel gauges needs thorough study to develop more reliability. A number of railroads are testing various prototype fuel-tank gauges at the present time, and test results or cost information are not yet available. Some railroads remove fuel gauges for rebuild or exchange on a scheduled basis. Railroads involved in run-through operation need a more accurate fuel gauge for fuel equalization or adjustment.

### 3. Fuel Saving Devices

The locomotive builders and railroads have been progressively developing modifications and improvements in their engines and related equipment to improve fuel consumption. A number of railroads have been conducting both standing and road tests to substantiate a number of the claims in fuel savings. Tables 1, 2 and 3 list various types of fuel saving equipment currently being applied to locomotives.

### 4. Purge Control

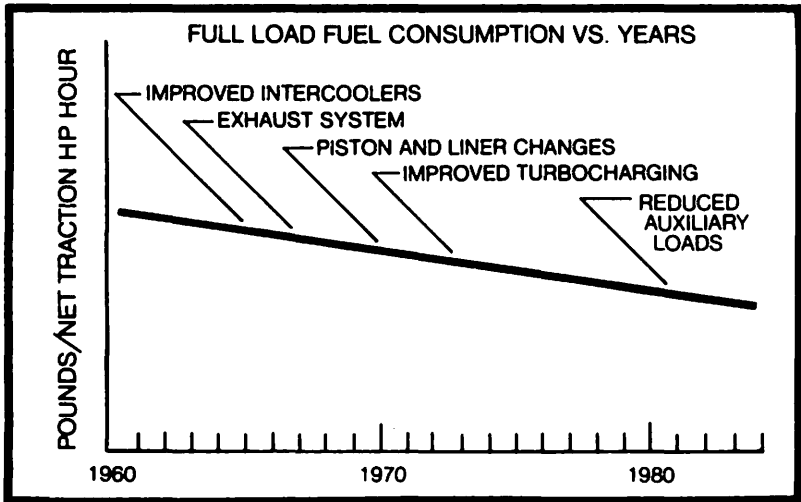
Most railroads include Purge Control on new EMD locomotives. This system can be retrofitted to existing locomotives. The purpose of this system is to prevent damage to the diesel engine in the event a hydraulic lock occurs when the engine is being cranked.

The starting procedure is simplified, as it does not require opening of the cylinder test valves. The Purge Control System limits the cranking speed of the diesel engine to the equivalent of 30 rpm for the first revolution of the cranking cycle. In the event a hydraulic lock occurs, this low rpm will result in the engine stalling without damage to the engine. It will also result in blowing the starting fuse. During the starting procedure, the cranking speed will be low for the first six seconds. The layshaft operating lever must not be moved during this time to insure that fuel is not injected into the cylinders during the purge control cycle. The layshaft lever may be moved as required after cranking speed increases to prime the engine.

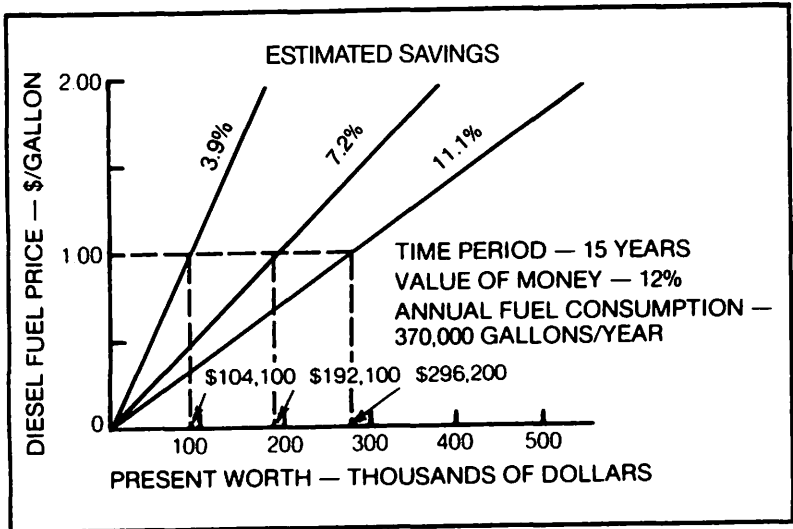
### 5. Blended Fuels

The railroads' Mechanical and Purchasing Departments and Locomotive Builders are constantly following the prices and supplies of alternate fuels. There is some blending of heavy fuels in the maritime industry. Even there, where the vessels are powered by engines similar to those used on the railroads, No. 2 diesel fuel is used. At the present time, No. 6 diesel fuel price is less than that of No. 2 diesel fuel. Increased use of No. 6 fuel will probably cause the price of this fuel to increase.

One railroad tested a blend of 90% No. 2 diesel fuel with 10% No. 6 diesel fuel during the static and over-the-road fuel tests conducted in early 1981. Problems



Graph I indicates improvements implemented by General Electric over the past several years and their relation to fuel consumption reductions.



Graph II correlates fuel saving percentages into actual dollars based on a 15-year period at 12% interest and consumption rate of 370,000 gallons annually.

TABLE 1 FUEL SAVING DEVICES

Locomotive Type	Apply To	Fuel Saving Equipment	Cost/Unit	Fuel Savings %	Savings/Unit/Year	REMARKS
EMD						Note: EMD fuel savings based on medium duty cycle fuel consumption at 400,000 Gal/Yr. Fuel cost - \$1.05/Gal. (UP)
	GP-9 GP38, GP38-2	Four-Stack Exhaust	\$ 5,500 (SP)	2.0 (Verified)	\$ 4,193	Farr indicates that their manifold can be applied to a unit with dynamic brake, but have yet to supply application drawings.
	GP40;SD40,45 GP40-2,SD40-2	Fuel Efficient 645 E3 Turbos	\$ 3,397	1.0 (Verified)	\$ 3,300	
	All SW,GP & SD with 645 567 D3A engines	Low idle 315 to 255 rpm	\$ 1,103 (CR)	15 in idle 0.7 (Advertised)	\$ 2,775	EMD confirms that low idle is possible on locomotives with 567 engine and 275 rpm idle. Reduced to 235 rpm with revised engine speeds.
	SD & GP40-2 SD45-2	Modify Dynamic Brake System (DR20 Module)	\$ 2,170	1.1 (Advertised)	\$ 3,629	Higher labor cost than EMM claims.
	All Turbo- charged engines	Farr Turbo Screen #64299	\$ 630	1.0 (Advertised)	\$ 3,039	Farr claims 447 Gal/Yr per 1" of pressure drop and claims 8-1/2" pressure drop reduction.

TABLE 2 FUEL SAVING DEVICES

Locomotive Type	Apply To	Fuel Saving Equipment	Cost/Unit	Fuel Savings %	Savings/Unit/Year	REMARKS
G.E.						Note: GE fuel savings based on medium duty cycle fuel consumption at 332,000 Gal/Yr, Fuel price - \$1.05/Gal.
	C-30-7	Fuel Economy Upgrade Package (Turbo-charger, Larger Radiators, New Cooling Fan, New Cool. Fan Gearing, Reduced H.P. Equipment Blower Low Idle)	\$50,500	3.75 (Advertised)	\$16,500	
	U23 B	Convert Engine Speed Schedule to Skip & Double 6 Engine Schedule	\$ 805	2 (Verified)	\$ 7,500	
	U30 & U33 B-30-7	Low Idle (450 to 385 RPM)	\$ 2,369 (CR)	0.6 (Advertised)	\$ 1,985	Higher cost for U30 and U33 account require Modulating Governor Kit at \$700 to \$2,000 per unit.
	U30 & U33	Upgrade Turbo	\$20,163	1.5 (Advertised)	\$ 5,500	Version - 1 is to trade-in a failed Elliot Turbo with major damaged for a new G.E. B-2 Turbo.
	B-30-7	Upgrade Turbo	--	1.0 (Advertised)	\$ 3,052	When G.E. B-1 turbo is unit exchanged with rotor damage, it is upgraded to B-2 turbo at no extra charge.

TABLE 2 FUEL SAVING DEVICES (Cont'd)

Locomotive Type	Apply To	Fuel Saving Equipment	Cost/ Unit	Fuel Savings %	Savings/ Unit/ Year	REMARKS
G.E.						
	U30 & U33	Modify Dynamic Brake Speed Schedule	\$ 2,100	1.2 (Advertised)	\$ 4,622	
	U30 & U33	Reduced H.P. Radiator Fan	\$ 6,260	2.1 (Advertised)	\$ 7,300	
	U30 & U33	Eddy Current Clutch	\$20,640	6.0 (Advertised)	\$20,900	A limited number has been on field test.

TABLE 3 FUEL SAVING DEVICES

Locomotive Type	Apply To	Fuel Saving Equipment	Cost/Unit	Fuel Savings %	Savings/Unit/Year	REMARKS
EMD or G.E.	Freight Units	Harmon Select-A-Power	\$ 1,300	4.0 (Advertised)	\$ 8,386	Must operate in sets of three or four unit consist to produce fuel savings. Each consist must have lead unit equipped with Event Recorder at cost of \$3,050 each. Device is controlled manually by the engineer.
	Freight Units	Coleman Sentry Power Dispatch	\$ 8,250	6.0 (Advertised)	\$18,610	Locomotive sets must operate in fuel saver mode. Microprocessor control allows ease in changing operating characteristics.
	Freight Units	Harmon Set-A-Speed	\$ 2,000	3.0 (Advertised)	\$ 9,310	See Remarks for Select-A-Power. Automatically controlled.
	Freight Units	Fuel Saver Switch	\$ 1,120	2.0 (Advertised)	\$ 4,000	Allows trailing locomotives in a consist to be limited to a maximum position of Run 1. Trailing locomotives can be controlled by the lead locomotives fuel saver switch, and fuel savings are developed by limiting the applied horsepower per ton.
	Freight Units	Magnet Valve for Deactivation of Water Cooler (Pneumatic)	\$ 226	0.2 (Verified)	\$ 414	

were encountered. Fuel filters began to collapse while the fuel measurement equipment was being calibrated, and the blended fuel test was abandoned.

Another railroad has two captive locomotives operating on a 80/20 blend of No. 2 and No. 6 diesel fuel. Several railroads in the early 1950's burned No. 6 fuel in dual fuel equipped locomotives with significantly increased maintenance costs.

Blended fuel will be covered in greater detail by the Fuel and Lubricants Committee.

## 6. Standby Heaters

Idling locomotives consume three to seven gallons of fuel per hour. Additional fuel is consumed by the Northern railroads during extreme ambient temperatures when units are required to be idled to maintain satisfactory engine coolant temperatures. The maximum fuel saving is attained when the diesel engines are shut down rather than left idling as fuel consumption is then reduced to a minimum.

During cold weather, shut down is only feasible when standby protection equipment is available. This equipment can be self contained on the locomotive or depend on an outside source of energy such as an electrical outlet: Locomotive standby protection equipment is used to sustain the locomotive coolant and lube oil temperatures during low ambient temperature engine shutdown.

Some units have been equipped with electrical immersion heaters that require connection to an out-

side power source. This arrangement requires the locomotive to be parked near the wayside electrical power source and someone to physically connect the cable to the external power source. Several manufacturers have designed self-contained, oil-fired and electric resistant-type engine heaters. A number of railroads have prototype models now under study or test.

Microphor — self-contained

Thermo Ignitor

Vapor — self-contained and  
wayside

Kim Hotstart

Webasto

The following is suggested specification for Auxiliary Heating Device (Standby Heater):

### Auxiliary Heating Devices:

1. Device must consume not more than one gallon (7.16 lbs.) of fuel per hour at any ambient temperature.
2. Device must generate sufficient BTU's to maintain engine coolant at a minimum of 100°F above ambient temperature. System would not be required to recover engine coolant temperature to the 100°F differential; however, sufficient capacity must be provided to maintain engine coolant above freezing if standby operation commenced with engine coolant below the 100°F level.
3. Sufficient circulation or auxiliary heaters must be provided to prevent freezing of all

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water piping external to the diesel engine.

4. Auxiliary heating must be provided to the air compressor crankcase/lube oil.
5. Auxiliary cab heating system must be provided, or electric or hot water must function, in engine shutdown mode to the extent the cab temperature can be maintained at a minimum of 50° F.
6. Adequate battery charging system must be provided to maintain locomotive batteries in a fully charged state.
7. Lube oil circulation must be maintained at a minimum of 2.5 gpm with oil spilling over engine heads or through oil coolers.
8. An automatic cooling water drain valve must be provided in order to protect the locomotive in the event of standby heater failure while unit is left unattended.
9. Device must be self-contained to the extent no external power or connections to the locomotive are required.

#### Temperature Controlled

##### Automatic Starting Device:

1. "Purge control" must be provided with systems that rotate and start the diesel engine.
2. System control must operate between freezing and 100° F.
3. Sufficient cycle/run time should be provided to insure batteries are maintained in a fully charged state.
4. Cab heaters must operate in in run cycle only.

## APPENDIX I DIESEL FUEL RECEIPT AND DISBURSEMENT

### 1. Purpose

This railroad has established interdepartmental responsibility by adopting a set of standard procedures to effectively control deliveries, inventory, and quality of diesel fuel.

### 2. Scope

The standard instructions apply to all departments on the railroad. The instructions function in conjunction with the fuel receipt and disbursement procedures currently in effect.

### 3. Precautions

An awareness program concerning the standard fuel control procedures was instituted at the local level by the Fuel Coordinator or his designees and all supervisory personnel. This awareness program is directed at all concerned to be made aware that any spill or leak is intolerable, and shall be done on a continuing basis so that the commitment to eliminate spillage is constantly reinforced in the work habits of each employee.

### 4. Responsibility

The Fuel Coordinator or his designee is responsible to make an adequate inspection of the diesel fuel facilities under his jurisdiction to prevent waste and to correct conditions which contribute to the waste of diesel fuel.

### 5. Quality Control

#### Inspection Instructions

The instructions govern the prac-

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tices of the Quality Control Department Inspectors only.

Specific Instructions:

1. Jointly with the Diesel Fuel Coordinator or his designee, arrange to observe delivery of diesel fuel. Also call on person responsible for wayside diesel fuel filtering system maintenance and arrange for filter inspection.

2. Observe all operations of diesel fuel delivery, noting any deficiency or problem to the local designated person.

3. Inspect wayside fueling facilities.

4. Arrange for sampling fuel from each storage tank.

Fill out all Quality Control inspection forms; any discrepancy found that could cause injury or loss of or damage to property must be called to the attention of local supervisor immediately.

#### 6. Storage Tank Diesel Fuel Inventory Instructions

A uniform procedure for an accurate accounting of diesel fuel inventory.

#### 7. Delivery and Receipt of Diesel Fuel

Prescribed practices that must be followed during delivery and receipt of diesel fuel at railroad diesel fuel dispersement facilities. Fuel Coordinator or his designee must maintain a file or log indicating time, date and nature of any diesel fuel spills, mechanical malfunction, water probe shutdown, etc., as well as when repairs or corrective actions were completed.

#### 8. Diesel Fuel Storage Tank

Practices that must be followed to prevent waste of diesel fuel from spills and leaks in immediate vicinity of a diesel fuel storage tank. The fuel Coordinator or designee must maintain log.

#### 9. Diesel Fuel Pump House

This section outlines practices followed to prevent waste of diesel fuel from spills and leaks in the pump house and immediate vicinity. Senior Mechanical Department officer at location of diesel fuel service facility or his designee must maintain a file or log indicating the time, date, and nature of any diesel fuel spills, mechanical malfunctions, etc., as well as when repairs and corrective actions were completed.

#### 10. Diesel Fuel Filters and Filter Housing

Standard practices to be followed to prevent waste of diesel fuel from spills and leaks around the filter housing and immediate vicinity. Senior Mechanical Officer at the location of the diesel fuel service facility or his designee must maintain a log.

#### 11. Locomotive Diesel Fuel Service Facility

Practices that must be followed to prevent waste of diesel fuel from spills and leaks around the locomotive service facility and immediate vicinity. Log must be maintained by Senior Mechanical Department Officer on all spills and corrective action taken.

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## 12. Locomotive Service Truck Diesel Fuel Dispersement Facility

Practices outlined to prevent waste of diesel fuel from spills and leaks around the locomotive Service Truck. Senior Mechanical Officer must maintain a log.

### DIESEL FUEL RECEIPT AND DISBURSEMENT

#### I. Purpose

Establish interdepartmental responsibilities and procedures.

#### II. Scope

Purchasing and Materials Department standard applies to all departments of the railroad.

#### III. Definitions

#### IV. Responsibilities

1. Responsibility / Procedure for Diesel Fuel Receipt (Tank Truck).
2. Responsibility / Procedure for Bulk Diesel Fuel Receipting (Pipe Line, Barge, or Tank Car).
3. Responsibility / Procedure for Fuel Dispersement.
4. Spill Prevention Control and Countermeasure Plan.  
Fuel Receipt Coordinators and Fuel Disbursement Coordinators general guidelines.
5. Review of Locations to be Closed. Quarterly review of locations receiving 5,000 gallons or less fuel per month to determine if any of these locations may be closed.
6. Calibration of Meters.  
All input meters calibrated for after installation and twice annually.

### III

#### TURBOCHARGERS

The number of turbocharged diesel engines used today in the railroad industry in the United States and Canada totals approximately 18,120: 11,420 EMD, 4000 GE, 150 Alco. In Canada, 1200 EMD and 1350 Bombardier. This is a discussion of turbocharger service life, failure modes, rebuild costs and potential savings offered by in-house repairs.

With a large share of unit exchange dollars absorbed in turbocharger repair, railroads recognize the need to reduce those costs by improved turbocharger performance. That can be achieved by means of improved diesel engine and air filtration maintenance and in-house turbo repair.

For many years the potential savings of in-house repair were out of reach. Today, the picture has changed. Far-sighted people have made repair material available to railroads who were interested in turbocharger rebuild and reducing rising repair charges.

Material to repair or completely rebuild any type of turbocharger is available from EMD, GE, Arrow-smith, Hunt-Spiller and Elliott. Along with material availability these manufacturers of turbochargers and component parts will provide necessary assistance to set up your own repair facility, type of fixtures, tooling and instructions.

EMD turbochargers covered by MI-275, Rev. B.

GE turbochargers covered by GEK-61381A, or MI-94313

for 16-cylinder, GEK-61249A for 8 and 16-cylinder.

Elliott turbochargers covered TC-70-A.

Bombardier and Alco turbochargers covered by MI-11209A.

The extent of in-house repairs will influence each railroad's set-up cost for necessary tooling, jigs and fixtures, inventory, training and, in some cases, the testing.

In reviewing turbocharger failure modes and overhaul costs, the policy of several railroads is to repair the lightly damaged turbo where realignment or redoweling is not necessary.

The type of repairs that would fall in this repairable category are:

- High mileage running turbo
- Clutch failure
- Exhaust leak
- Excessive carbon deposits
- Oil leak at cradle gasket
- Internal oil leaks
- Light foreign material damage to turbine or impeller

Turbochargers falling in these categories, depending on the railroad, could run between 35% and 55% of the turbochargers now being unit exchanged.

Due to the complex design of the EMD turbocharger using the drive gear train and the over-running clutch, many railroads implement in-house repairs on the free wheeling-type turbo used on GE, Alco and Bombardier engines for two reasons:

- 1) Less complexity and lower set-up costs.

- 2) Availability of rebuild material.

Railroads that establish a policy of removing running turbochargers on a time or mileage increment will have a significant unit cost reduction over a railroad that elects to remove a turbo for failure only. When turbo maintenance is performed on time or mileage increments and repair is made on turbos with light damage as outlined above, the average unit exchange costs for railroads doing this selective repair could increase significantly, raising the national average repair cost. This will also have some influence on national average failure modes.

EMD furnishes to all railroads the national average primary failure modes and to each railroad their own failure mode percentages. This information should be used to identify problem areas, improvements or need for improvements to enable each railroad to evaluate its performance and costs.

If your railroad does not receive this information on a regular basis, it is available on request.

Information concerning each railroad's turbocharger failures is furnished by General Electric and Arrowsmith but does not show national averages.

A significant increase in clutch failures has been noted in the past few years. In 1979 the national average for clutch failures was 5.20%; in 1980 it was 8.95%, and in 1981 it rose to 17.7%, with several railroads experiencing a slight increase over the national average.

This committee believes that increased clutch problems are a result of changed operational modes, such as the number of engine startups, low idle, two-speed dynamic braking and fuel savers, which cause increased clutch loading.

Clutch failure provides an excellent opportunity for in-house repair to produce significant cost savings, as this usually requires rebuilding the clutch or unit exchange.

Another area where in-house repairs has attractive cost savings is within the running turbocharger category. Considerable savings are available through repair or replacement of oil seals, exhaust leaks, gear trains, cradle gasket oil leaks, carbon deposit buildups or high mileage.

Each railroad involved in in-house repair or contemplating it should carefully monitor turbocharger performance. If performance, reliability and service life decrease as a result of an in-house repair program, it will be necessary to evaluate procedures, tolerances, and material used that could be associated with the decline and related negative cost picture.

At this time, several railroads known to this committee are involved in repairing turbochargers used on EMD, GE, Alco and Bombardier engines. Recently the CN, N&W and UP started repairing the EMD turbocharger on a limited basis. BN, Family Lines, UP, CP, CN and Bombardier are repairing the turbocharger used on GE, Alco and Bombardier engines.

Service life on turbochargers is

also difficult to identify from the manufacturers' view due to the variables and with customers involved with in-house repair. EMD studies show 52 months' average service life, and General Electric studies indicate primary turbo failures are running 12% at 375,000 miles or about four years to normal top deck overhaul.

Due to the various methods used in cost structuring, this committee was unable to develop a clear picture of the basic overhaul costs for a running turbocharger when rebuilt in kind.

At this writing, the average costs to rebuild a failed turbocharger were given by EMD at \$13,995 for the E3 and \$14,380 for the D type; Arrowsmith for all types, \$11,439.

Due to the increased cost in fuel and the need for improved fuel-efficient diesel engines, the locomotive manufacturers, as well as the turbocharger rebuilders and replacement parts manufacturers, have redesigned various parts in the turbocharger to furnish the best known efficiency combinations for optimum fuel conservation. EMD and GE now offer to railroads a complete upgrade program that includes the fuel efficient turbocharger, fuel injection material and lower-horsepower drives and fans.

With the options available toward increased locomotive fuel efficiency and cost saving advantages by performing in-house turbocharger repair using the latest design changes, it can help Mechanical Departments operate more efficiently.

**DIESEL MECHANICAL  
MAINTENANCE**

**Six-Year Index**

1981

**Increased Service Life  
Through Improved Technology**

1. Running Gear
2. Filtration
3. FRA Rules
4. Follow-up on Previous Topics

1980

**Fuel Economy through  
Improved Maintenance in the  
Coming Decade**

1. Fuel conservation
2. Winterization
3. Utilization of on-board load test
4. New FRA Rules
5. Welded crankshafts

1979

**Maintenance for High Reliability**

1. Welded crankshafts
2. G. E. power assemblies
3. Assigned maintenance terminals
4. Radiators
5. Dye and cooling system
6. Air compressors
7. Viscous and gear dampers
8. Hard bore liners
9. Progress toward elimination of oil leaks.

1978

**Problems, Causes, Prevention  
and Repairs**

1. Power assembly water leaks — E. M. D.
2. Turbos—Diagnosis of failures to replacement
3. Winterization
4. Update
  - a. Viscous dampers
  - b. Grooveless connecting rod and main bearings — G. E.
  - c. Solid low pressure fuel lines — G. E.
  - d. Air compressor

1977

**Better Management of  
Mechanical Maintenance**

1. Air compressor
2. Crankshaft failures
3. Vibration dampers
4. Fires — mechanical
5. Road failures

1976

**Improved Locomotive Availability  
by Judicious Maintenance**

1. Recommended maintenance schedule
2. Definition of availability
3. Quality control
4. Update on truck maintenance
5. Progress report
  - a. Piston reclamation — G. E.
  - b. Exhaust silencers
  - c. Scored liners — G. E.
  - d. Scored liners — E. M. D.
  - e. Engine air filters
  - f. Engine fluid temperatures
6. Storage of Diesel Engines — short term



**J. F. McDONOUGH**  
Chief Mechanical Officer  
Union Pacific Railroad Co.  
Omaha, Nebraska



**R. P. NEELEY**  
General Mech. Supt.-Locomotive  
Union Pacific Railroad Co.  
Omaha, Nebraska

LMOA wishes to express its thanks to Union Pacific Railroad for again hosting Pre-convention Presentation in Omaha.

Our New Developments Committee's presentation was well received in what we trust was a mutually beneficial experience.

Our thanks again to Messrs. J. F. McDonough and R. P. Neeley and others responsible for and participating in this activity.

# Monday, September 20, 1982

2:15 P. M.

## REPORT OF THE COMMITTEE ON NEW DEVELOPMENTS

Pre-Convention  
Presentation  
Union Pacific  
Railroad



April 6, 1982  
Red Lion Hotel  
Omaha, NE

**D. G. GOEHRING, Chairman**  
Manager, Maintenance Planning  
National Railroad Passenger Corp.  
Washington, D. C.

### VICE CHAIRMAN

A. A. Chacon, Asst. General Mechanical Engineer-Loco., Union Pacific Railroad  
Omaha, NE

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### 1982 TOPIC:

**"QUALITY MAINTENANCE — IMPROVEMENT THROUGH  
NEW DEVELOPMENTS"**

**PERSONAL HISTORY****DAVID G. GOEHRING**

Born Pittsburgh, Pennsylvania, September 28, 1930. Lived in a rural area until he entered college in 1949. Received a Bachelor of Science degree in Mechanical Engineering from Lafayette College, Easton, Pennsylvania, in 1953, and was accepted into the Pennsylvania Railroad Mechanical Department's Junior Engineering Program. In late 1953, his railroad career was interrupted in order that he could spend two years with the Army.

His training program was completed in 1958, and his first assignment was Relief Assistant Foreman in the car shop, Pitcairn, PA. This was followed by assignments in Harrisburg, Philadelphia, Lewistown, and Renovo in Pennsylvania, and as Master Mechanic in Chicago, Illinois.

In 1968, he accepted the position of Chief Mechanical Officer, Lehigh Valley Railroad, a position he held for three years when Amtrak asked him to head their locomotive department in December, 1971.

While at Amtrak, he has held various positions in the Mechanical Department and is currently working with the maintenance planning of car and locomotive equipment and associated budgets.

He and his wife, Anne, have four children. They live in Gaithersburg, Maryland, where a modest garden and yard keep him occupied in his spare time. On weekends and vacations, they can often be found in their cabin along a cool stream in

the mountains of central Pennsylvania.

He serves on the Board of Trustees of Robert Packer Hospital, Sayre, Pennsylvania, and is active in the Boy Scouts of America.

**COLD WEATHER  
ENGINE SHUTDOWN  
PROTECTION**

The problem of protecting locomotives that must layover without benefit of a heated enginehouse has existed for several decades. It is a subject that has blown hot and cold over the years and now is red hot as a result of increased fuel costs, depressed railroad earnings, and the most severe winter in years.

An ideal solution to the problem of protecting layover units would be an inexpensive ultra-reliable device that would allow the locomotive to be shut down in any weather at any location and, without external electrical power, would automatically maintain the cab equipment, the cooling water, the lubricating oil and the cranking battery in a state that would permit the locomotive to return to service on demand. Regardless of reliability, every layover system should include an automatic cooling system dump valve to insure against freeze damage from system failure.

Past systems addressing the layover problem have been of two general types. The first type relied on some means of causing the engine to start and run on temperature demand, either by manual remote control or automatically.

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AMER-kleen nonflammable filters are ideal for engine intakes. They cost less to use and throw away than washing and reoiling metal filters. With AMER-kleen filters, you don't need filter cleaning equipment at all.

Air cleaning efficiency is greater than that delivered by any panel-type filters available for locomotive service. AMER-kleen filters are progressively packed for greater dust-holding capacity.

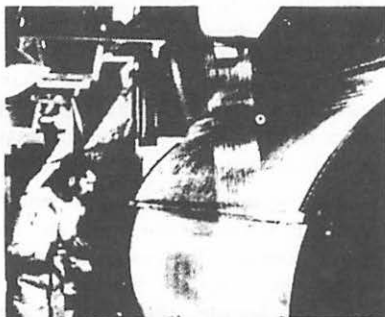
And because AAF glass-fiber filaments are spun continuously, and bonded with a heavy-duty adhesive, fiber particles cannot be dislodged despite air volume and dirt buildup. For additional information on the most practical filter for engine intakes, write Manager, Railroad Products, American Air Filter Company, Inc., P. O. Box 1100, Louisville, Kentucky 40201.



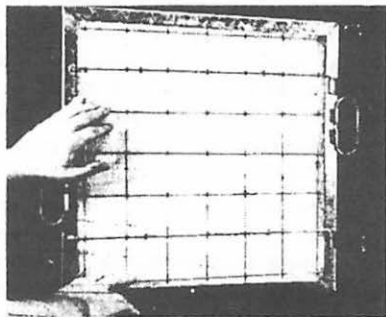
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Designed specifically for locomotive service.



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The second type relied on an oil-fired, gas-fired, or electric water heater along with pumps to maintain temperatures. Each type has advantages and disadvantages, but two important disadvantages have been the need to plug into wayside power and the risk of engine damage from cylinder hydraulic lock.

At this time there are two innovative systems in the development stage. One is manufactured by Microphor, Inc., P. O. Box 490, Willits, CA 95490. It is intended to maintain a locomotive in startable condition to -20 degrees F. It utilizes a small liquid-cooled diesel engine of under 20 horsepower driving a 10 kilowatt A. C. generator. It is rated at 100,000 BTU per hour and is designed to use less than one gallon of locomotive diesel fuel per hour. The generator provides a relatively constant engine load and its output furnishes power to operate the electric circulating pumps for water and fuel, to charge the locomotive battery at 10 amps., and to power electric immersion heater elements in the cooling system expansion tank. The small diesel engine furnishes additional heat from its own cooling system and exhaust system by means of heat exchangers. The overall space required is approximately 24" x 40" x 36" high.

There are several options to be offered, including such things as circulating systems for lube oil, an automatic start-stop feature for additional fuel savings in mild weather, a failure mode indicator panel, a remotely mounted electri-

cal control panel and remote temperature sensing of up to 10 locations. Two prototypes are on field test, one on a western road since January, 1982, and one in the north central area since February, 1982.

That system is expected to be in production later in 1982 at about \$8,500 per kit plus the cost of options. The locomotive installation is presently estimated at requiring between 75 and 100 manhours but plans to modularize the production models is expected to simplify installation considerably

The second system is of the automatic engine start type. Named "Thermal Igniter," when fully developed and tested later in 1982 it will be available through Maxson Corporation, 500 Como Avenue, St. Paul, Minnesota 55103.

This system will protect against hydraulic lock by electro-mechanically actuating the cylinder test valves at the beginning of each cranking cycle as well as by providing slow turnover for the first engine revolution also known as "creepy-crank." Additional features include a monitor to afford protection in case of any condition that would result in excessive cranking current and an enunciator panel to permit quick trouble shooting after a malfunction.

This system responds to engine coolant temperature and an ambient sensor for evaluating the wind chill factor. Based on this ambient sensor, the system logic determines the need to increase engine speed above idle in severe

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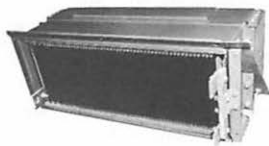
## FOR DEPENDABLE 3-WAY SERVICE

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cold and actuates the necessary throttle circuits. When ambient temperatures are high and layovers are extended, the device can revert to a time-based start cycle instead of a temperature-based cycle to maintain lubrication films and battery condition.

It is planned to have a prototype on test by sometime in June, 1982. No estimate of price is available at this time.

The committee is aware of other interesting concepts but knows of no other prototypes being constructed.

#### **Farr Four Stack Exhaust Manifold**

Installation of the Farr four stack connected exhaust manifold arrangement on 16-cylinder locomotives can reduce exhaust back pressure and improve engine fuel efficiency, especially in the higher throttle positions. Savings accrue from a combination of better scavenger air supply and from reduction in horsepower requirements of the Roots blower. Additionally, exhaust temperatures, measured at the leg of the manifold, will be reduced in the neighborhood of 60° Fahrenheit, which should materially benefit valve performance and life expectancy. With a cooler running engine, less horsepower will be required to operate the cooling fans.

One test application on a Western railroad was made with a GP-9 locomotive with a properly tuned two stack exhaust engine. The same locomotive was then modified

to accept the four stack connected manifold. No other changes were made to the locomotive between tests. In the eighth throttle notch on the load box, the engine, prior to being modified, used 98.5 gals. per hour of fuel, and developed 1882 gross horsepower. After being modified, it used 98.2 gals per hour, but with the horsepower increased to 1909 gross horsepower. There was proportionate reduction in the fuel rate and increase in horsepower through throttle notches 8 through 5.

When all projected simulated duty cycles are considered, including idle time, dynamic brake time if applicable, and considering that this type of unit will be in light or medium duty most of the time, the test concluded that there will be approximately 2% fuel savings by converting GP-9 locomotives to a four stack arrangement. Sound level readings taken 100 feet from the center of the locomotive and using the weighted DB-A level increased from 87 to 88 after application of the four stack modification. These levels fall well below the allowable noise level as prescribed by the FRA.

Two other tests were run by another railroad, during which units equipped with the Farr four stack four manifold connected exhaust configuration were compared to the conventional EMD two stack two manifold not connected and to a Farr four stack four manifold not connected type. In all cases, locomotives had been outshopped for program work immediately pre-

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ceding these tests, and all had been load tested for proper operation and horsepower. Tests were run in January and July. Following is a summary of those tests; all results were in eighth notch throttle operation on a load box.

1. A fuel savings of 2.3% was realized when comparing fuel consumption (gallons per horsepower-hour) of a Farr four stack, four manifold, connected exhaust configuration to a conventional EMD two stack, two manifold, not connected exhaust configuration. A 48.6% reduction in exhaust manifold pressure was observed.
2. A Farr four stack connected manifold showed a 1.4% fuel savings when compared to a Farr four stack non-connected type. A 19.1% reduction in exhaust pressure was observed.
3. All fuel consumption calculations were computed on a gallons per horsepower-hour basis, to assure uniformity in expressing results. In each test, it was observed that the locomotive which produced less horsepower than its competitor also was less efficient, consuming more fuel per horsepower output.
4. Sound pressure readings, measured 100 feet forward of the locomotive while running in eighth notch, also showed a slight increase in noise levels, but were within acceptable levels.

Preliminary tests run on a GP-38 locomotive with the Farr four stack connected manifold are showing fuel savings of 2.98% as an average through all throttle positions. The exhaust manifold pressure was reduced an average of 33.8% through all throttle positions.

Cost of the conversion kit, including the joint assemblies and gaskets, is presently about \$3000. It will take about 35 hours to convert the stack on an individual basis, with 25 to 30 hours a possibility if assembly line procedures can be utilized. There will be a labor cost of approximately 8 hours to change the stacks, with total labor charges of 33 to 43 hours. If fuel costs are estimated to be \$1.00 per gallon, and presuming a locomotive is in medium duty service using 200,000 gallons of fuel per year, a fuel savings of 2% would net \$4000, or 100% of conversion cost in a one year period. This may vary considerably, as fuel costs fluctuate, and service requirements differ.

#### New Fuel System For General Electric Locomotives

The Pre 1982 GE Fuel System has many items that are prone to failure. These failures cause locomotive malfunctions that range from light loading due to low fuel pressure, to locomotive engine fires caused by a broken fuel line.

The maintenance forces' major complaint about the fuel system is its marginal design. When everything is perfect, the system works



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well, but a variation in any of several components can cause a system malfunction, and finding the cause of the problem is often difficult. Many fuel filters have been replaced when the real problem was a defective relief valve.

To improve this situation, General Electric has redesigned the locomotive fuel system. Specific goals of the redesigned fuel system were to improve fuel filtration, increase filter life, reduce troubleshooting problems, improve reliability, increase fuel heating in the tank and reduce fuel consumption.

The new design consists of the following:

#### **Fuel Strainer Eliminated**

The fuel strainer was originally designed to protect the fuel pump from large dirt particles. But higher cloud points in today's fuel will wax the strainer element in cold weather and shutdown the engine due to fuel starvation.

In recent years, several railroads have eliminated the strainer element. Subsequently, GE laboratory tests indicated that the pump could ingest surprisingly large dirt particles without harm and General Electric has decided to eliminate the strainer.

#### **Larger Fuel Transfer Pump**

Fuel pump capacity has been increased from 3½ gpm to 7 gpm. The larger capacity makes the system less susceptible to failure from minor problems like a leaking pressure relief valve. The higher capa-

city pump circulates more heated fuel to the fuel tank, an advantage during severe winter conditions. The excess warm fuel returns to the tank near the suction intake line where it is drawn in and reduces wax accumulation.

#### **Fuel Pre Heater**

GE offers the option of a fuel heat exchanger installed in the suction line ahead of the fuel pump. The capacity of the heat exchanger has been doubled to 60,000 btu/hr. GE recommends this application include a thermostatic valve to automatically cut off heat in warm weather.

#### **Primary Filter**

The primary filter size has been substantially increased to provide a minimum of 90-day fuel filter life. The new filter contains four times the filter paper area as the previous standard filter, has a two-stage construction and a 13 to 15 micron rating.

The new filter requires a larger filter housing. The new housing is designed to also accept the older filter element in case the railroad decides that it does not need the larger filter. The new housing incorporates a vent valve which permits rapid draining of the housing when the filter has to be changed.

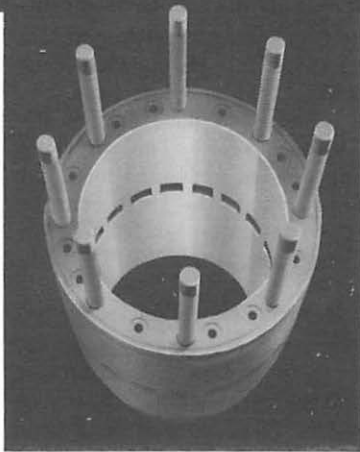
#### **Secondary Filters**

General Electric is working on adding a pair of spin-on secondary filters following the primary filter. These elements will have a 20 micron rating and serve as a back-up to the primary filter. With the



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addition of the secondary filters, the injection equipment will remain protected if the locomotive is operated without a primary filter, an undesirable but expedient past practice.

### Fuel Hose and Piping

A major problem with the previous design has been engine fires caused by fuel squirting onto the hot exhaust manifold when a hose, "gooseneck" fitting or pipe breaks. To correct this, the jumper hose has been changed by utilizing a high-temperature material and increasing the hose diameter from 1/2" to 5/8". Both changes are designed to eliminate hose failure caused by vibration and pressure pulsations in the hot environment.

The fuel piping crossover at the free end of the engine that connects the right and left bank has been rerouted to pass underneath the turbocharger. The previous routing crossed under the manifold section behind the turbocharger and fires would be ignited when a fuel line broke.

### New Header Connection

Many fires, reported by one railroad, were caused by a broken "gooseneck" connection. Extensive testing by GE found that the gooseneck connection would fail after only a few hours of vibration at the right frequency. Also many goosenecks were over-stressed when hoses were applied by using a single wrench instead of using the two wrench method recommended by GE.

The new fitting has been test vibrated in the laboratory for several thousand hours without failure. It is a 3-piece construction consisting of: a tee fitting, a main housing and a hollow bolt with two o-rings. The main body housing is designed to withstand the stress that causes the goosenecks to fail.

### Fuel Return Sight Glass

The previous design used a fuel pressure gauge as a means of indicating when sufficient fuel was available in the system to start the engine. The fuel gauge had a high failure rate because of high-pressure pulsation. The new system replaces the fuel pressure gauge with an in-line sight glass, located in the fuel piping immediately after the regulation valve. The sight glass also indicates when the system has a suction leak. This feature, not previously available, eliminates a constant troubleshooting problem.

### Parallel Fuel Headers

In addition to increasing the size of the fuel header piping, the two headers are now connected in parallel instead of the former series connection. The new design provides more fuel to the high-pressure pumps with less pressure drop. Maintaining a higher, constant fuel pressure to all cylinders eliminates variation in fuel pump timing between the first and last cylinder, resulting in improved engine efficiency.

### Test Points

Three test points, which can be fitted with quick disconnect fit-

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tings, have been incorporated into the fuel system to measure header pressure at the fuel pump discharge, at the spin-on secondary filter inlet and at the regulating valve. An estimate of filter cleanliness can be made by measuring pressures at these test points, then calculating the difference.

In summary, the new system is designed to eliminate all known weaknesses of the previous system. Items prone to failure, such as the jumper hoses and the goosenecks, were redesigned and made stronger; fuel filter life was lengthened; the strainer was eliminated and the fuel pressure gauge replaced with a sight glass. At the same time, a slight improvement in fuel efficiency was achieved.

The committee has reviewed the new design and agrees that the new system will be a big improvement over the present design.<sup>(1)</sup> The committee also recommends that General Electric develop an easy method to determine when the spin-on filters are plugged. EMD does this with the bypass sight glass.

### Work and Power Meter

For many years, railroads have established major engine overhaul policies on either a time or mileage basis. An argument exists among railroads as to which is the best method.

The argument against using mileage as the criteria for over-

haul is that different types of service require different amounts of work. For example, a locomotive on an expedited train with three horsepower per trailing ton will do less work/mile than a locomotive hauling a coal train at one horsepower per trailing ton.

The advent of fuel saver devices that place trailing locomotives in Throttle One while other locomotives remain in higher throttle positions further increases the variations in workload that locomotives perform when operating the same mileage.

The argument against using time as the criteria for engine overhaul does not consider the varying amount of time that individual locomotives spend out of service, and like "mileage criteria" for overhauls, does not consider the work differential during operation. A locomotive that has an average availability of 75% is assumed to do less work in a given period of time than a locomotive that is available 90% of the time. But, will it?

One solution to knowing how much work a locomotive performs is to measure and accumulate the work done by the locomotive. The Farr Company has developed a meter that will measure and accumulate kilowatts. The meter is a solid state analog to digital electronic device that displays continuously both kilowatts and kilowatt-hours and is permanently mounted in the locomotive.

The meter multiplies main generator output voltage times main

<sup>(1)</sup> For more information, refer to General Electric Gems, Volume VIII, Issue 2, April 23, 1982.

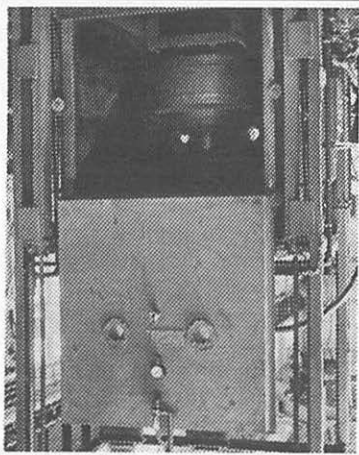
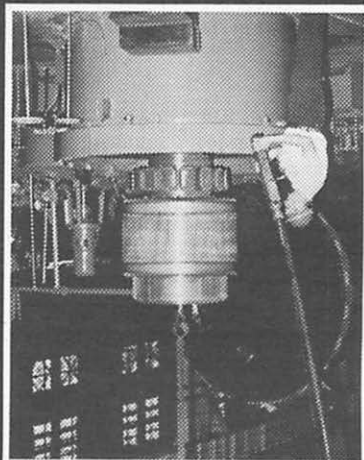
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generator current, measured by a shunt, and converts the product to a digital signal. Each pulse in the signal represents  $1/12,000$  of a kilowatt hour and the frequency of the signal at one kilowatt is 3.33 Hertz. To display kilowatts, the number of pulses is divided by 5 and counted for 1.5 seconds. To display kilowatt hours, the number of pulses is divided by 12,000 and accumulated in a separate counter. The kilowatt display is four digits, and the kilowatt hour display is eight digits.

To connect the device to a locomotive requires six connections: two for main generator voltage, two for main generator current and two for 74 volt power supply. The main generator current signal is connected to the current shunt, which is applied to most newer locomotives. The meter has an internal switch so that it can be used with either a 2,000 amp-50 millivolt or 4,000 amp-50 millivolt shunt.

An internal battery is used to provide power to preserve the contents of the kilowatt-hour counter when a loss of 74 volt power occurs. To extend the life of the battery, power is provided only for the memory, the display is inoperative. It is estimated that the battery will have a life of five years.

One railroad that has tested the meter reports some initial failures. But after circuit modification, the meters operated more than three months without failure. That railroad reports that the meter accuracy is within 1% until main generator current or main generator

voltage drop to low values. Voltages less than 100 volts or current less than 400 amps causes accuracy to drop to 12%. It is also reported that the meter will read 140 KW with 1,000 volts and no current instead of zero kilowatt. This condition would not occur under normal conditions.

The committee sees the kilowatt-hour meter not only as a means of establishing maintenance policy, but also for measuring compensation for locomotives used in run thru service. The meter could provide for off line payment based on actual work performed rather than on how long the locomotive is off the property.

Cost of the meter is approximately \$1,500, and installation can be completed in a few hours.

The committee recommends to the manufacturer that a low-horsepower feature be added to illuminate an annunciator light when the locomotive has operated for more than 15 minutes in 8th throttle position at less than 85% rated power. This feature would alert the maintenance force when trailing locomotives are not loading properly.

#### **Application of Cartridge-Type Journal Bearings to EMD Road Locomotive Trucks**

Although the use of cartridge-type journal bearings in EMD trucks is not a new development—This has been done on switcher locomotives for years—The use of these journal bearings in EMD



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road locomotives does represent a fairly new application. At least two railroads are using cartridge bearings in both four-axle and six-axle EMD truck applications.

These bearings are self-contained, preassembled, preadjusted, prelubricated, completely sealed units, they can be applied to and removed from the axle without exposing the bearing elements, seals, or lubricants to contamination or damage.

The preassembled bearing reduces the number of separate parts to be applied to the axle to a minimum. The bearing is pressed on the axle as a completely sealed unit and is retained on the axle by an end cap secured by three cap screws and a locking plate.

An adapter is used to fit the bearing assembly between the pedestal jaws of the truck frame. These are available from EMD, or cylindrical bearing boxes can be converted for use with cartridge bearings. At least one railroad has started a program of retrofitting units originally equipped with cylindrical-type bearings to cartridge bearings using these remanufactured boxes.

Cartridge bearings offer maintenance savings in several areas. Probably the most important is the NFL (no field lubrication) concept, which provides a bearing that does not require lubrication or periodic checks between wheel renewal periods of up to 250,000 miles. This offers obvious savings over cylindrical bearing journal boxes that require regular checks of oil level,

draining of accumulated water, and checking and adjustment of lateral.

Savings may also be realized at initial installation. Since the bearing is factory assembled and lubricated, application to the axle is relatively simple. It is only necessary to press the bearing on the axle, apply the end cap, torque cap screws to secure the cap and bend the locking plate into position to retain the cap screws.

This compares favorably with cylindrical roller bearings that require application of an inner race to the axle and assembly of the rollers within the journal box.

Cartridge journal bearings are performing well under EMD road locomotives and have experienced only a few minor problems. One of these is leakage of a small amount of grease around seals but this has not been detrimental to the performance of the bearing. The cartridge roller bearing can be applied to EMD road freight locomotives and may be considered as an alternative to the cylindrical roller bearing.

#### GE B30-7A

In July 1980, the Missouri Pacific placed in service three B23-7 locomotives with experimental 3000-horsepower, 12-cylinder engines. As of December 1981, the three test locomotives had accumulated over 400,000 miles in both local and through freight-operation. The performance of the engines proved that the 3000-horsepower, 12-cylinder 7 FDL engine is a reliable and

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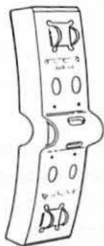
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durable powerplant. As a result of the field test, General Electric released the production B30-7A locomotive.

The 12-cylinder 7 FDL engine incorporates the latest of General Electric's engine technology. The engine features:

1. Grooveless connecting rod bearings and main bearings that are expected to yield service life increases of 50 to 100 percent over grooved bearings.
2. Hardened cylinder liners provided by a patented Melonided Process.
3. New intake and exhaust valves designed for extended service life.
4. An improved steel crown piston.
5. General Electric's Model 1612 turbocharger designed for the 12-7FDL engine.
6. A new low-pressure parallel fuel system consisting of larger jumper hoses constructed of high-temperature material coupled with larger diameter headers that resist vibrations and leaks. (See New Fuel System for General Electric Locomotives.)
7. Larger 18 millimeter double helix pumps that inject fuel within a shorter period of time with the injector timing varied for different throttle positions. This permits closer matching of injector timing to horsepower requirements. Previous single helix pump designs did

not provide this capability and injector timing was a compromise setting for the full horsepower range.

8. Improved service life fuel injection tips produced by using electrostatic discharge machining.

Electrically the B30-7A incorporates the new General Electric technology that includes:

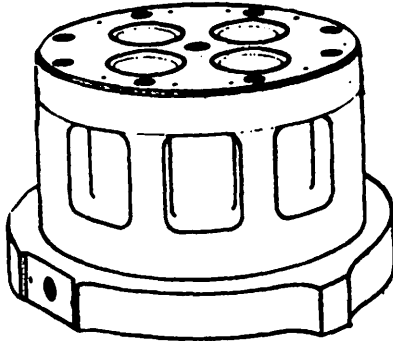
1. The 752 AF traction motors, when combined with a fine pitch 83/20 gearing, provides a continuous tractive effort rating of 64,000 pounds.
2. The Sentry Adhesion Control System. This system is more sensitive than previous systems in detecting a wheel slip. Three successive stages of wheel slip correction are selectively applied depending on the severity of slip. The system recalibrates itself when the locomotive is in the coasting mode to compensate for wheel diameter differences due to wear. The Sentry System provides up to 30% more average adhesion over earlier locomotives.
3. Elimination of traction motor transition in favor of generator transition. The four 752 AF motors are permanently connected in parallel to compliment the Sentry System. In order to provide the increased current demands required, General Electric developed the GTA 24 traction alternator and rectifier. The GTA 24 is designed with two windings.

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Under starting or low-speed high-current operation, the windings are connected in parallel, providing twice the current available from a single winding. For operation at high speed, the windings are connected in series, providing the higher voltage required for full horsepower utilization. Connection change is automatic.

The B30-7A also incorporates several improvements in mechanical systems:

1. A new gearcase was developed for use with the 752 AF traction motor. It is designed with machined and gasketed joints between halves, eliminating the need for matched sets. Also, more efficient seals are used in the bore area to reduce lubricant leakage. A new mounting arrangement eliminates the need for special fasteners required on previous GE designs.
2. A non-lube dynaflex coupling is used for the air compressor and cooling fan drives.
3. A hub mounted eddy current radiator fan clutch provides for three fan speeds: off, low, and full. This reduces the average auxiliary on the engine when maximum cooling is not required, which results in fuel savings.

The upper electric control compartment has been redesigned for improved accessibility and maintenance. By relocating heat generating components, cooling air in the

cabinet is not required, and the associated air filter has been eliminated.

In addition to fuel efficiency gains described above, several other systems are provided or are available.

1. A full time engine low idle. If, however, engine coolant temperature drops below a specified level, a temperature switch is used to raise the idle speed until the proper coolant temperature is obtained.
2. A dynamic braking system, when so equipped, that automatically matches the engine speed to the cooling requirements of the braking grids, which results in a reduction in the average dynamic braking fuel rate.

The B30-7A locomotive incorporating the latest technology in engine design, electrical system design and mechanical systems is General Electric's latest entry in the field of efficient locomotives of the 80's.

#### EMD GP 49

EMD's 50 series locomotives evolved from the 40-2 Series, and similarly, EMD's latest offering, the GP 49 locomotive evolves from the 39-2 Series and GP 39X test locomotives.

The GP 49, as presently offered, is a 2800 tractive horsepower locomotive incorporating the Super Series Wheel Slip Control System and many other features introduced

in the 50 Series locomotives. These were discussed in the 1981 New Developments Committee Paper about EMD's GP 50 and SD 50 locomotives.

The diesel engine used in the GP 49 is the 12-645F3B. It is a 12-cylinder, 2-stroke cycle diesel that produces 3000 brake horsepower at 950 rpm, with 2800 available traction horsepower. The 12-645F3B engine incorporates many of the improvements applied to the 16-645F3B engine used in the 50 Series, such as the rocking piston pin, crowned rocker arm rollers, increased hardness camshafts, a one piece crab plate combined with new design crab bolts, laser-hardened cylinder liners, strengthened exhaust valves, strengthened crankcase, and a gear-type vibration damper.

The 12-645F3B engine also incorporates a fire ring piston with stainless steel rings to provide the engine with a compression ratio of 16 to 1, versus the 14.5 to 1 ratio used in the 16-645F3 engine. The higher compression ratio coupled with the 0.5 inch plunger injector, a new turbocharger, and 950 rpm engine speed, provides a 3000 brake horsepower rating.

The 12-645F3B engine drives an AR15 traction alternator which feeds power to parallel-connected D87 traction motors.

As stated previously, the GP 49 incorporates the Super Series Wheel Slip Control System that is designed to allow up to 5% wheel creep. It provides an average usable adhesion of up to 24%, a 33%

increase over previous EMD systems.

The GP 49 also has the MS or Motor Simulator module. This module simulates heating characteristics of the traction motors and permits the locomotive to operate at higher power levels, providing traction motor temperatures have not reached their upper operating limits. Power output will be reduced as motor temperatures rise to prevent traction motor damage.

The GP 49 Super Series Locomotives uses a moderate size engine that develops the horsepower of previous large engines and should return significant maintenance and fuel savings over the life of the locomotive when replacing older locomotives of comparable horsepower.

## ELECTRIC LOCOMOTIVE DEVELOPMENT

### Introduction

The development of electric locomotives in the United States is advancing again after a quiet period of 35 years. In the past, General Electric and Westinghouse were responsible for most of the electric locomotive development in the United States. In the 1970's, EMD in cooperation with ASEA began developing and producing high-performance electric locomotives.

Although electric locomotive production in the United States is small in comparison with European countries, electric locomotives built here are technically equal in per-

formance and reliability to those built outside the U. S. Obviously, production of electric locomotives by United States manufacturers depends on major U. S. railroads undertaking mainline electrification projects.

### History

The first mainline electrification in the U. S. occurred in 1894 when the B&O electrified its tunnels in Baltimore. Other mainline electrification projects that followed included the Great Northern and Milwaukee Roads in the West, and the Virginian, New Haven and Pennsylvania Roads in the East. Prior to 1940, the most advanced electric locomotive built in the U. S. was the Pennsylvania Railroad's GG-1. The GG-1 was an improved version of General Electric's 3,400-hp, 11000 volt straight AC locomotive built for the New Haven Railroad in 1931.

The GG-1's statistics are still impressive by today's standards:

Weight — 477,000 lb.

Length — 79' 5"

Height — 15'

Tractive effort - max — 65,500 lb.

Max continuous speed — 100 mph

Rail HP, continuous — 4620

Rail HP, short time —

Approx. 9,500

Traction Motors — 12, AC Series wound, single phase 25 HZ.

To take advantage of the slow-speed, high-torque characteristics of the DC traction motor, electric locomotive manufacturers devel-

oped the AC rectified locomotive. The first rectified locomotive was a 4000 hp passenger locomotive built by General Electric and delivered to the New Haven Railroad in 1955. In 1956, twelve 3300-hp rectified freight locomotives were delivered to the Virginian Railway.

In 1960, GE began delivery of sixty-six 4400-hp silicon rectified 11KV AC locomotives to the Pennsylvania Railroad. The Pennsylvania Railroad monitored the E44s to compare their average maintenance costs with equivalent diesel electric horsepower locomotives in operation at that time. It was concluded that the E44 cost approximately 25 percent to maintain as that of equivalent horsepower diesel-electric locomotives operating in comparable service.

In 1969, the Muskingum RR received two 2,500-hp, 25KV AC rectified locomotives that utilized commercial or 60 Hz frequency and thyristor control. In 1973, General Electric delivered 6,000 hp, 50KV AC, 60 Hz, thyristor controlled E60C locomotives to the Black Mesa and Lake Powell Railroad. These two railroads are small, private utility roads that utilize automated rail operations to haul coal from mine to electric generating plants.

In 1972, Amtrak began a search for a high-speed locomotive to replace the GG-1. The 30-year-old GG-1 was suffering from old age and obsolescence. Amtrak invited General Electric, EMD and foreign manufacturers to develop and bid

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on a new high-speed locomotive. General Electric was selected to build a passenger version of the Black Mesa & Lake Powell E60C. It was to be geared for 120 mph and capable of supplying Head End Power (HEP) for train heat, air conditioning and lights. The E60CP employs thyristor control of DC traction motors and can operate from single-phase, 11KV AC, 25 Hz and 12.5KV or 25KV AC, 60 Hz. The traction motors and running gear are similar to current diesel electric designs but are modified to handle 1000 hp per traction motor. The E60CP has a continuous rail horsepower of 5,100 and a short time rail horsepower of 9,800. With 120 mph gearing, the locomotive develops a starting tractive effort of 75,000 lbs. The traction motors have roller support bearings.

#### Recent Developments and Current Production Models

In 1975, EMD produced its first electric locomotive, the prototype GM6C. This is a 6-axle, 6000 hp unit intended for heavy-duty, drag freight operations. It employs modified Electro-Motive traction motors, trucks and running gear derived from diesel-electric practice. The main transformer, thyristor converters and controls are built by ASEA. It is designed to operate on 11KV, 25 Hz or 25KV, 60 Hz system.

In 1976, EMD built a second prototype demonstrator, the GM10B. It develops a nominal 10,000 diesel-equivalent hp and is intended for

high-speed, heavy-duty freight service. It is equipped with separately-excited, frame-mounted traction motors manufactured by ASEA. The B-B-B fabricated truck arrangement with elastomer primary suspension is a departure from usual U. S. arrangements. The locomotive's main transformer, thyristor converter and controls are also manufactured by ASEA. The GM10B develops 100,000 pounds of continuous tractive effort at a Nominal adhesion of 26.5 percent.

Beginning in 1980 and extending through the first half of 1982, Amtrak received 47 EMD AEM-7 locomotives. The AEM-7 is an Americanized version of the ASEA RC4, which was brought to this country and tested by Amtrak on the Northeast Corridor. The AEM-7 specifications are:

- Length — 51 feet
- Weight — 201, 400 lbs.
- Voltage — 11/12.5/25 KV
- Frequency — 25/60 Hz
- Rail HP, cont. — 5,800
- Rail HP, short time — 7,000
- Max. speed — 125 mph
- Aux. HEP — 500 KW
- No. axles — 4, B-B arrangement
- Wheel diameter — 51"
- Traction Motor — LJH 108-1A (ASEA)

The AEM-7 is currently going through its shake-down period. Amtrak maintenance personnel and EMD engineers are working to correct technical problems not unusual to new locomotives. Availability is averaging 85% and will improve to 90-95% as experience

is gained and problems are corrected.

Amtrak believes that it has found the reliable motive power unit needed for its 125 mph train operation in the Northeast Corridor. The AEM-7 currently is hauling trains of 6 cars on a 2-hour 59-minute schedule between New York and Washington. Amtrak's goal is a schedule of 2 hours and 40 minutes and the AEM-7's performance indicates this can be accomplished.

Maintenance costs for the AEM-7 have not been established since warranty repairs and learning of new maintenance procedures are in progress. The locomotive's unique high-speed characteristics prevent comparing its maintenance costs with current freight or passenger diesel electric locomotives

since no comparable service is performed by other locomotives in this country.

#### **New Developments, U. S. and Foreign**

Three EMD developments have already been discussed, the AEM-7, GM6C and GM10B.

General Electric recently completed ninety-two 2,800KW, six-axle, thyristor-controlled locomotives for the Taiwan Railway. They are used in freight and passenger service utilizing a catenary voltage of 25KV, 60 Hz. The locomotives are double ended with full width cabs and a desk-type console for the engineman. Other specifications are:

Length — 56 ft.

Weight — 211,680 lbs.

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Currently, General Electric is designing and preparing to build a new electric locomotive for Mexico. This locomotive will have an improved drive system design with high power factor and increased performance. It will use all thyristor control and eliminate staging contactors.

GE also is installing "chopper" control to an existing Conrail (former P. R. R.) E44. This FRA/GE program will give the E44 —

- individual axle control
- high power factor
- low harmonic currents

The chopper control in a locomotive is experimental. It demonstrates that American manufacturers are continuing to develop and test modern electric locomotive designs in spite of a limited domestic market potential.

The committee has summarized electric locomotive developments so that in the event there is major electrification of America's railroads we will be familiar with some of these locomotives and their capabilities.

Briefly, there are three major benefits from operation of electric locomotives when compared to diesel electric locomotives operation:

1. Lower maintenance cost per unit (no internal combustion engine).

2. Fewer units required to match diesel equivalent horsepower requirements (exception would be heavy, slow drag service where rail adhesion is critical).
3. Eliminate enroute fueling and servicing.

The interest by U. S. industry to build electric locomotives and support their operation is stated in a paper titled *Is U. S. Industry Ready for Railroad Electrification* by H. B. Henderson. "U. S. industry has the systems and equipment knowledge to provide an electrification system design as well as an understanding of the unique requirements of U. S. railroads. This combination can produce a reliable, cost effective electrification system that will improve railroad productivity through real savings in maintenance and energy expense."

#### COMPUTER DEVELOPMENTS— A MANAGEMENT TOOL

The 1980 paper of the New Developments Committee included a section entitled "Computer Innovations for Increased Reliability and Availability." As stated, "The Chief Mechanical Officers must be given the necessary computer tools to assist them effectively and efficiently in the management of their operations." It has become apparent that all levels of Mechanical Department Management have informational needs that can be and have been solved by the computer.

The Santa Fe has met this challenge and has developed a middle and upper level management tool in order to aid in locomotive fleet

management. The report entitled, "Executive Summary-Current Locomotive Fleet," (Figure I), is updated three times daily and has enhanced the information of the Centralized Power Bureau, Chief Mechanical Officer and his staff, Shop Superintendents and other on-line management personnel.

The Executive Summary, (Figure I), captures all active locomotives in the fleet and reports their current status. The locomotives are divided into two major categories; those tied up in a mechanical shop and those on-line.

Those locomotives reported IN SHOP are held in the following categories.

1. Scheduled Repairs—units held for routine scheduled maintenance, such as 46-day inspections,

periodic inspections including 92-day, 368-day and 736-day inspections.

2. Wreck Repairs—units held for repairs due to wreck damage.
3. Class III Repairs—units held for major overhaul and complete rebuild.
4. Unscheduled Repairs—units held for repairs other than those mentioned above.

The sum total of those units held IN SHOP is subtracted by the computer from the total active fleet arriving at the total units on-line. The units reported on-line are further divided into one of nine defect levels as follows:

—Defect Level 1—unit cannot be moved from present loca-

PAGE	EXECUTIVE SUMMARY-CURRENT LOCOMOTIVE FLEET					PAGING =					
	ACTIVE (	IN SHOP )				( DEFECT LEVELS )					BD 1
FLEET	SCHL.	WRKS	CLS3	USCH	ON-LINE	1	2	3	4-7	8-9	TURN RATIO
1947	70	26	32	93	1606	10	50	28	60	263	120 11.4%
	3.6%	1.3%	1.6%	4.8%	82.5%	0.6%	3.1%	1.7%	3.7%	16.4%	6.2%
*****											
GE	14	5	8	21	293	3	5	3	7	44	31 12.9%
372	3.8%	1.3%	2.2%	5.6%	78.8%	1.0%	1.7%	1.0%	2.4%	15.0%	8.3%
EMD	56	21	24	71	1308	7	45	25	52	219	89 11.0%
1569	3.6%	1.3%	1.5%	4.5%	83.4%	0.5%	3.4%	1.9%	4.0%	16.7%	5.7%
OTHER	0	0	0	1	5	0	0	0	1	0	0 16.7%
6	0.0%	0.0%	0.0%	16.7%	83.3%	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%
*****											
ARGT	16	6	0	22	433	3	7	6	8	64	37 10.0%
522	3.1%	1.1%	1.5%	4.2%	83.0%	0.7%	1.6%	1.4%	1.8%	14.8%	7.1%
CLEB	17	8	2	20	518	1	14	10	21	92	23 8.0%
588	2.9%	1.4%	0.3%	3.4%	88.1%	0.2%	2.7%	1.9%	4.1%	17.8%	3.9%
BARST	35	12	22	48	621	4	24	12	30	96	54 14.8%
792	4.4%	1.5%	2.8%	6.1%	78.4%	0.6%	3.9%	1.9%	4.8%	15.5%	6.8%
SRDND	0	0	0	0	0	0	0	0	0	0	0 0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OTHER	2	0	0	3	34	2	5	0	1	11	6 11.1%
45	4.4%	0.0%	0.0%	6.7%	75.6%	5.9%	14.7%	0.0%	2.9%	32.4%	13.3%
*** ADDITIONAL DATA ON NEXT PAGE ***											

Fig. 1

tion. (Perhaps due to excessive flat spots or locked up running gears).

- Defect Level 2—unit can be moved, but must move dead. (Engine cannot be started for various reasons).
- Defect Level 3—unit can be moved, but must move isolated. (Unit is running but cannot be placed on-line - no horsepower).
- Defect Level 4—unit is in reduced excitation, 66% horse power loss (GE only).
- Defect Level 5—unit has traction motors cut out, 25% to 33% horsepower loss.
- Defect Level 6—unit has engine speeds cut back, up to 25% horsepower loss.
- Defect Level 7—unit can be moved, but must move at reduced speed. (Perhaps due to flat spots on wheels).
- Defect Level 8—unit has an operational restriction, with 100% horsepower. (Perhaps non-operational dynamic brakes or unit cannot be used as a lead unit account no cab heat or a bad automatic brake valve, etc.).
- Defect Level 9—unit has minor defect requiring repair (burned out light bulbs, minor oil or water leak, etc.).
- Defect Level 0—unit has no defects.

Defect levels one, two and three are reported separately on the Executive Summary. Defect Levels four, five, six and seven are combined together as they represent units operating at less than 100%

horsepower. Defect Levels eight and nine are also combined as they represent units with 100% horsepower.

Finally, those units last reported as a Turn are included on the Executive Summary. These are units at a Mechanical facility receiving a daily or turn inspection, including fuel, sand, etc.

The last column of the Executive Summary is the Bad Order Ratio or the Shop Ratio. This percentage is calculated by dividing the total number of units in-shop by the total number active.

Using the same categories as described above, the Executive Summary goes on to look at the fleet dividing it up in various ways, as follows:

1. By Manufacturer—fleet examined dividing GE units from EMD units and others (Sulzer, etc.).
2. By Shop Assignment—the locomotive fleet is assigned to three major repair shops for maintenance responsibility; Argentine Shop, Cleburne Shop and Barstow Shop.

Page two (Figure II), of the Executive Summary reports on locomotives held at the major shops and secondary shops. This portion of the report reveals the various shop loads and does not differentiate shop assignment.

Subsequent pages of the Executive Summary divide the fleet by type of power, i.e., GP-39-2's, SD-45's, B-36-7's, etc.

Any of the many categories described above can be printed out in

PAGE	2	EXECUTIVE SUMMARY-CURRENT LOCOMOTIVE FLEET							PAGING =		
ACTIVE (	IN SHOP	)	(	DEFECT LEVELS			)	BD			
FLEET	SCHL	WRKS	CLS3	USCH	ON-LINE	1	2	3	4-7	8-9	TURN RATIO

-----

ARGT	15	2	8	26	0	0	0	0	0	0	25	67.1%
	76	19.7%	2.6%	10.5%	34.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	32.9%
CLEB	17	6	2	17	0	0	0	0	0	0	12	77.8%
	54	31.5%	11.1%	3.7%	31.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.2%
BARST	34	7	0	33	0	0	0	0	0	0	45	62.2%
	119	28.6%	5.9%	0.0%	27.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	37.8%
SBDND	0	7	22	3	0	0	0	0	0	0	0	99.9%
	32	0.0%	21.9%	68.8%	9.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OTHER	4	4	0	14	0	0	0	0	0	0	38	36.7%
	60	6.7%	6.7%	0.0%	23.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.3%

TUE OCT 20, 1981 7:04A CENTRAL TIME \*\*\* ADDITIONAL DATA ON NEXT PAGE \*\*\*

Fig. 2



## LOCOMOTIVES PROTECTED BY FARR FILTRATION SYSTEMS RUN LONGER BETWEEN OVERHAULS.

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graph form and in color by the computer. Weekly or monthly graphs of the various categories greatly aid the user to identify trends which may be developing.

Santa Fe has developed, and is expanding on, several other new developments with the computer. Among them are:

1. The tracking of major serialized locomotive components, such as traction motors, main generators and alternators, including frames, armatures, bearings and windings, both armature and coil. Engines, including turbo chargers, crankshafts and power assemblies, along with jackets, heads, liners, pistons and rods. The system tracks the installation, removal and repairs performed to the components. The reasons for removal as well as time and/or miles since last overhaul or since installation is also tracked. Components under warranty or under test also can be tracked. All status changes of the serialized components are held in the locomotive data base on a real time basis.

2. Shop Floor input into CRT's by the mechanic actually doing the work, whether it be changing or making repairs to a component being tracked. On-line reporting by mechanical forces as it relates to the status of various locomotives with regard to the Executive Summary discussed earlier.

3. A software package which allows the user to write his own inquiry in order to retrieve information from the locomotive data base. The inquiry can very easily

be custom developed, depending on the users needs.

4. A locomotive worksheet reporting system which is now building histories in the locomotive data base with regard to repairs or maintenance performed.

5. A verbage data base allowing shop personnel to receive job letters or current Engineering instructions with regard to projects, tests or modifications to the various locomotives in the fleet.

Future developments being planned or pending management decisions include:

1. Computer generated locomotive worksheets on a per/unit basis depending on the defect or maintenance required for that unit.

2. Computer generated shop utilization of manpower. Available manpower can be compared to actual work performed and compared to standards developed for that work. Actual costs to maintain units by mechanical location or by manufacturer could be captured.

3. Automatic re-ordering of material from the Store Department depending on material standards developed for the work or inspection being performed.

In summary, the committee would recommend each railroad examine its own needs and resources available when entering into the development of computer programs. Certainly the blending of mechanical forces with programming experts as has been done on the Santa Fe has led to a successful program. This blend is endorsed and encouraged by this committee.

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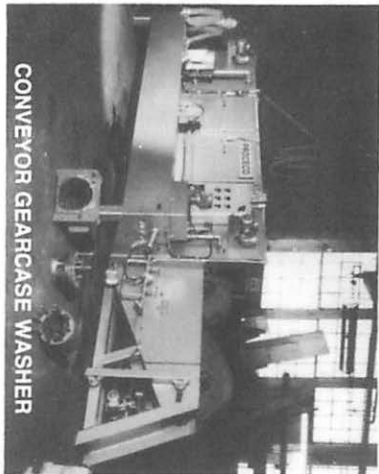
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**J. J. BUTLER**  
Chief Mechanical Officer  
Consolidated Rail Corporation  
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LMOA wishes to express its thanks to Consolidated Rail Corporation for again hosting Pre-Convention Presentation in the Altoona area.

Our Diesel Electrical Maintenance Committee's presentation was well received in what we trust was a mutually beneficial experience.

Our thanks again to Jim Butler and his forces at Altoona Shops.

# Tuesday, September 21, 1982

9:00 A.M.

## REPORT OF THE COMMITTEE ON DIESEL ELECTRICAL MAINTENANCE

**Pre-Convention  
Presentation:  
Consolidated  
Rail  
Corporation**

**April 27, 1982  
Sheraton  
Motor Inn  
Altoona, PA**

PICTURE  
NOT AVAILABLE

**T. L. WESTERFIELD, Chairman**  
Senior Electrical Engineer  
Chicago & North Western Transp. Co.  
Chicago, IL 60606

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### 1982 TOPIC:

**"QUALITY MAINTENANCE — ASSURING THOROUGH REPAIRS"**

## PERSONAL HISTORY

### T. L. WESTERFIELD

Born April 15, 1946 in Arkansas City, Kansas.

Attended public schools at Springfield, Missouri, and Cheyenne, Wyoming. Graduated high school Cheyenne, Wyoming, 1964.

Served in the U.S. Navy as a Radioman.

B.S. in Electrical Engineering from University of Wyoming.

Joined the Chicago and North Western in July, 1972 as a Management Trainee at Chicago. March, 1973 was promoted to Electrical Engineer and in February, 1979 to Senior Electrical Engineer.

He is a member of LMOA, Institute of Electrical and Electronic Engineers and Instrument Society of America.

## I

### QUALITY MAINTENANCE — ASSURING THOROUGH REPAIRS

#### General

Productivity has become the buzz word of the '80's. Like motherhood and apple pie, everyone is for productivity, but no one has a clear plan for achieving it. Many railroads have installed systems to attempt to measure productivity, assigning a standard to each task and then comparing the actual labor time to the work accomplished. The problem with this sort of system is that it is difficult to distinguish between successful repair and incomplete repair. A shop which consistently does correct re-

pairs will actually show less work completed than a shop which does the same repair over and over without correcting all the problems. Clearly, achieving true productivity requires a means of assuring thorough repairs.

One important ingredient of productivity is thus quality. As has been shown repeatedly, quality cannot be inspected in. A quality control man can prevent bad work from leaving the shop, but rework is still required, which lowers true productivity. Quality requires that the job be done right the first time. What the quality control man can contribute is an analysis of where things are going wrong so that corrective action can be taken.

Corrective action to improve productivity will require change in the design of equipment (the locomotive) or job procedures or both. Much progress has been made by builders and railroads in both of these areas. Much remains to be done. Consider the following: Many railroads have installed so-called "fuel saver" devices to control utilization of excess power in certain situations. There is concern over the effect of this operation on traction motor brushes and commutators. A brush manufacturer reports tests which show that low power operation can cause greater film stripping action than moving a locomotive dead.

One railroad found a 25 percent increase in brush wear rate in GP-40 locomotives which had significant amounts of service in "fuel

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saver." Corrective action in this case required equipment modification (a change in brush grade) and/or procedure change (rotating locomotives so that no one unit spends too much time in "fuel saver"). However, one additional factor developed during the investigation was that the engines on the units with higher brush wear were running above specification on power output. Incomplete repair, in this case governor adjustment, resulted in reduced productivity.

While on the subject of brushes, concern has also been expressed about the practice of towing dead locomotives long distances. Removing brushes will reduce both brush and commutator wear, although this does not seem to be a serious problem. This also will prevent a buildup of carbon dust around the commutator area. Some fuel savings should be available by a reduction in rolling resistance.

Previous years' papers have contained this committee's recommendations on test equipment for maintaining quality in traction motor shops. Use of various types of test equipment by eight railroads is summarized in the following chart:

#### TESTS ON TRACTION MOTORS

Type of Test	Railroad Use	Percentage
Megger/Hipot	8	100
Inductive Test Equipment	7	87.5
Commercial Test Set	4	50

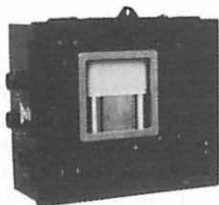
Vibration Check	6	75
Bearing Run In	7	87.5
Core Loss Check	4	50
Load Test	2	25
Field Impedance Check	4	50
Run In	7	87.5

Even though the traction motor shop is using the best equipment and turning out high quality work, improvements can still be made in performance. A case in point: One U. S. railroad had a group of GP-40 locomotives in assigned service on one division. These locomotives showed an excessive rate of road failure. Management set up a "tune-up" program where each locomotive was thoroughly tested and put in proper operating condition. The road failures dropped dramatically. But an added bonus was a substantial reduction in traction motor failures. In some cases it took a full week to correct all the problems in the locomotive. The result of continued incomplete repairs to locomotive controls took its toll on the traction motors.

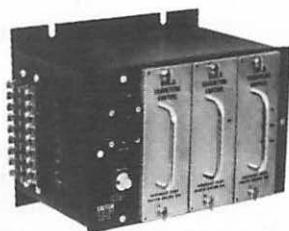
To assist maintenance officers in assuring thorough repairs, this committee has prepared a series of troubleshooting guides and check-out procedures for transition control on EMD and GE locomotives. We have attempted to make the guides detailed enough to allow easy adaptation to the locomotives on your railroad yet still general enough to cover most models. In future papers, we will discuss loading problems, wheel slip, and grounding.

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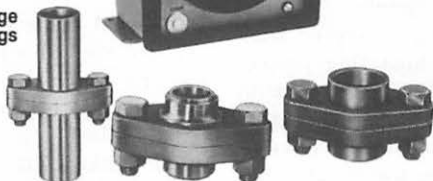


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Three general principles apply to any troubleshooting and repair effort:

1. Begin at the beginning and perform ALL tests.
2. Repair defects as you find them.
3. Retest after completing repairs.

Attempting to bypass steps or repairs will inevitably result in confusion, incomplete repairs, and poor quality.

## II

### TRANSITION TROUBLESHOOTING

#### A. Safety

Expedient repair of a defective locomotive, no matter how badly needed, is not worth the slightest injury to the workman. Working safely is a responsibility of every railroad employee from the chief executive officer on down. This responsibility cannot be delegated away or ignored without serious consequences. Beyond such general areas as blue flag protection, proper clothing, and care on steps and walkways, the procedures in this guide require that the maintenance officer be aware of some special hazard:

#### 1. Electric Shock and Burns

These procedures require personnel to work on energized equipment. Lethal voltages are present, and sufficient energy is available to cause severe burns should an arc be accidentally struck. Test equipment must be rated for the voltages which could be produced. Care

must be taken to have meters on the proper range and the range should not be changed under load. Consideration should be given to installing energy limiting resistors in high voltage test points.

#### 2. Movement of Locomotive

It must be kept in mind that the locomotive being worked on is defective. It cannot be depended on to work correctly. Since the tests are performed directly on the propulsion circuits, all concerned must be aware of the possibility of unexpected movement of the locomotive.

#### 3. Housekeeping

These procedures may involve several large pieces of test equipment. It may be necessary to open access doors or false flooring to observe or test. Provision must be made to prevent injury to all personnel, those involved in the test and those who are "just passing through."

#### B. Visual Inspection

From the schematic drawing, determine which devices are directly concerned with transition. Typically, this includes relays on EMD units marked TR, PR, FTR, BTR, FTX, FTRA and/or PTR and any resistors, switches, and capacitors associated with these relays. On GE units, look for relays marked CR1, CR1DM, TSR, SSR1. It is a good idea to list these parts on paper and check off as the equipment is inspected. A pre-printed checklist for each class of locomotive can save time and aid less experienced personnel.

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The unit has an aluminum exterior and a stainless steel interior. It is bolted to a 13 gauge steel base. It comes complete with drain and overflow. The 17" high stand is optional.

### SPECIFICATIONS:

Height of cooler and stand 46"-  
 Height of cooler 16 1/2"  
 Width of cooler 12"  
 Depth of cooler 19 1/4"  
 Height of optional stand 17"  
 Width of stand 12 1/2"  
 Cooler interior stainless steel  
 Cooler exterior aluminum  
 Insulation urethane foam  
 Water tank capacity 2 quarts  
 Water bottle capacity 2 gallons. (1 gallon bottle available)  
 Ice capacity 12 lbs.



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Locate each device on the list and inspect for evidence of burning, arcing, breakage, loose or defective wire terminals, and general condition. A chart can be used to good advantage to assist in locating the devices. All obviously defective parts should be replaced before attempting further tests.

### C. Control Sequence Checks

**Note:** Due to the hazard of unexpected movement of the locomotive, it is recommended that these tests be performed with the engine shut down.

Using the locomotive service manual as a guide, check the operation of ALL locomotive controls. Make note of operation of intermediate steps and time delays. With the engine shut down, it will be necessary to simulate some functions with jumpers or by blocking in relays. It is good practice to keep a written list of these actions as an aid to restoring the locomotive to normal conditions. A pre-printed list can be an extremely useful tool for this purpose.

#### 1. GE Locomotives

1. With engine shut down, controls set for motoring, and sufficient control air pressure (50 psi) to operate power contractors, turn Generator Field breaker on, Engine Control switch to run, and move throttle handle to first notch.

2. Disconnect axle alternator wires which control transition speeds (on some GE locomotives the axle alternator wires connect to the wheel slip panel). On lo-

comotives built since 1977, the alternator wires connect to the transition panel (TEP). (Check locomotive schematic for details.)

3. Connect the frequency output leads from GE 17TM14 test set or GE 17MM37 test set to the terminals from which axle alternator wires were removed.

4. Connect the D. C. input cord to the locomotive 74 volt D. C. source. Observe polarity—red positive, black negative.

5. Place range/function switch to desired range (usually 10 to 100 Hz position for transition).

**CAUTION:** Do not exceed 400 Hz when testing wheel slip, transition or speedometer systems. Excessive output frequency may damage these systems. When operating the RANGE/FUNCTION switch, set the FREQ ADJUST knob to the minimum (ccw) position and turn the test set power switch off.

6. Place a test lamp or meter to indicate TSR or SSR1 transition relay pickup. Lamp or meter will indicate actual transition pickup and setting. This may be connected to input to CR1-DM time delay module DK wire "Positive." Connect the other lead to a convenient negative source on the locomotive.

**NOTE:** Many locomotives use a transition time delay circuit. This causes the traction motor power contractors to be energized at some preset time (seconds) LATER than the transition panel is actuated. Refer to the locomotive schematic to determine

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exact transition time delay action.

7. Place the test kit Power switch to ON.

8. Turn the Freq. Adjust rheostat to obtain frequency desired.

9. As frequency is slowly increased watch the lamp or meter, for indication of the actual transition setting. Then, after the delay period the CR1 will pick up, dropping out generator field contactor "GF" and series contactors and picking up parallel contactors and finally, re-energizing GF contactor.

10. After transition to parallel is accomplished, turn frequency adjust rheostat slowly to decrease frequency and note when backward transition occurs, approximately 1.6 mph or 4 Hz less than pick up. This is accomplished by dropout of TSR relay.

11. Transition relay (CR1) is de-energized and no time delay is involved.

12. Locomotive goes through backward transition, series contactors pick up and parallel contactors drop out. GF contactor does not drop out during backward transition.

13. This would be an appropriate time to check speedometer, overspeed, and dynamic brake extended range contactor operation.

Test equipment needed for adjusting transition:

1. Frequency test kit:
  - 17MI4A1 test kit
  - 17MM26 test kit
  - 17MM28 test kit
  - 17MM37 test kit

2. A test light (to identify TSR pickup) 75 v. 10 w. maximum
3. Three-eighths inch nut driver
4. Small screw driver
5. Flashlight

The following is a list of publications produced by General Electric which refer to transition testing:

- |               | Publication No. & Title  |
|---------------|--|
| GEK 61414A —  | 17TM14 Test Kit-Operating Instruction  |
| GEK 61382B —  | M1 73252-FL182 Speed Event Panel   |
| GEMS Vol. 4 — | Issue 11 - July 22, 1977, Improved Test Set for Adjusting Transition Panels                      |
| GEK 30150 —   | Control Equipment, sections 11 and 111   |
| GET 6344 —    | Locomotive Electrical Equipment Systems Analysis   |
|               | NOTE: Always refer to individual locomotive schematic for proper transition adjustment settings. |

## 2. GE Locomotive Transition Tips

The transition circuits on GE locomotives are very reliable and only fail occasionally. Following are some problems, tips and suggestions from a western railroad:

1. Safety is the most important item when checking transition. Obey all safety rules to avoid personal injury.

2. When checking transition, do not use shortcuts by jumpering out

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a device. The device you jumper out may be defective.

3. Replace the older Adlake time delay relay with an Artisan timing module.

4. Interlock problems on power contactors will not allow proper sequence.

5. BKT pawl springs broken and missing cause incomplete sequence during transition.

6. CR1-DM delay module open.

7. Use test lights to identify transition pickup and power reduction and time delay to actual power contactor change.

8. Few transition cards are found defective. Transition module cards suspected defective should be bench checked and tested.

9. Check alternator ohmic value (73.4 to 83.5 ohms).

10. Look for broken wires at axle alternator. A caulk compound may be inserted into axle alternator wire connection box to prevent wire vibration and breakage.

11. Axle hand spin test may be used to find out if alternator will develop voltage (should be 1 to 2 volts AC).

12. The axle alternator can be checked visually by removing the outboard cover and inspecting the stator winding to see if it is squid. Note: The spring clips holding the stator do vibrate loose if locomotive has been used on rough track. This can allow breakage of wires to stator. Visual inspection of rotor can also be made, determining whether it is loose on shaft or striking stator.

13. When using the 17TM14A1 test kit, it is not necessary to remove any wires from TEP (N) and (M) terminals.

14. Use proper settings when adjusting transition. Settings are displayed on the respective locomotive schematic.

15. Track testing is probably the only 100% sure fire method of qualifying transition.

16. On locomotives with repeated failures, the sequence should be checked several times to try to find intermittent problems.

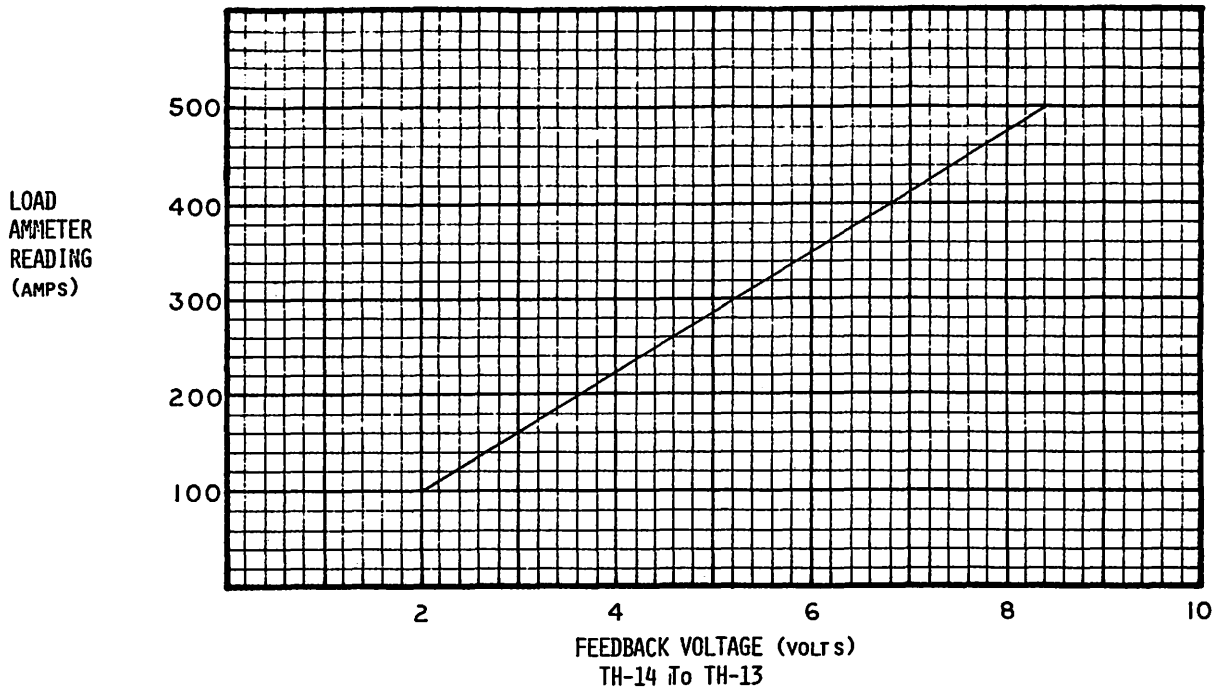
### 3. EMD E-I System On Locomotives Without Field Shunting

1. Dash 2 units must be running to perform sequence checks. Earlier models do not have to be running, in this case, block in the NVR relay and pick up the FPC relay.

2. If the unit is running, remove the generator field fuses or turn off the generator field circuit breaker. On Dash 2 units, turn the test switch to CIRCUIT TEST position. On earlier models, turn the test switch to the MANUAL SEQUENCE TEST position.

3. Position controls as follows:  
Engine Run Switch ON  
Generator Field Switch ON  
Isolation Switch to RUN  
Reverser to FORWARD or REVERSE, whichever is the safer direction  
Throttle to 1

4. Verify that series contactors are all picked up and that generator field contactors are picked up.



FEEDBACK VOLTAGE (volts)

TH-14 to TH-13

FIG. 1

NOTE: GRAPH IS FOR PF18 MODULE.  
MOST OTHER PF MODULES ARE  
WITHIN 10% OF THESE VALUES.

5. On Dash 2 units, press and **HOLD** the test switch on the TR module. On earlier models, press and **HOLD** the Manual Fwd. Trans. switch. The FTX and PR relays should pick up and the generator field contactor drop out. Verify this before releasing the switch.
  6. Release the test switch. FTX should drop out, power contactors sequence to parallel connection, TDR and PRA relays will pickup, and the generator field contactor should pick up again.
  7. As soon as possible after generator field contactor pickup has been verified, again press and hold the Forward position pushbutton or test switch. After a short delay, FTX picks up. On Dash 2 units, EQP drops out. The generator field contactor drops out. On newer units, the Wheel Slip light will come on.
  8. Release the test switch. On Dash 2 locomotives, the PR relay and generator field contactor drop out and power contactors return to series immediately. On other models the Backward pushbutton must be operated for this test. On all locomotives, the generator field contactor should pick up after the series contactors pick up.
  9. Return throttle to **IDLE**. Turn test switch to **NORMAL** position.
  10. If no defects are located during sequence checks, proceed to the calibration checks. If any defects are discovered, the complete sequence test should be run to verify repairs before proceeding.
4. **EMD Locomotives—Calibration Checks**
    1. The TR module calibration must be checked on a test fixture. If no tester is available, the Stall Test procedure should be done before replacing the TR module.
    2. On earlier locomotives, a quick check of calibration can be made using only an MG set, even on a dead locomotive.
    3. Attach a test light across the FTX coil to indicate FTR relay pickup.
    4. Controls remain as in the sequence test. Insert telephone plugs or rods into test jacks. Connect the MG set to the rods or plugs. Connect a voltmeter with at least 1000v capability to the MG set output.
    5. On the "Charts and Graphs" drawing, extend the FTR PICK UP, SER. PAR. line to the point where it crosses the "O" current line. Gradually increase the MG output voltage until FTR picks up. Compare this voltage with the value from the chart. PR and FTX should be picked up, generator field contactor dropped out.
    6. Gradually reduce the MG output voltage until FTR drops out. Compare with the FTR DROP OUT, SER. PAR. to PAR. value on the graph. Power contactors should sequence to parallel connection and generator field contactor will pick up.
    7. Again increase the MG output voltage until FTR picks up. Check this value against the FTR PICK UP, PAR. & DELAY line on the graph. Generator field contactor should drop out.

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8. Reduce the MG output voltage until FTR drops out. The generator field contactor should pick up. Continue to gradually reduce MG set voltage until BTR drops out. Compare this value with the BTR DROP OUT line on the graph. The power contactors should sequence to series connection.

9. Reduce MG set voltage to 0 and disconnect it. Remove the rods or plugs from the test jacks. Move throttle to IDLE, turn off the generator field switch, and Isolation Switch to ISOLATE.

10. If adjustments are necessary, it is recommended that the full adjustment procedure in the Locomotive Service Manual be followed. If the calibration discloses no problems, proceed to the Stall Checks.

#### 5. EMD Locomotives—Stall Checks

The following tests require that power be applied to the traction motors. To prevent movement of the locomotive, make certain the brakes actually apply, that the locomotive is properly blocked. Ensure that all personnel are in the clear and aware that the locomotive is under power. Set the reverser for the safer direction.

1. Replace the generator field fuses and start the engine. On Dash 2 units, turn on the generator field circuit breaker and turn the test switch to NORMAL.

2. While the engine is warming up, make the following preliminary checks on Dash 2 units:

From	To
TR-1	Battery Switch Negative 74 v. DC
TR-14	Battery Switch Positive 74 v. DC
PF-13	Battery Switch Positive 74 v. DC
PF-14	Battery Switch Positive 74 v. DC
TR-8	TR-10—60 v. AC

3. Move the throttle to 1. The current shown on the load ammeter should be between 200 and 350 amps. Do not proceed if the current is outside these limits.

4. On pre-Dash 2 units, measure the main generator output voltage. Then measure the voltage from J to M on the BTR relay. This value should be one tenth the main generator voltage. Measure the voltage from J to M on the FTR relay. This voltage should be one third the voltage found at BTR.

5. On Dash 2 units, check the AC voltages between the following test points. Readings must be balanced within 10%. For voltage inputs:

TR-2 to TR-3

TR-2 to TR-4

TR-3 to TR-4

For current inputs:

PF-15 to PF-16

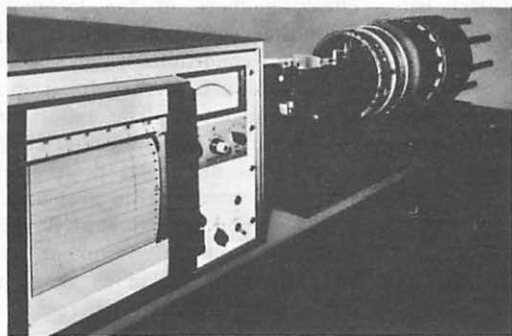
PF-15 to PF-17

PF-16 to PF-17

Check the DC voltage between TR-13 and TR-14 and compare against the graph in Figure 1.

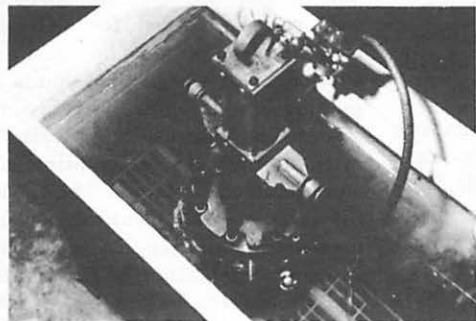
#### 5. EMD Locomotives—What Now, Sherlock?

If these tests have disclosed no problems at this point, the mainte-



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nance officer must face the unsettling possibility: maybe its not transition trouble. Problems in the fuel, governor, and excitation control systems can prevent the locomotive from making transition, especially on units with E-I type systems. An over-the-road test with an experienced electrician observing may be necessary to identify these problems.

### III ONBOARD DIAGNOSTIC SYSTEMS

The need for a skilled observer on board a locomotive described in the transition troubleshooting procedure brings up the need for some sort of automatic equipment for performing this function. Such a system could overcome the problems of boredom, fatigue, inattention, and inexperience which so often plague the human observer. While the need for such equipment is apparent, there are some pitfalls along the way.

Actually, on board diagnostic aids are not new. Locomotives have had annunciation lights, bells, buzzers, since the beginning. The builders have progressively added latching relays and test points to aid troubleshooting. The committee strongly recommends that this evolutionary process be followed in the development of on-board diagnostic equipment.

Such equipment must meet two tests. First, the indications it provides must be meaningful. An example of a failure to meet this

requirement was the Grid Overcurrent annunciator on early Dash 2 locomotives. The annunciator was checking more of the locomotive than the regulation portion; some transient conditions which the regulator did not correct for tripped the annunciator. The result was that maintenance personnel simply ignored the annunciator. A circuit revision corrected this problem.

The second requirement is reliability. Diagnostic equipment must be more reliable, much more reliable, than the parts where failure is to be detected. The result of a deficiency in this area is that the device will be ignored.

Given the requirements of evolution, meaning, and reliability, this committee recommends that each railroad develop detailed guides for troubleshooting each model and variation in the fleet. These guides will provide the basis for software that will be needed for the next step, which would be carry-on equipment to assist a mechanic by guiding him through the procedure and storing the results of tests for later analysis in pinpointing the most common problems. The reason for carry-on equipment versus permanent installation is to permit extended evaluation of equipment and procedures before the system is built into the locomotive. It also protects test equipment from continued exposure to the locomotive environment of dirt, vibration, and electrical transients while the test equipment is not being used.

The ultimate step should be a permanently installed system that



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would continually monitor locomotive performance and report malfunctions. However, as previously mentioned, this will prove a very challenging task if the equipment is to provide data of any value. The committee recommends that work in this area proceed cautiously and that each step be thoroughly tested before continuing.

#### IV

##### STARTING SYSTEMS

Some alternatives for engine starting have been discussed by the Mechanical committee in this year's proceedings. Many railroads have modified EMD locomotives to use that builder's Engine Purge ("Creepy Crank") system. The following guide should aid in maintaining that system.

The following starting procedure should be followed as described on the FP/ES switch nameplate:

1. Pull back on layshaft during purge cycle.
2. After purge cycle is complete, push layshaft to assist start.
3. Maximum cranking time 20 sec.
4. After cranking allow 2 minute cooling before reusing starters.
5. Do not inch engine with starters.

If the engine fails to crank over when the fuel prime/engine switch is held to the engine start position, bar the engine over to ensure that there is no hydraulic lock, then hold the BYPASS switch on the EP module to the closed position and hold FP/ES to the engine start position. Refer to the follow-

ing troubleshooting section to locate the cause of the system failure.

It is important that normal starting procedures (opening test valves, barring the engine over, etc.) be followed when using the BYPASS switch. The cab instruction nameplate emphasizes this.

##### A. Troubleshooting

I. Engine does not crank with use of EP module BYPASS switch.

A. Check for pick-up of EPC contactor.

NOTE: When the engine purge system is operating properly, the EPC contactor should pick up, drop out, and pick up again before the STA contactor can pick up.

1. If the EPC contactor fails to pick up check the following:

- a. Turbo lube pump circuit breaker (turbocharged units).
- b. Control circuit breaker (Roots blown units).
- c. EP module LED lights with cranking attempt.
- d. EP module for foil damage. Damage to the module foil indicates other problems exist on the unit. The complete starting system should be checked.
- e. EPC contactor coil.

B. If EPC contactor cycles properly but engine fails to crank, check the following:

1. Pick up of STA contactor.
- a. Isolation switch in START/STOP/ISOLATE position.

- b. STA contactor coil.
- 2. Pick up of ST contactor.
- a. Starting Fuse.
- b. Starter motor pinions engaged.
- c. ST contactor coil.

## II. Engine cranks with use of EP module BYPASS switch.

A. WITHOUT using the BYPASS switch, check for EPC contactor pick-up.

1. If the EPC contactor fails to pick up, check the EP module for any visible damage.

- a. Damage to the module foil indicates other problems exist on the unit. The complete starting system should be checked.

b. Replace EP module and check for proper system operation.

2. If the EPC contactor picks up but fails to cycle, check the following:

- a. Insure proper connections to the EPC contactor interlocks.
- b. Possible damaged or inoperable interlocks.
- c. Grounds in starting motors.
- d. Wiring to EP module.
- e. Replace EP module and check for proper EPC contactor operation.

3. If the EPC contactor cycles properly but engine fails to crank, replace EP module and check for proper system operation.

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We of the Chicago Railroad Diesel Club were again pleased to be hosts to the Locomotive Maintenance Officers Association for their April 5, 1982 Pre-Convention Presentation.

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# Tuesday, September 21, 1982

10:30 A.M.

## REPORT OF THE COMMITTEE ON SHOP EQUIPMENT

Pre-Convention  
Presentation:  
Chicago Railroad  
Diesel Club



April 5, 1982  
Midland Hotel  
Chicago, IL

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Senior Engineer-Facility Planning  
The Family Lines Rail System  
Jacksonville, FL 32202

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### 1982 TOPIC:

**"QUALITY MAINTENANCE THROUGH MODERN TOOLS"**

## PERSONAL HISTORY

### THOMAS A. KESSENGER

Thomas A. Kessenger was born in Louisville, Kentucky, May 24, 1945. He attended grade school and high school in Louisville, graduating high school in 1964. Tom was employed by the Louisville and Nashville Railroad the same year as a machinist apprentice and within two years was placed in a special mechanical management training program.

Tom attended the University of Louisville and studied mechanical engineering through I. C. S. School of Scranton, Pennsylvania.

In 1969, he was promoted at the L&N to Engineer Methods and Procedures at South Louisville Shop and in 1977 was promoted to General Engineer Methods and Procedures. In 1977, Tom was promoted to his present position as Senior Engineer — Facility Planning. In January of 1981 he was transferred to Jacksonville, Florida due to the consolidation of the SCL and L&N Mechanical Departments into one department of the Family Lines Rail System. All of Tom's job assignments have been shop related.

From 1965 to 1971, Tom also served as a member of the U. S. Army Reserve. He has been a member of the LMOA since 1972 and first served on the Shop Equipment Committee in October 1974. Tom has also been a member of the American Society of Mechanical Engineers since 1976.

His hobbies include woodworking, skiing and horses.

Tom has been married to the former Kathy Pfaff of St. Paul, Minnesota since August 10, 1970. She is a teacher of special education.

## INTRODUCTION

As the cost of labor continues to rise, railroad management looks toward modern automated machinery to help reduce operating cost. This type of equipment is greatly needed to increase production, using fewer direct labor man-hours, and to improve quality at the same time.

Automated machines and industrial robots are being applied to many railroad shop equipment jobs presently being performed manually. Each year new tools are being invented and adapted to railroad use. These special tools also reduce labor and improve quality.

Some railroads, due to the high cost of repair, are looking toward rebuilding locomotive components that were traditionally sent out to vendors. One of the items most recently being evaluated for in-house repairs is the EMD turbocharger.

Today, more than ever, railroads are trying to reduce job related injuries. Personal injuries are costly, wasteful and painful to the injured personnel.

The Shop Equipment Committee will present thoughts covering all of these areas in this paper entitled "Quality Maintenance Through

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Modern Tools." The committee presents the following:

1. Tools.
2. Rebuild line for EMD turbochargers.
3. Locomotive air brake equipment line.
4. Industrial robots.
5. Automated machines.
6. Safety related items and equipment.

### I. Tools

Having and using the right tools are primary prerequisites to quality maintenance of any equipment. Maintenance costs can be reduced and equipment operational dependability and efficiency can be increased with minimum effort, within a reasonable period of time by using the right tools.

The following are a few of the many tools available to help us perform quality maintenance:

#### A. Model 69200 P&J Coil Insulation Testor

Locomotives without a doubt offer one of the most demanding environments that mechanical devices can be subjected to, and within the locomotive itself, the traction motor lives in the worst environment of all. Railroads are continually searching for better ways to improve the reliability of rebuilt or repaired traction motors.

During the month of January 1980, a representative of a locomotive manufacturer was invited to one railroad's traction motor shop to inspect its equipment and analyze its methods of traction motor

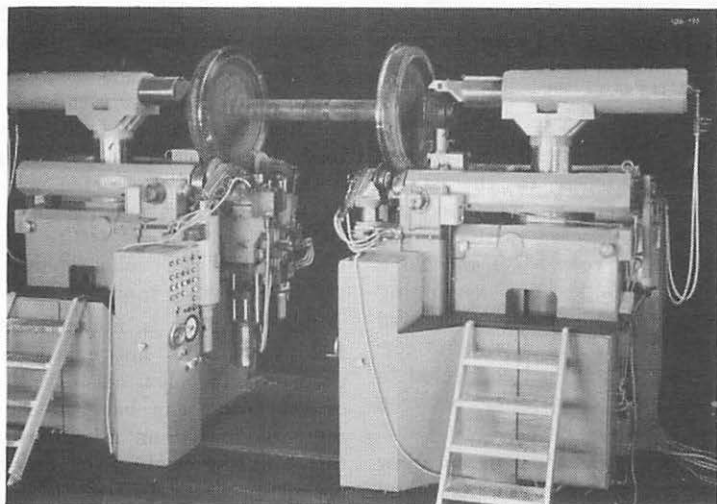
repair. Upon his recommendation, one piece of equipment purchased was the P&J coil insulation analyzer. The analyzer was installed during September, 1980.

The P&J analyzer is actually a high frequency surge tester and can be used to detect defective coil insulation and even an incorrect number of turns. The method used to check for defective coils is that of comparison, that is, a known good coil is referenced with a coil under test.

With the coil under test and the reference coil being identical, a high frequency current is supplied to each coil simultaneously. The resulting wave forms are then observed on a dual trace oscilloscope. If two identical wave forms are observed, the test coil is good. If, however, the wave forms differ, the trace showing the higher frequency is shorted or if the trace flickers, the coil is breaking down internally.

Operation of the analyzer is relatively simple, although the oscilloscope controls may appear somewhat complicated. Instructions are included with the analyzer, but are also included in the EMD MI 3950-4, pages 8 thru 10. Oscilloscope switches and levers are color coded with dots to indicate their proper positions. Once set, they require no further adjustment.

After turning on the analyzer, a few minutes are required for warm-up. During this time, the connections between the field coils can be stripped of insulation and made ready for test.



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NOTE: Since the following procedure is done without the use of the analyzer ground wire, extreme caution should be used while performing the test. The stator should have been previously high-potted.

One of the analyzer colored test leads is attached to the stator "FF" lead, and the corresponding black lead connected to the brayed connection between No. 1 and No. 2 main field coils. The remaining analyzer colored lead is connected to the stator "F" lead with its corresponding black lead connected to the brayed connection between main field coils No. 1 and No. 2.

The instructions just given allow comparison between the axle and bottom main field coils which are in series and the suspension and top main field coils which are also in series.

The analyzer should now be ready to test (ready light glowing). First, adjust the voltage control to zero. The safety foot control pedal is then depressed and must remain depressed throughout the test. Next, the test button is pressed and a red blinking light will show to warn that the test leads are energized. The voltage control is then rotated clockwise until the meter reads 7000 volts.

The sweep frequency of the oscilloscope is now adjusted to approximately 1 micron second per division or until an easy to read wave form is observed on the screen. A trace with two similar patterns indicates all coils are good. Two dissimilar patterns indicate a shorted condition with the

trace of the higher frequency (more cycles per second) indicating the coil pair with the probable short.

Since the analyzer test leads are color coded to coincide with colored leads on the oscilloscope, the pair with the probable shorted coil can be identified by moving the AC-DC-GRD switch from DC to ground and noting the color coding on the lead to that input.

The analyzer is not limited to field coils only, but can also be used on interpoles. Also, coils out of the frame can be checked, but must be placed on a similar material during testing in order to obtain an accurate trace.

As a final check, the stator should be checked hot. The field coils can be heated by passing a current of 1100 to 1200 amps DC for a sufficient time to produce 130° to 140° rise.

The P&J analyzer has found considerable use in traction motor overhaul areas.

#### **B. Tame Model 88 Lower Liner Bore Insert/Puller Installer For EMD Engines**

The Tame Model 88 tool is a hydraulically powered puller/press designed to remove and install EMD engine lower liner bore inserts quickly and safely. The cycle time to remove the old insert and install the new insert is less than two minutes. Savings of up to 16 man hours over other methods are possible when changing a complete set of inserts in a 16-cylinder engine. The tool is available as a

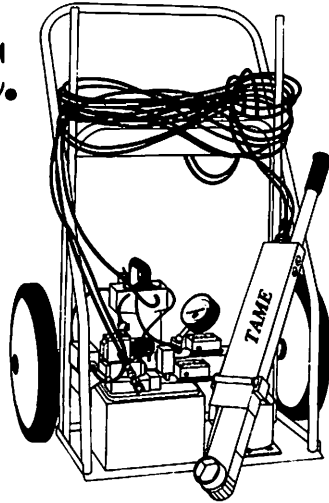
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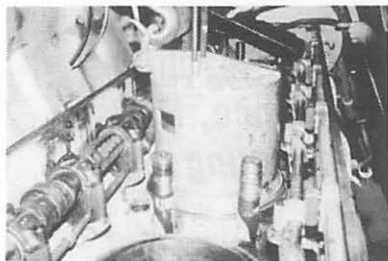


Fig. 1

complete assembly on a cart for easy mobility. (Fig. 1)

To operate this tool it is necessary to have access to a 1/4 ton or larger overhead hoist and supply air of 10 CFM @ 90 to 100 PSI.

1. Remove push/pull assembly from cart via lifting shackle and not less than a 1/4 ton crane.
2. Position push/pull assembly over crankcase cylinder bore of bad-order insert and lower into cylinder bore (in the same manner as a power assembly is installed), until pulling ring is seated on cylinder head retainer surface and push/pull assembly is centered in cylinder bore. (Fig. 2)
3. Connect air line to shop air line receptacle.
4. The lower liner insert tool is powered by two air/hydraulic pumps in parallel. One is a high volume pump to quickly extend and retract the power cylinder. The other is a high pressure pump to generate the force needed to pull bad-order inserts out and to press new ones in.

5. Push "PRESS" control button to extend push/pull block until the four spring loaded puller pawls clear the bad-order insert and pop out beneath it (Fig. 3)

**CAUTION:** Full engagement of all four puller pawls is essential to the operation of this machine. Failure to meet this condition may result in damage to the lower liner bore insert tool and/or the engine being serviced.

6. Check air line regulator pressure setting. It should be set at approximately 60 psi input air pressure to pumps. At 60 psi input the pressure pump will generate approximately 2800 psi hydraulic pressure which will deliver approximately 11 tons of force at the pulling head. This force is sufficient to pull most lower liner bore insert rings. If more pulling force is required for an especially tight insert, increase the pump input pressure only enough to obtain the force required to pull this insert. Promptly return the pump input pressure to 60 psi upon removal of the tight insert. The lower liner insert tool is capable of approximately 17½ tons of pulling force at 100 psi pump input and 4600 psi hydraulic pressure, although this much force should rarely, if ever, be required to pull a bad-order insert. It is recommended that on a particularly tight insert the pump

input pressure be increased only enough to pull this particular insert, and then re-adjusted to 60 psi.

7. Being sure that all four puller pawls are engaged, push the "PULL" control button to pull the bad-order insert. Continue up only far enough so that the new insert may be placed in position on the lower liner bore. At this time do not remove bad-order insert from push/pull block.
  8. Entering through an adjacent air box opening place the new insert squarely on the lower liner bore. At this time, check the four spring loaded push pawls for full engagement inside the air box.
  9. Being sure that all four push pawls are engaged, push the "PRESS" control button to press the new insert into position.
- NOTE: The force is being transmitted to the new insert by the bad-order insert which remains in place on the push/pull block throughout this operation.
10. Noting that the new insert has been pressed to the proper depth, push the "PULL" control button to retract the push/pull block with the bad-order insert, to the full up position.
  11. In the full up position the bad-order insert will fall free from the puller pawls and the push pawls will disengage inside the air box.

12. Remove the bad insert thru an adjacent air box opening and discard. At this time check the four push pawls to assure full disengagement inside the air box.

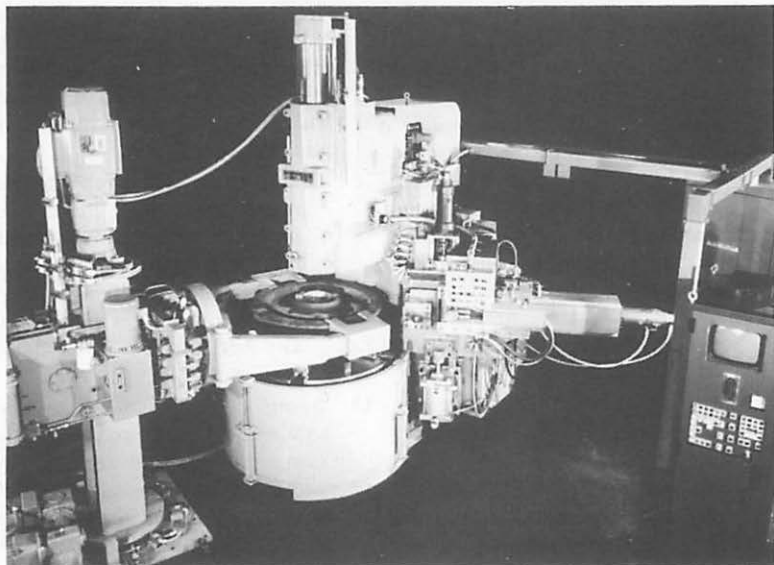
CAUTION: Attempts to remove lower liner insert tool from cylinder bore without full disengagement of push pawls may result in damage to the lower liner insert tool and/or, the engine being serviced.

13. Being sure that all four push pawls are disengaged, raise the lower liner insert tool out of the cylinder bore via the lifting shackle. Puller is then ready to move to the next bore.

#### C. Sweeney Model 221 and 221-1 Torque Multiplier Set

The torque multiplier set is designed to be used for torquing cylinder head crab nuts on EMD engines. The set is available in two configurations, Model 221 for manually applied input torque and Model 221-1 for pneumatic application of input torque.

The production 221 set contains the Sweeney Model 393 Torque Multiplier which at 18 lbs. is an extremely compact design capable of producing 3,200 ft-lbs of output torque. With a power ratio of 18.1:1, input of 133 ft-lbs is required to produce 2,400 ft-lbs of torque on the cylinder head crab nut. The design allows for continuous rotation of the input end in either the clockwise or counter-clockwise direction, enabling the



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- Automatic 4-position turret for hub facing and turning.
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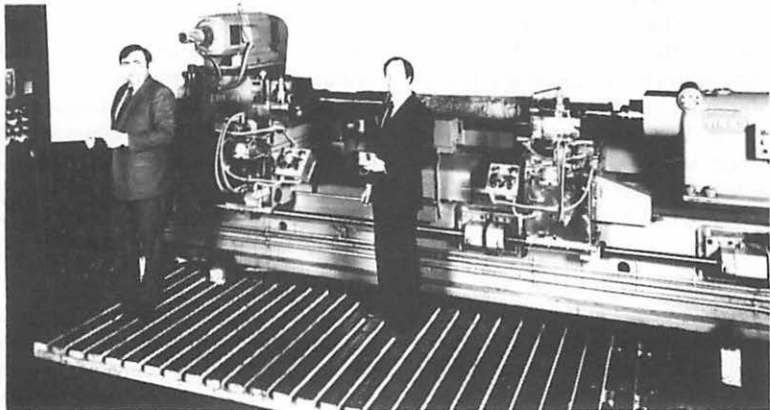
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mechanic to take a larger "bite" when applying input torque. An anti-backlash mechanism prevents gear train wind-up from feeding back through the multiplier to the operator's hands and causing a potential safety hazard.

The Model 393 Torque Multiplier is equipped with a shearable output drive which is designed to fail at 3 to 8 percent over the multiplier's maximum output capacity, thus preventing costly damage to the internal gear stages of the tool. The inexpensive output drive is easily replaceable and for convenience a spare is supplied with each torque multiplier set.

The Model 221-1 Pneumatic Drive Torque Multiplier Set is available for those torquing applications where speed and maximum operator ease are desirable. The Model 221-1 Set includes an air control kit enabling the mechanic to apply specific torques to the fastener by presetting the input air pressure. Input air pressure to output torque charts are supplied with the set. One of the unique features of the Model 221-1 is the ability quickly to dismount the air motor and use the multiplier manually in the event of a failure of the air source. This feature also enables the mechanic to manually verify applied torque with a torque wrench.

Accurate application of high torque values is important if a locomotive is to be properly maintained. Certainly accurate torque is critical if the margin of safety

designed into the various systems of a locomotive is to be maintained. The 393 Torque Multiplier is configured to be as "universal" as possible, enabling it to fit applications such as fuel tank bolts, generator hold down bolts, traction motor fasteners, wheel bearing retainer nuts, etc. The torque reaction handle of the 393 eliminates the requirement for an individual anchor to fit each application.

#### D. Wahl Heat Spy Telematic Infrared Thermometer

The Wahl Heat Spy Telematic Infrared Thermometer is intended to perform non-contact surface temperature measurements (measuring temperature above ambient) on remotely located electrical and mechanical apparatus. The instrument responds to the infrared energy radiated from the object. Using a sophisticated electro-optical system to achieve high sensitivity and resolution, the instrument detects and measures differences as small as 1°C, for target sizes as small as 1.6 inches in diameter at a distance of 40 feet. Accurate measurements can be accomplished on targets from 0 to 300 feet away without being affected by ambient air or background conditions. The instrument does not depend on external sources of illumination or radiation, and will not be affected by sunlight.

The Telematic's unique "temperature rise above ambient" or temperature difference concept allows for a wide variety of utility and

industrial applications in the areas of test, inspection and maintenance.

Typical electrical utility applications include inspection of connections, switches, circuit breakers, fuse disconnects, insulators, and other types of electrical apparatus where excessive temperature rise above ambient is a critical parameter in determining potential failures. It may also be used to compare the temperature differences between side by side connections operating under the same load to determine if one is hotter than the other and, therefore, in need of service.

General industrial applications include inspection of steam traps, heat exchanges, petroleum cracking towers and chemical reactors, manifold systems and for general plant maintenance on electrical machinery and apparatus.

The general operation technique for utility work or other outdoor targets is as follows:

With the function switch "ON", aim the instrument at an ambient target in close proximity to the area of interest to obtain a comparable reference temperature.

Squeeze the trigger switch and hold. The instrument will now register zero on the scale and all other targets will be compared to this reference value. Now scan the area of interest for hot spots by sighting through the telescope.

The instrument will continue to measure and indicate the radiation from all objects within its field of view. If the objects are the same as the reference, no rise in the

meter will occur. If there is a hot spot, the meter will move up-scale and register the temperature difference above the original reference source. Likewise, the meter pointer will move down-scale when aimed at targets colder than the reference.

To lock the peak temperature reading on the meter, depress the forward trigger switch while scanning the target area. The instrument may be removed from the target and the temperature read precisely.

Also, when measuring electrical apparatus on a high line, the wind factor or chill factor can change that local ambient compared to the ambient temperature on the ground. For these cases the "above ambient" temperature measurement concept is particularly advantageous.

For measuring differential temperatures on industrial apparatus, the same general method is used. Instead of using the local ambient as a reference, the first reading (in the auto-zero mode) is sighted in on one of the critical target points. For example, in checking or inspecting a steam trap, the outlet port is first sighted in, in the auto-zero mode. The trigger is pulled to scan and the inlet port is then sighted in. The instrument will now indicate the differential temperature between inlet and outlet ports. This AT measurement is a critical parameter in determining the efficiency of a steam trap operation.

## 2. REBUILD LINE FOR TURBOCHARGERS

### Tools for EMD Turbocharger Repair

Recently parts for the repair of EMD turbochargers have been made available to the railroads by EMD as well as Hunt Spiller, and Arrowsmith Companies. The mystery of the interior of the turbocharger is being explored by railroad mechanics and many are in the process of tooling up to repair their own turbochargers.

EMD has made available Maintenance Instruction No. 275 revision B, which outlines the repair procedure and a repair shop layout as well as the necessary tools to accomplish the repair.

The following illustrations show the basic tools.

#### A Suggested Shop Layout for Complete Turbocharger Repair By EMD

Most railroads will probably have some of this equipment in shop that can be utilized for turbocharger repair.

#### A Trunnion for Disassembly And Assembly of the Turbocharger

It is an advantage to be able to turn the complete turbocharger to a vertical or horizontal position for ease in assembly or stripping. The trunnion has a gear reduction unit with a hand wheel that will easily turn the turbo to any position and lock it in place.

#### Gear Section Stand

This stand supports the gear section for removal and application

of the idler gear and the planet gears. The gear section can be overhauled on this fixture.

#### Compressor Section Lifter

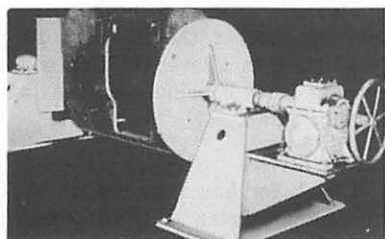
This is a three-point lifter that fastens to the compressor bearing support lifting pads. The swivel leg fastens to the air duct flange and is tightened with the hand wheel. The lifting eye is on an adjustable slide for equalizing the weight to the center of balance for level position of the compressor section when assembling the turbocharger.

#### Compressor Section Stand

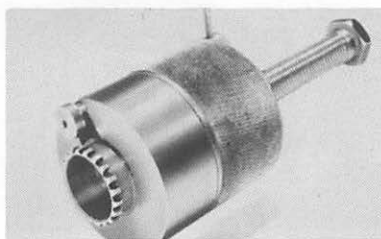
This stand supports the compressor section and has a spring loaded thrust plate and center bore to support the turbine wheel in proper position for aligning with the compressor section when it is lowered onto the turbine wheel. A protection sleeve is placed over the spline shaft when the two parts are assembled.

In addition to the tools we have illustrated there are various tools for use with the arbor press to remove various bearings and pins, jigs for positioning when machining, alignment jigs centering the sections when drilling dowel holes, and various lifting devices for handling smaller parts of the main sections of the turbocharger.

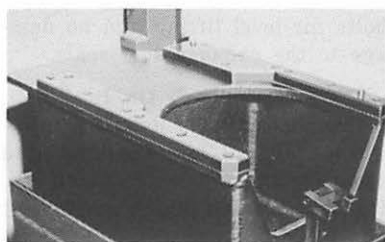
Most of these tools will be in-shop designs by the railroad shops to fit the needs of the machines they will be using to do these jobs. EMD Maintenance Instruction 275 Revision B is a good



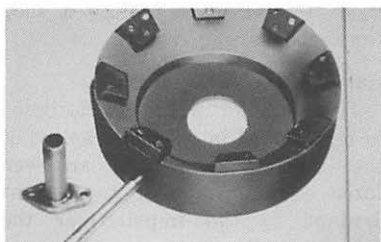
**Trunnion**



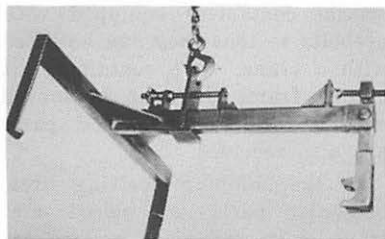
**Impeller Puller**



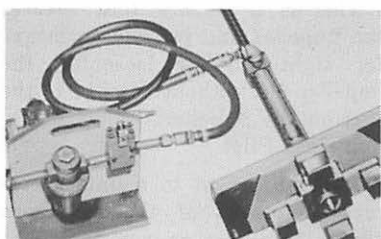
**Gear Section Stand**



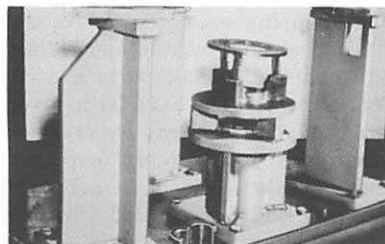
**Impeller Protector**



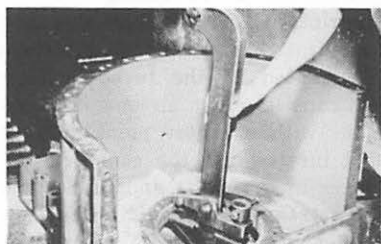
**Compressor Section Lifter**



**Sun Gear Pilot**



**Compressor Section Stand**



**Main Housing Lifter**



**Turbo Lifter**

guide to use when tooling a shop for turbocharger repair.

#### **Impeller Puller**

The impeller puller is designed to be inserted in the inner spline of the impeller and exerts an even force on the impeller to prevent damage to the impeller or the splined shaft.

#### **Impeller Protector**

This is a fixture that secures the impeller and provides a means for tightening or loosening the impeller nut without damage to the fins on the impeller.

#### **Sun Gear Pilot**

It is important to maintain correct alignment of the sun gear when installing or removing the compressor section of the turbocharger to avoid damage to the labyrinth seals, the bearings and bearing seal surfaces. This fixture is mounted on the turbo housing and consists of an air operated cylinder with a center point plunger that inserts into the counter sunk center in the shaft and guides the compressor section and shaft in a center aligned position when lowered to the housing.

#### **Main Housing Lifter**

This lifter centers in the center bearing bore of the main housing and lifts it in a level position when placing the housing on the assembly stand.

#### **Turbo Lifter**

This lifter has four chains with hooks that fasten to the mounting pads in the main housing eyebolts and the short chains hook into the compression bearing support eyebolts for level lifting and no damage to the exhaust duct seals.

### **3. Locomotive Air Brake Component Parts Repair Room**

One railroad has constructed a room for the repair of 26L, 24RL, H6, and K14 air brake component parts for approximately 1,450 locomotives.

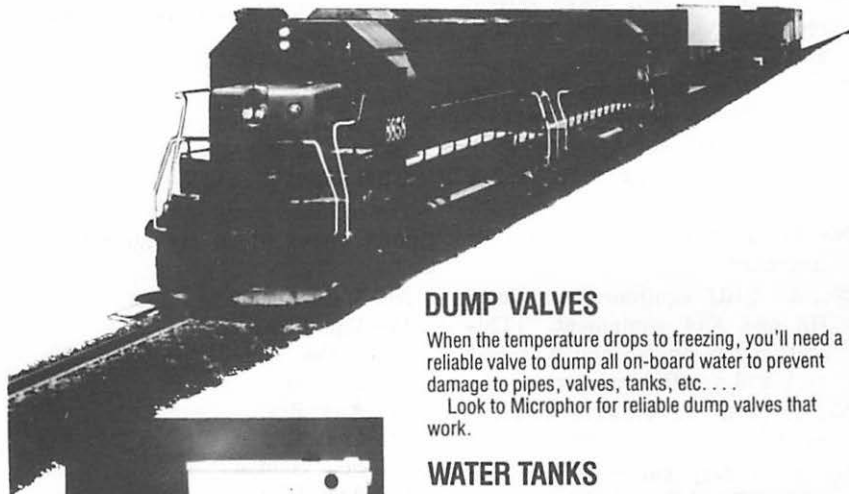
Sets of equipment are received in special containers equipped with eyebolts so that they can be lifted with a crane. Two containers fit onto a frame that can be moved with a forklift. Individual parts are also received.

In the shipping-receiving area, bad-order parts are placed onto trays on a motorized roller conveyor which carries them through a spray-wash machine and on to the stripping area. Parts are disassembled and gaskets and o-rings are removed. Small parts are put into a perforated box; large parts are put onto a tray; and other parts are put into an expanded metal basket. Each basket with its tray and box is placed onto a motorized roller conveyor which carries it through a spray-wash

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and spray-rinse machine. When a basket is placed onto the conveyor, the appropriate button on the work station selector panel is pressed. The basket is automatically guided to its assigned work station by limit switches controlled by a microprocessor.

Parts are repaired, gasketed and assembled at the following work stations:

- No. 1: Vent valves; A-1 charging valves and quick release portions.
- No. 2: Independent brake valves; reducing valves, split portions and suppression valves.
- No. 3: Windshield wiper motors; automatic blow-down valves, sander relays and horn relays.
- No. 4: Control valves and P-2-A application valves.
- No. 5: J. relay valves and flow indicators.
- No. 6: 24RL equipment and some H6 and K14 equipment. (This station has an H6 and K14 test rack and a 24RL test rack).
- No. 7: 26L automatic brake valves.
- No. 8: Safety valves; gages and some H6 and K14 equipment.

Repaired parts travel by motorized roller conveyor to the shipping-receiving area. Empty baskets are returned by motorized roller conveyor to the stripping area.

26L equipment is taken off the outbound conveyor and placed onto a microprocessor-controlled test rack. Each piece is held in place with quick disconnect lugs. The rack is capable of testing a com-

plete set of equipment or individual pieces. By pushing one button, a series of tests is performed. After completion of the tests, a green light indicates the part is satisfactory or a red light indicates the part has failed. The control panel contains a start button, a stop button, a green light and a red light for a complete system test and for each of the following parts:

- Control Valve
- Brake Valve
- J-1.6—16 Valve; J-1.14—14 Valve
- J-46 Valve
- J-64 Valve
- P-2-A Valve
- A-1 Charge Valve
- H-5-A Valve
- HB-5 Valve

The control panel also contains twenty gages which are identified as follows:

- 30—Main Res.
- 15—Equal Res.
- 1—Brake Pipe
- 20—Ind. App.
- 5—Aux. Res.
- 9—Control Res.
- 7—Sel. Volume
- 16—App. Pipe
- 30—Brake Cyl. 1
- 30—Brake Cyl. 2
- 16A—App. Pipe
- 10—App. Pipe
- 25—P. C. SW.
- 26—Suppression
- 41—Suppression
- 53—B. P. Cut-Off
- 35—P. C. Emerg.
- 12—Emerg. Reset
- H-5-A
- HB-5

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In the shipping-receiving area, sets of equipment are placed into storage bins. As they are needed, frames with two containers or individual parts are delivered to locomotives within the shop or shipped to other points on the railroad.

#### 4. Robots for Railroad Shops

Robots in industry are growing at a fast pace. According to one authority quoted in a recent Wall Street Journal article, 4370 robots were in use in the United States at the end of 1980. By the end of 1981, the total was expected to be 5639, or growth for that year at the rate of 29%.

An analyst at the Bache, Halsey, Stuart, Shields investment and brokerage house projects a trend line near 40% compounded annual growth rate by 1990.

Coming down to specific companies, General Electric—the whole company—had ten robots in service in 1977, a number that grew to 145 units by the end of 1981. It's Transportation Operation didn't have any in 1977, but installed nearly two dozen in the same period of time.

Clearly, this fast growth rate can't go unobserved by the railroad industry. Is there a place for robots in railroad shops? If so, what is that place? What is the starting point? What are the expected returns?


In trying to answer those questions, let us first consider just what kind of a machine is being talked about. A somewhat abstruse definition of a robot is a "Multi-


function, reprogrammable, multi-materials handler." A much less charitable and less sophisticated definition is "a one-armed blind idiot." In plain English, a robot is a machine that can do many different jobs, can handle a variety of materials, and whose program or instructions can be altered according to the job one wants done.

In any event, robots don't look like the mechanical men of science fiction. If one resembles anything, it might be a fire hydrant with telescoping arms.

Production Engineering magazine, in an article published in January, 1982, gave a helpful set of robot classifications by type of control:


- \* Manual manipulator—a manipulator directly operated by man. No built-in program is involved.
- \* Sequence robot—working steps of the manipulator occur sequentially in compliance with a preset procedure, conditions, and positions. In a fixed sequence robot, the preset information cannot be easily changed; in a variable sequence robot, the information can be easily changed.
- \* Playback robot—a manipulator which memorizes a working procedure taught by a man operating the robot and which can then continuously repeat the procedure. This is sometimes referred to as an apprentice robot.
- \* Numerically controlled robot—a manipulator which can execute commands received as numerically loaded working information.




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\* Intelligent robot—a manipulator which can decide its own behavior through sensing and recognizing abilities.

Robots are also classified by size—considering both the weight of parts to be handled and the radius of working space. Some giant robots can handle more than a ton, and have a reach in excess of 30 feet. At the other end of the scale, a micro-robot handles up to a quarter-pound and moves it just a few inches.

Considering this range of controls and sizes, what might be the place for robots in railroad shops? Reference to General Electric's Transportation Operation experience is appropriate, since it handles the same sort of components, worked to similar tolerances, and using many of the same processes as do railroad shops.

For example, one application at G. E. uses a manual manipulator to move heavy shafts.

Another of the early applications was use of a Shin-Meiwa robot to weld traction motor gear cases. Quite soon, it was learned that parts dimensional accuracy (mostly burned-out) had to improve from 1/4-inch tolerance to 1/16-inch tolerance or better. The robot could not compensate, as could the human welder. In the end, however, the welds were more uniform, and the gear cases had less warpage.

Bottom line results—a second robot welder (also Shin-Meiwa) was added. Now two robots with four operators on two shifts

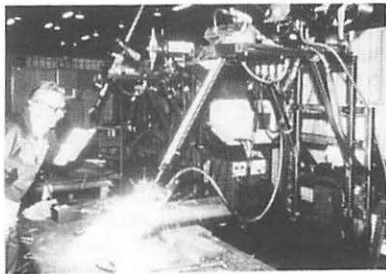
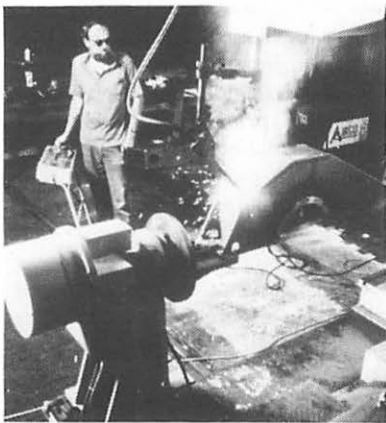
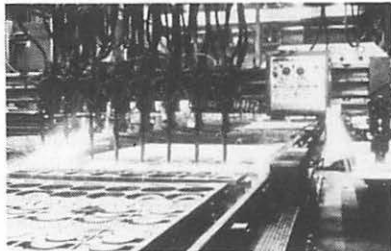
achieve higher production rates with no more floor space.

Other applications include welding of underframe bolsters, moving cylinder liners in and out of matching stations, moving commutator caps and shells in and out of similar machining stations, and feeding punch presses.

As mentioned earlier, these include almost two dozen robots, made up of Cincinnati Milacron T-3 units, Unimation 4005G, Shin-Meiwa TW150A, and Auto-Place Series 50 robots. A few of these are used as "apprentice robots" and for development work. Allied supporting equipment includes NC variable-tool punch presses and highly precise gas burners.

The earlier reference to robots being blind was not strictly true. Several of the robots in Erie feeding 500-ton punch presses include as peripheral equipment a visual sensor to observe the "face" of scrap coming out. It makes sure that all is present—none left behind. This feature is intended to prevent a double-stack which could very well damage the punch and die.

Robots may have better vision, even pretty good vision, in three years or so. Cincinnati Milacron is also developing a program and equipment that is more tolerant of misplaced components. That program will compensate for mislocation of the subassembly and welding fixture, for instance, but not for an increased gap between pieces.



In that respect, associated equipment is important to a successful robot application and also represents substantial costs. Sensing devices, locating devices, and parts positioning devices are all necessary. And, in most cases, the user knows more about the end result to be accomplished than does the equipment supplier. No substitute exists for "integrated turnkey." That means that the owner, operator, or worker is even more responsible for the end result than the robot vendor.

With all these weighty considerations, speculations, and problems facing us, what is the final payoff? Why even consider robots?

- \* **Productivity:** An improvement from 25 to 300% or more can be anticipated, depending upon the application.
- \* **A capacity gain:** More parts can be produced in the same period.
- \* **Less scrap:** Because a robot does its job more uniformly—the same way every time—fewer rejects can be expected.
- \* **Space utilization:** All the above add up to a saving in floor space.

More parts can be produced per square foot per day.

What kind of attendants, workers, maintainers are needed? Generally speaking, the person tending the machine must be a skilled machinist, a journeyman welder, or qualified at whatever the machine is doing. He has to be at least as skilled as the machine, and therefore be able to recognize and correct for inadequate quality of work. General Electric generally pays at the same, or sometimes a slightly higher job rate, for the robot attendant as for doing the same work manually. The productivity gain is made through one attendant taking care of several robots.

GE at Erie is starting to look at painting applications for robots. In the beginning, at least, this won't be finish painting of locomotives. But painting of components, even large ones, and particularly the application of prime paint coats, is a very real possibility.

One railroad shop application of a robot has been documented for this committee. Here, a Cincinnati Milacron HT3 handles material to manufacture gondola car coupler carrier plates.

The robot swings to pick up a pre-cut piece of plate from a specially-constructed material holding rack. Its head first moves directly over the stack of material, then descends vertically until a limit switch on the outward end strikes a piece of material. The resulting

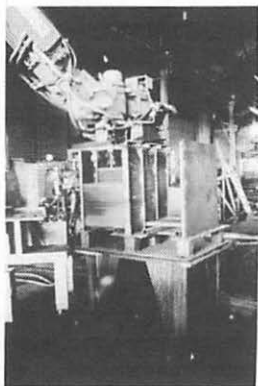
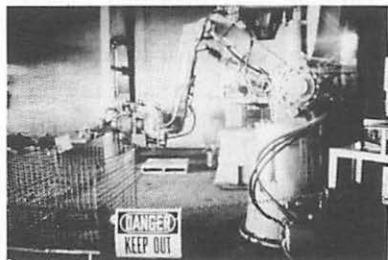
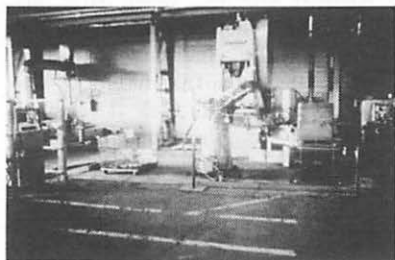
signal actuates a programmed subroutine to make the pickup, and also causes the arm to progress sequentially as each stock of material is used up.

Pieces are actually picked up by a 12-volt electromagnet. The magnet and its power supply were made especially for the railroad to use with the robot. Reverse magnetization on a pulsed basis makes it possible to both pick up and release small, lightweight parts.

First operation on the plate is performed in a 140-ton hole-punching press. A side and back gauging device provides positive part alignment and compensates for any variation in pick-up locations. The robot then guides the plate through the hole-punching sequence, controlling the entire operation.

After punching, a photocell and light at an inspection station checks that all the holes have been made. If any have been missed, the robot will abort to neutral position and actuate an amber warning light to notify the human attendant that something is wrong with the system.

A piece in which the holes are properly punched is next moved by the robot to the 250-ton press for bending. After setting it in place, the robot arm moves back out of the way, actuates the press then moves back to pick up the completed part. A fail-safe device senses a continuation of the press operating cycle, or double-tripping. Sensing of that condition will also abort the robot to neutral position and turn on the warning light.



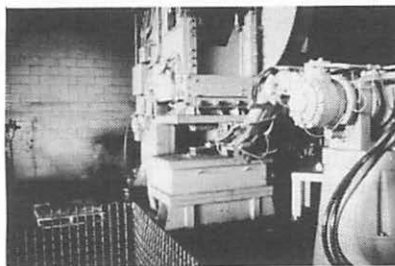
The completed part is again moved to the inspection station where, this time, the photocell verifies that the robot has indeed lifted it out of the press. Failure of the check stops the system and activates the light. If this check were not made, double-stacking of parts could result, which would damage the press.

Completed parts are then stacked into six evenly sorted piles on a skid, using an indexing sub-routine. The cycle will now repeat and continue to repeat until the supply of parts is exhausted.

Each cycle, including punching six holes, two inspections, and bending requires one minute, nineteen seconds.

While the installation just described is the only one operating at present, and is in a car shop, a number of possible locomotive shop applications for robots have been identified by the same railroad:

- \* Welding build-up on traction motor frames
- \* Moving motor frames in and out of positions in the rebuild line



- \* Turning over parts that require machining on both sides in a computer controlled turning center.
- \* Inserting and removing parts in a heat treating system
- \* Loading palletized heads into an assembly line conveyor
- \* Assembling valves in cylinder heads
- \* Loading pistons into and removing them from a sulfuric acid tank
- \* Welding gear cases after initial assembly
- \* Material handling in the sand-blast area
- \* Truck weld build-up on worn surfaces
- \* Building pallets, either wooden or welded steel.

GE manufacturing engineers speculate that welding applications in car construction should prove attractive. They also look toward car wheel-and-axle shops. Robotic development for handling wheels in a boring mill, for example, is very nearly here.

In passing, it should be noted that currently all GE Transportation Operation robots are working on only one part, and are not re-programmed from time to time, with the exception of one robot. That one is working on two different parts, although they are quite similar.

In closing, a useful set of guidelines has been developed:

- \* Keep it simple. When first applying a robot, try a simple but economically lucrative application. Many are fascinated by the technology and feel it applies only to complex tasks. Avoid failure that could dampen upper management enthusiasm.
- \* Implementation should start in hostile areas. Being where the work environment is unpleasant to the workers, such as forge, welding, and paint shops. An area that has a history of OSHA citations might be ideal.
- \* Consider applications where productivity is lagging. This is especially true on repetitive jobs that can be demeaning to the human spirit.
- \* Evaluate long term needs. Try to identify all possible applications from the start and minimize the number of suppliers. Unnecessary expense occurs if duplicate (but non-interchangeable) parts are purchased for different brands.
- \* Implementation cost will be inversely proportional to the cost of the robot. More flexible expensive robots have less precise requirements for the peripheral equipment. Those requirements can be taken care of by software. Less expensive robots are relatively inflexible. They are normally equipped with a fixed number of sequences that are not readily expandable.
- \* Assume Murphy's Law will prevail. If it can happen — it will. Take all precautions reasonable

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to assure success. Add sensors as necessary, to eliminate possible incidents. Estimate sensor necessity by the cost of possible damage without it, compared to the cost of the sensor equipment.

- \* Don't expect suppliers to furnish turnkey implementations. What you really want is integrated turnkey. Most robot systems are interfaced to something you know more about than the robot supplier. Don't pull against that supplier but expend the same effort as is required in a successful human marriage. Sixty percent effort on the part of each partner achieves a one hundred percent result.
- \* Don't forget people requirements. Robots consist of some type of electrical, electronic, mechanical, and hydraulic devices, all requiring maintenance by people. Those people must understand that they affect the accuracy as well as the overall function of the robot. Programmers must also understand that poor programming can jeopardize both equipment and humans.

Due to the non-repetitive nature of much of their work, locomotive shops have an unusual challenge in robotic applications. Concentrated effort will be required to achieve success.

### 5. Automated Machines

Automated machines have been used in other industries for a number of years, but only for a few

processes in the railroad industry until recently.

Probably the most common use of railroad automation was in the handling of equipment, particularly in wheel, air brake, and engine component areas, where there was sufficient volume to justify the expenditure and where the pieces were more nearly alike, making the automation simpler.

As reasonably priced machines with tape control became available, some railroads invested in "machining centers" where diesel engine heads or liners could be reworked, or for tape controlled lathes used for turning axles. Tape controlled machines were also purchased to punch holes in steel plates, angles, and channels at precise locations.

With the recent availability of programmable controllers at moderate prices, a whole new field of automation was opened up to the railroad shops. It was only natural that one of the main areas of concentration of this new avenue was the wheel shop, a semi-repetitive process that required many man-hours of skilled labor. Machining limits and surface finishes were already set, so the computer could be programmed accordingly. A production line was a natural—computers were set up to control a measuring station to measure the axle; a lathe to turn the axle; boring mills to bore the wheels and machine corresponding surfaces, such as the dust guard area; and mounting press to complete the

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process. Computer control was capable of maintaining quality work output with resultant labor savings—a necessity for the survival of the American railroad system.

With the acquisition of these modern tools, it was necessary to train personnel in their maintenance, particularly in the area of electronics. Some electrical employees of the railroads had studied certain aspects of electronics through correspondence courses, or had attended vocational technical schools, and in some cases, had taken specialized courses offered on college campuses. These employees who had advanced their knowledge of this field through personal endeavor were a natural to take the jobs the railroad offered in this field.

In addition, railroads interviewed and hired specialists who were already trained, mostly for non-agreement or appointed positions. These specialists then became the overseers for the installation, maintenance, and trouble shooting operations of the computerized machines.

On some railroads, industrial engineers worked on the computer programs and were then assigned to follow up trouble when it occurred on specific machines. In many cases, the industrial engineers had a college degree, an associate degree, or other advanced specialized training. On some railroads, Plant Engineering departments were expanded and addi-

tional engineers were hired to supervise the installation, maintenance, and repair of this specialized machinery.

With non-agreement people, the problem of displacement was eliminated. It was more logical to send these non-agreement people to the schools provided by the machine or computer manufacturers and know that the trainees would not be subject to displacement as is the case with agreement employees.

Voluntary classes were set up at the railroad training centers to teach interested agreement employees the basic techniques of computer technology, hydraulics, repair and maintenance of this new machinery. Positions were advertised that called for electronic skills and background, and higher rates or grades were set for these positions.

Because of the limited number of these specialized agreement positions and the fact that the constituents were paid the higher "A" rate, it was felt that more stringent qualifications could be required. Interviews were conducted with those applicants for the electronic positions before the position was awarded, to try to insure that the person bidding had the desired background and knowledge to develop the skills necessary to properly service and repair the computer controlled machinery. Employees who could not do the work either bid to other positions or were disqualified and replacements sought.

Normally when a machine was delivered, factory personnel came to supervise the installation, set up, and trouble-shooting necessary to turn the unit into a production machine. During this changeover period, the older machines which had been doing the work were kept in production to the extent necessary while the new machines were brought on line and up to full output. In some cases, the old machine had to be moved to a temporary location, so that the new machine could be installed in its proper place in a production line.

Machine and/or computer manufacturers provided lists of critical spare parts and these were acquired and kept on hand to insure continuous production. If a part was required that was not on hand, special handling was used to procure it quickly so that the machine could be returned to service. At times this might mean sending an employee to the factory or manufacturer's parts warehouse for the needed item, or picking it up at the airport or bus station to minimize downtime. Most of the equipment can be run in the manual mode, utilizing the computer to control the process steps that it is still capable of controlling and have an employee manually fill in to temporarily overcome the failed portion.

It was found that some of the cards or sections of circuit board from the computer controlled machines could be repaired in the diesel locomotive card repair facil-

ity. However, in many cases, the parts and/or tolerances were not similar and when substitutions were made, inaccuracy in the controlled machine resulted.

In general, it was found that computer controlled machines have a much higher output per day than manual machines, and this results in a much more critical situation when the machine is down. It may take the output of two or three manned machines to equal this output, and usually neither the machines nor the men are available to fill this vacuum. When the computer controlled machine is out of service, non-agreement and agreement employees usually work "round the clock" until the machine is capable of resuming production.

Proper maintenance is the key to keeping these critical machines working full time. Manufacturers provide suggested maintenance programs and time intervals. Coupled with a good record keeping system, these programs can be modified to suit the conditions encountered — replacement or service time lengthened or shortened as needed, modifications made to the machine to eliminate a poorly designed part, or program changes made to speed up or slow down cuts in particular areas to improve quality or increase quantity (output). It is important that the user know his machine and process.

Figure 1 shows a Cayuga welder used to automatically weld armature bearing bore and suspen-

sion bearing bores. A Texas Instrument 1053 Programmable Controller operates this automatic machine.

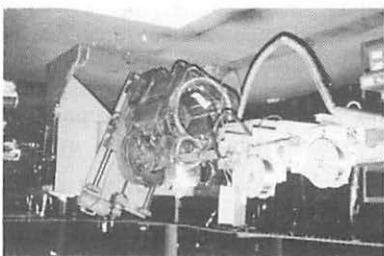
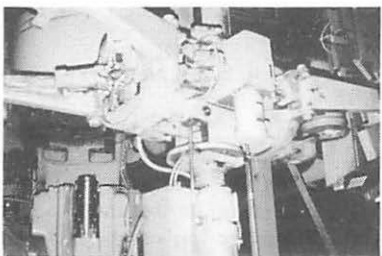
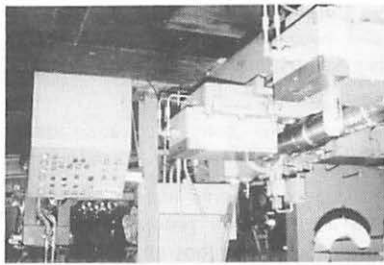
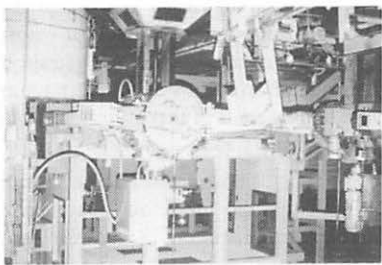
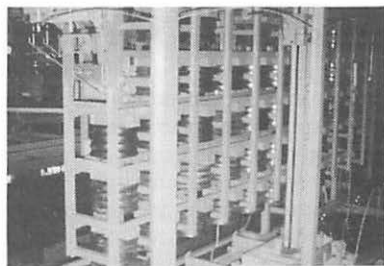
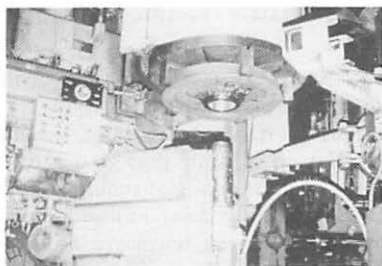
Figure 2 shows the Niles burnishing lathe, rebuilt and equipped with a Texas Instrument Programmable Controller for burnishing locomotive axle suspension bearing areas.

The next several figures show the wheel handling system. Handling begins outside with mounted wheel sets that are arriving from all parts of the Conrail system. When the wheel set arrives, an inspector measures all the required areas and feeds this information into the Modicon 1084 Inventory System. Each wheel set (once put in inventory) can be called for as needed with the details concerning just what work must be completed to restore the wheel set for further use. The handling system, controlled by a Modicon 384B, will deliver the wheel set to the necessary machines so that this work can be completed, restoring the wheel set to reuseable condition. Depending on what restoration is required, the wheel set goes to a wheel washer, tread lathe, mounted wheel journal turning and burnishing lathe; or if it must be demounted to the dismount press, the axle to the journal lathe, the burnishing lathe, magnaglo, and then to the axle measuring station where new wheels are programmed; and then to the mounting press.

Final handling is for outbound

loading to system points or for use in the locomotive shop.

Figure 3 shows the loose wheel handling system where wheels are held in stacks of four, each on a pallet. These pallets of 4 each loose wheels are stored in the Modicon 1084 Inventory System and are moved by the automated handling system controlled by a portion of the Modicon 384B system, previously mentioned. The pallet is "called for" as wheels are needed for feeding the two automated boring mills. The operator, or overseer of the system, pushes a button to select which one of the three wheel types is desired for boring, and four wheels on a pallet are delivered to the boring mill area. Here, a Cromeco computer, utilizing a "floppy disc," takes over controlling an axle measuring station, the loose wheel handling system that feeds the boring mills, and the two boring mills themselves. Two axles made ready for wheel mounting are fed through the measuring system, are measured automatically, and two wheels are fed (flange up) into each of the twin boring mills with side arms. The mills bore the wheel and face one side of the wheel hub area. The wheel handler removes wheel one, and puts in wheel two for axle two. In the meantime, wheel one is turned over and is inserted back into the boring mill (flange down) as soon as wheel two, side one, is completed and removed. Wheel one is finished and goes on to the mounting press to be pressed on the axle. Wheel two



goes into the boring mill where side two is completed, is taken out and goes on to the mounting press to be mounted on axle two. The computer now puts the boring mill to work on the first wheel of the next 4-wheel pallet.

#### 6. Traction Motor Gear Case Repair

Traction motor gear cases perform the important task of carrying gear lubricant for the traction motor pinion and axle bull gear. Although ruggedly built, the traction motor gear case falls prey to many circumstances which may lead to early replacement of the gear case or even to the entire motor wheel assembly.

Problems from over filling, under filling and leaking may cause and indeed have caused premature pinion/bull gear failures and traction motor pinion end bearing failures. If caught in time, the damage caused may be minimal, but if not, could be as severe as derailment of the locomotive. Obviously then, maintaining the integrity of the gear case is of prime importance.

Close attention must be paid to the fit of the gear case halves, as these dimensions are critical.

We will deal here with the removal, cleaning, inspection, repair and installation of traction motor gear cases as performed by one major railroad.

Traction motors arrive at the shop via special flat cars equipped to handle motor wheel assemblies.

Motors are unloaded via overhead crane directly onto the floor of the strip area. The motors are placed in an upright position and made ready for stripping.

With the traction motors in this position, fairly easy access to the Huck bolts may be had, and it is here that the first special gear case maintenance equipment is used, a hydraulic Huck collar cutter.

The business end is a small hydraulic cylinder. The cutter head is angled from the hydraulic cylinder to provide clearance while in operation. The tool is quite similar to a conventional nut splitter and functions in the same manner.

In operation, the tool is placed flush over the Huck collar to be cut.

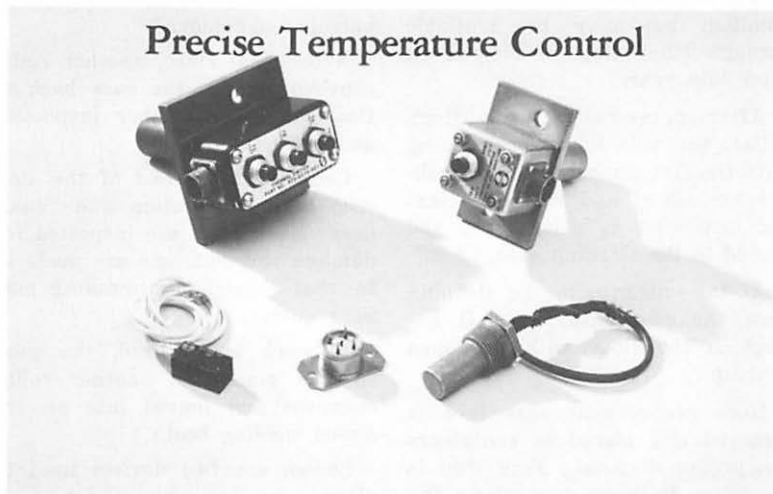
The cutter is positioned as far to the right as the gear case permits and a single cut is made.

The cutter is then positioned to the extreme left and a second cut is made.

The result of this operation is the easy removal of approximately one quarter of the Huck collar. The remaining portion can easily be spread with a hammer and drift punch and removed. The use of the cutter prevents damage to the flat washers and gear case halves, as sometimes happens if removed with a torch.

The Huck collar cutter Model 532 must be modified to the Model 532M to work successfully on traction motor gear cases. This modifi-

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cation is available only through Huck Manufacturing of Canada, Limited, but may be available through Huck Mfg. of New York later this year.

After removal of the Huck collar, the bolt is removed along with the flat washers. These washers are saved and re-used. Next the gear case is pried loose and moved to the cleaning area.

At the entrance to the cleaning area, the gear cases are left sitting on the floor with the open side up.

Here excess gear case lube is removed and placed in containers for proper disposal. This step is necessary in order to prolong the life of the cleaning solutions.

Next, the gear case halves are lifted onto a roller conveyor. This conveyor transports the case halves into an adjoining room where the final cleaning process begins.

Actual cleaning of the gear cases is done in a Proceco washer. The cases are fed into the washer on the roller conveyor with the open side down. As the gear case enters the Proceco, a chain conveyor begins to carry the case at a set speed. Inside the washer are three stages of wash and one rinse.

Heat is supplied by steam, with vapors being vented above, and cleaning provided by high-pressure water jets.

The same conveyor that carries the gear case through the washer also removes sludge as it

returns through the bottom of the washer tanks. Sludge is caught in barrels and removed.

After final rinse, another roller conveyor brings the case back to floor level for further inspection and processing.

Located at the end of the Proceco is an inspection and repair area. Here cases are inspected for damage and decisions are made as to what repairs or upgrading may be required.

If work is required, the gear case is placed on another roller conveyor and moved into an enclosed welding booth.

Shown are two devices used to align gear case gutter retainers. Again, the desire is to modify older gear cases to the most modern configuration.

The jig is placed in the parting line channels and automatically aligns with the seal channels to orient the gutter retainer for welding. It is important that gear case parting line channels and seal channels maintain proper alignment for a perfect fit.

This device is used to check the upper half of the gear case.

An easy slip fit indicates proper alignment.

Also, proper seal channel alignment can be checked easily.

A similar fixture is used for checking alignment of the bottom half with the difference that the jig is placed on the gear case rather than the gear case on the jig.

# MAINTENANCE EQUIPMENT FOR LOCOMOTIVES

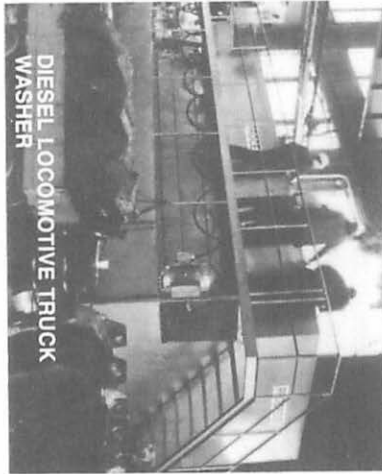
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The tool is used in the same way, requiring an easy slip fit to ensure proper alignment.

If for any reason the fixture does not easily slide into place, the fixture is removed and corrective measures taken.

After upgrading and alignment checks have been made, the felt seals and cotton cording are applied.

The cases are now returned to the build-up area and are ready to be mounted. Mounting of the gear cases requires an extremely vibration-resistant system. This railroad is presently using a Huck fastening system. Shown is a Huck hydraulic fastening tool.

The huck fastening bolt is shown, with a rounded head and its breakaway portion. Also incorporated are two hardened flat washers and the Huck bolt retainer collar.

The hardened flat washers supply a larger clamp load surface to help ensure that no loosening occurs during operation.

One washer is applied to each side of the gear case mounting pads and when secured in place, appears as shown. The use of the Huck fastening system has virtually eliminated problems with loose gear case mounting bolts.

At this time other tools and fixtures are in the planning or building stage to enable us to build a better, more reliable gear case.

The next improvement will be the application of plastic gear case seal conversions as reported last

year by the Committee of New Developments.

## 7. Safety Related Items & Equipment

This section of our paper will cover personal protective equipment that may be appropriate for railroad employees.

The Williams-Steiger Occupational Safety and Health Act of 1970 attempted to promulgate as an occupational safety or health standard any National consensus standard and any established Federal standard which would tend to enhance the safety of the workman and the workplace.

The Occupational Safety and Health Act, better known as OSHA is a vast and complex network of laws, rules and regulations. We will attempt to cover some of the personal protective equipment whose use may be wholly or partially governed by this law.

The following are some of the areas covered under the Personal Protective Equipment section:

- Eye and face protection
- Respiratory protection
- Occupational head protection
- Occupational foot protection
- Electrical protective devices
- Occupational noise protection.

### A. Eye and Face Protection:

Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently avail-

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able a type of protector suitable for the work to be performed and employees shall use such protectors

The design, construction, testing and use of devices for eye and face protection shall be in accordance with American National Standard for Occupational and Educational Eye and Face Protection.

### **B. Respiratory Protection**

In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, gases, smokes, etc. the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures, such as local and general ventilation, substitution of less toxic materials, enclosure of the operation, etc.

When effective engineering controls are not feasible or while they are being instituted, appropriate respirators shall be used pursuant to the following requirements.

Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended.

The employer shall be responsible for the establishment and maintenance of a respiratory protective program which shall include certain basic guidelines outlined by OSHA.

Proper selection of respirators shall be made according to the

guidance of American National Standard Practices for Respiratory Protection.

Respiratory protection is no better than the respirator in use. Frequent random inspections shall be conducted by a qualified individual to assure that respirators are properly selected, used, cleaned, and maintained.

The respiratory program shall make provisions for the proper care and maintenance of the respirators. This will include inspection for defects, cleaning and disinfecting, repair and storage.

The equipment shall be properly maintained to retain its original effectiveness.

### **C. Occupational Head Protection**

Helmets for the protection of occupational workers from impact and penetration from falling and flying objects and from limited electric shock and burn shall meet the requirements and specifications established in American National Standard Safety Requirements for Industrial Head Protection.

Some industries have provided a lightweight helmet for their employees which does not meet these American National Standards and thus may not fulfill the intent of OSHA's provision under head protection.

### **D. Occupational Foot Protection**

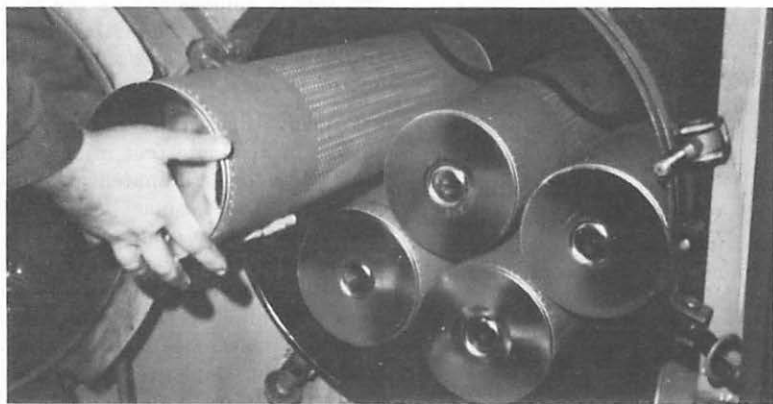
Employee Foot Protection is necessary whenever hazards of the job may be capable of causing injury or impairment to the employees' feet.

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#### **E. Electrical Protective Devices**

When certain electrical hazard conditions have been met, proper rubber protective equipment will be provided which shall conform to the appropriate American National Standard. Such items are covered as rubber matting for use around electrical apparatus and rubber insulating gloves. The gloves must be suitable for the hazard involved and be properly maintained and inspected per OSHA guidelines.

#### **F. Occupational Noise Exposure**

When the sound levels in the work environment exceed the prescribed limit outlined by OSHA, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce the sound to the required limits, personal protective equipment will then be provided and used to ensure that the sound levels are controlled sufficiently for the employee.

Under certain conditions the employer shall administer a continuing, effective hearing conservation program as outlined in detail by OSHA.

Some employees have felt that the requirements for personal protective equipment under OSHA have been excessive; however, our railroad definitely feels proper use of this equipment will reduce personal injury.

In 1969, we started a vigorous safety program which began with mandatory safety hat use in certain areas, mandatory eye protection which includes the use of side shields and goggles under certain conditions, safety shoes which the company partially subsidizes. Most recently we have embarked on a complete respirator program.

We feel as that these programs pay dividends in employee safety and this is emphasized by the fact that we have won the distinguished Harriman Award for safety seven out of the last ten years.

We have drastically reduced incidents of head and foot injury and have virtually eliminated eye injuries. At times, some people felt that opposition to some of the programs might have outweighed the benefits. However, after much work with all concerned, safety has become a way of life on our railroad and the employees as well as the company are reaping the benefits.

**SHOP EQUIPMENT****Five-Year Index**

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6. Supply/Service Facilities
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  - b. Traction Motor Basics — Southern
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1978

**New Facets and New Concepts — Problem Solvers in Shop Equipment**

1. Updating
  - a. Fuel Facilities
  - b. Fastner Systems
  - c. Gear Grinding
  - d. Rerailing Equipment for Locomotives
2. New Facets in Locomotive Painting Facilities
3. More Managed Maintenance for Machinery
4. New concepts in Cleaning Traction Motors
5. Radio-Control Cranes
6. Tool Control

1977

**A Better Way — Work Smarter Not Harder**

1. Power Assembly Changeout
2. Power Wrenches in Use
3. Wheel Truing Machines
4. Metrics and the Effect on Machinery
5. More New Developments in Shop Equipment
  - a. Engine Barring-Over Devices
  - b. Magnetic Base Drill Press
  - c. Bolt on Stub Shaft
  - d. Hydraulic Draft Gear Carriage
6. Managed Maintenance for Machinery

**COMMITTEE ON FUEL AND LUBRICANTS**  
**PRE-CONVENTION PRESENTATION, KANSAS CITY**  
**GOLD BUFFET RESTAURANT, APRIL 13, 1982**

Railroaders and supplymen were pleased to be hosts to the Locomotive Maintenance Officers Association Committee on Fuel and Lubricants for their Pre-convention presentation at Kansas City on April 13, 1982.

A large turnout was had, which was made possible through the efforts of Mr. J. G. Carr, Supt. of Shops, Santa Fe Railway, Kansas City, Kansas, and his associates.

Anyone interested in forming a diesel club in the Kansas City area and possibly the Omaha area should write to Mr. Carr expressing their comments.

# Tuesday, September 21, 1982

2:00 P.M.

## REPORT OF THE COMMITTEE ON FUEL AND LUBRICANTS

Pre-Convention  
Presentation:  
Santa Fe Railway  
Kansas City, MO



April 13, 1982  
Gold Buffet  
Kansas City

**DONALD D. HUDGENS, Chairman**  
Manager-Field Laboratories  
Union Pacific Railroad Co.  
North Platte, NE 69101

### VICE CHAIRMAN

W. C. Hamilton, Assistant Engineer of Tests, Family Lines Rail System, Louisville, KY 40232

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### 1982 TOPIC:

"QUALITY MAINTENANCE THRU FUEL AND LUBRICANTS"

## PERSONAL HISTORY

### DONALD D. HUDGENS

Donald Hudgens was born February 23, 1940 in Omaha, Nebraska. He attended public schools in Omaha, graduating from high school in 1958. He attended the University of Omaha and received his BA in Chemistry in 1962.

Upon graduation he worked as an analyst for the Food and Drug Administration in Kansas City before returning to Omaha to accept a position as Junior Chemist with the Union Pacific Railroad in 1963. In 1965 he was promoted to Chemist and in 1970 to Lubrication Engineer and transferred to North Platte, Nebraska. In 1980 he was promoted to his current position as Manager of Field Laboratories.

He is married to the former Jackie Whitmore and they have one son and three daughters.

## I ENERGY CONSERVING LUBE OILS

Friction in an internal combustion engine can be reduced through selection of proper lubricants. The more friction is reduced, the more useful work is obtained per unit of fuel consumed. Since fuel is a major expense of the U.S. railroads, which consume four billion gallons per year, getting more useful work from this fuel is obviously a method of reducing operating costs. With this in mind, engine builders, oil suppliers, and railroads, are currently working toward this end with friction modi-

fier technologies and viscosity studies.

There are several types of friction modifiers for lubricating oils, such as the suspended-solid types including graphite and molybdenum disulfide, and oil-soluble types which include organic and organometallic compounds. Friction modifiers do their job in the boundary lubrication regime, i.e. when the oil film separating the two surfaces becomes so thin that surface irregularities come in contact with one another. High speed gasoline engines operate in this regime to a much greater extent than high or medium speed diesel engines and we would expect the most significant savings in these engines.

This can be shown as follows: Figure 1, taken from SAE paper No. 810317, shows the results of a 20-car test in which oil-soluble friction modifier technology was used in a SAE 10W-40 gasoline engine oil. A 4.2% fuel economy was attained compared to fuel consumed when using the SAE 10W-40, non-friction modified reference oil. Figure 2, taken from SAE paper 801349, shows the results of a test of the same friction modifier technology in four Ford trucks powered by Cummins Formula 290 diesel engines. Service was over-the-road at 55 mph with gross load of 60,000 pounds. Friction modified lubes B, S, R, and O showed a fuel economy advantage of  $3\% \pm 1\%$  over the best non-friction modified lubes Y, W, and L. Results are statistically significant at the 95% confidence level.

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the ten major North American railroads using Baird oil analysis spectrometers to detect wear.

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Experimental work has been done to apply this technology to oils used in the medium speed diesel locomotive engines. Figure 3 shows results of an oil company sponsored test at Southwest Research Institute. Fuel consumption when using a commercially available LMOA Generation 3 railroad engine oil was compared with fuel consumption using that same oil treated with the friction modifier in a laboratory two-cylinder EMD engine. The friction modified oil showed an advantage of  $1.1\% \pm 0.29\%$  at the 95% confidence level.

With the background of the SwRI test and assistance of a railroad company, a full scale railroad engine test was carried out with these same two lubricants. A locomotive with an EMD 645 E-3 engine was coupled to a load box. Fuel consumed and power produced were precisely measured at idle and throttle notches four, six, and eight. Data were analyzed using AAR approved methods. As shown on Figure 4, at idle the friction modified oil showed a fuel economy advantage of  $3.35\% \pm 0.69\%$  over the non-friction modified reference oil. Combining notches six and eight data an advantage of  $0.41\% \pm 0.2\%$  at 95% confidence level was shown.

The detailed procedures for conducting this test have been proposed for ASME paper later in 1982.

It is obvious that measuring fuel efficiency at these low levels is difficult and requires precise measurements and a large amount of

data to obtain statistically significant results. However, it appears that friction modifiers can be made to work in railroad engine oils and with further advances in this technology, fuel efficiency may be improved to a more significant level.

Viscosity is the resistance of flow of a liquid. Paradoxically, the lubricant introduced into an engine to reduce friction has within itself internal resistance requiring energy to overcome. By manipulating the viscosity of the lubricant, through base oil selection and viscosity index improvers, we can reduce internal resistance at lower temperatures while maintaining sufficient viscosity at higher temperatures to adequately lubricate the engine. This is what a multiviscosity or multigrade oil does. A multigrade oil exhibits the characteristics of a lighter oil at lower temperatures and a heavier oil at elevated temperatures. Tests have shown that through the use of a 20W-40 multigrade lubricant, compounded for locomotive engines, considerable fuel savings are feasible.

Fuel savings through the use of 20W-40 lubricants have been demonstrated in full size two-cycle locomotive engines. Engine durability testing in railroad field tests in the U. S. and Canada to date show no adverse effect in using multigrade lubricants in a two-cycle engine. Further durability testing in four-cycle engines is currently in progress on a major railroad.

Prior to initiation of full scale field tests, stationary tests on a mainline freight locomotive with

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a 16 - cylinder, 3000 - horsepower, turbocharged two-cycle engine were used to systematically study operating variables in fuel consumption.

The locomotive was installed at a western railroad load box test facility. Accurate fuel consumption and power output measurements were obtained by special instrumentation. Tests were run on a statistically designed basis with repeat runs to ensure the changes in fuel consumption were statistically significant. Data were obtained using a computerized data acquisition system. This system enabled rapid changes in operating conditions to be recorded. From the study, three factors showed significant influence on brake specific fuel consumption. They were:

1. Lubricant viscosity.
2. Coolant temperature.
3. Cooling fan power consumption.

By establishing the fuel savings at set throttle positions and then applying the savings to the various railroad duty cycles (i.e, switcher light, medium, and heavy duty services) predicted fuel savings of a locomotive in service were obtained.

Figure 5 summarizes the four railroad duty cycles, published by EMD. The percentage time in each throttle position is shown together with the percentage fuel typically used. These percentage figures were used in the locomotive fuel economy study.

Figure 6 shows the fuel savings obtained in throttle positions one,

four, and eight using an SAE 20W-40 lubricant. The figure also shows the estimated fuel savings of the railroad duty cycles obtained by applying throttle position fuel saving data (Figure 6) to the duty cycle (Figure 5).

Fuel savings demonstrated by the SAE 20W-40 lubricant versus the SAE 40 lubricant were shown to be 3% in the switcher duty cycles, 1.5% in the light-duty cycle, 1.2% in the medium duty cycle and 1% in the heavy duty cycle. Projecting these reductions in fuel consumption to overall railroad operations, the savings become significant.

A research study shows that increasing the coolant operating temperature by eliminating one cooling fan can result in additional fuel savings. As shown in Figure 7, up to 3% additional fuel savings are possible depending on duty cycle. This figure shows the combined advantage of reducing parasitic load and decreased viscosity because of higher coolant temperatures. It is not recommended that cooling fans arbitrarily be shut off, but if engine designs lead to operating at higher coolant temperatures, improvements in the oil oxidation and thermal stability properties may also be required.

In summary, since the two technologies presented here function in different operating regimes, we would logically assume any savings could be additive or at least complementary. This has been demonstrated in other studies to be the case with lubricants for high speed engines, but to date we are unaware



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of any comprehensive studies in medium speed diesel locomotive engines. However, savings for each technology individually have been proven and the friction modifier discussed here can be made avail-

able in at least one oil supplier's product. The multigrade lubricant field tests are currently under way, and upon successful completion this product should become available.

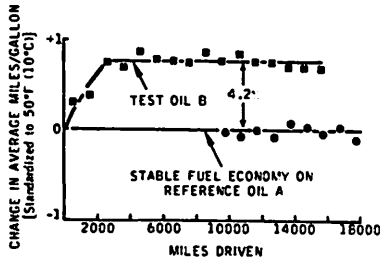
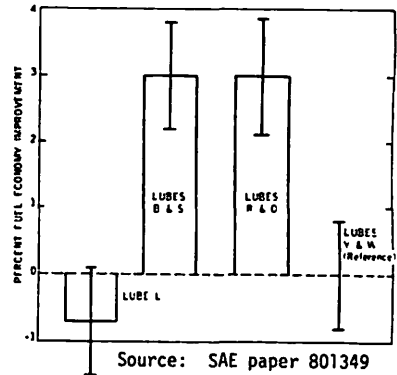


Figure 1 - Test Oil B Shows Fuel Economy Benefit.  
Source: SAE paper 810317

Fig. 1

Test Oil B Shows Fuel Economy Benefit  
Source: SAE paper 810317



Source: SAE paper 801349  
Fig. 2  
Controlled truck test data

LABORATORY TWO CYLINDER  
ENGINE TEST DATA - FUEL EFFICIENCY

ENGINE: EMD 2-567D MODEL  
CONDITIONS: SPEED =  $835 \pm 2$  RPM  
OUTPUT =  $209 \pm 4$  BHP

PHASE	LUBE	NO. OF REPLICATES	BRAKE SPECIFIC FUEL CONS.	
			LB/BHP·H	% $\Delta$
1	REFERENCE OIL	64	.4682	-
2	REFERENCE OIL PLUS OIL SOLUBLE FRICTION MODIFIER	52	.4630	$1.1 \pm .29$ (95% C.L.)

Fig. 3

COOPERATIVE TEST PROGRAM - FUEL ECONOMY LUBRICANT

- o FRICTION MODIFIED ENGINE OIL GIVES STATISTICALLY SIGNIFICANT BETTER ECONOMY IN THE EMD 645E-3 ENGINE THAN REFERENCE OIL.
- o THE MOST PROBABLE ADVANTAGES, FRICTION MODIFIED OIL OVER REFERENCE OIL.

<u>CONDITION</u>	<u>% ADVANTAGE</u>	<u>CONFIDENCE INTERVAL (95%)</u>
IDLE	3.35	± 0.69
THROTTLE #6 AND #8	0.41	± 0.2

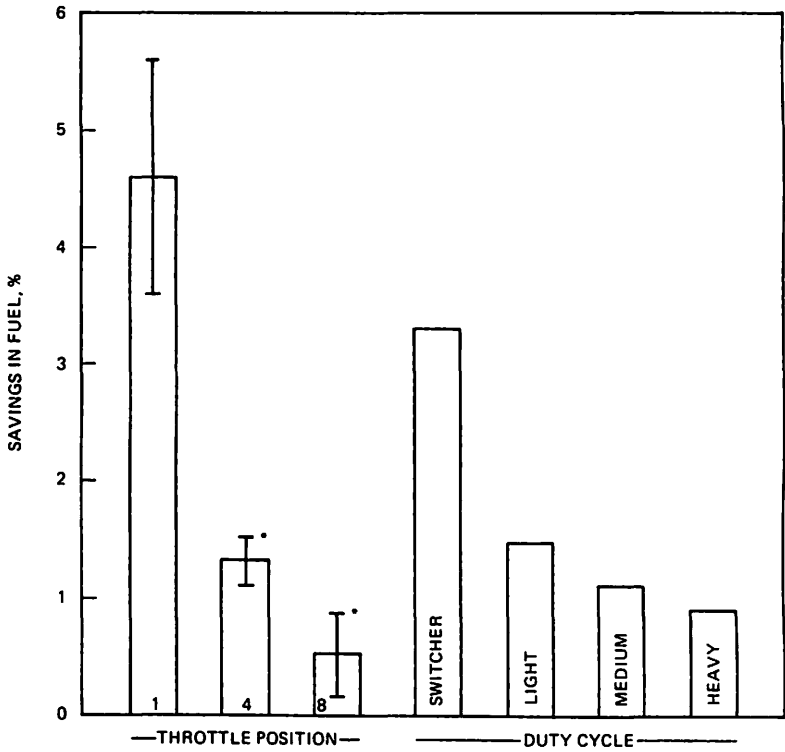
Fig. 4

EMD RAILROAD DUTY CYCLES  
(PERCENT OF TIME AND PERCENT OF FUEL)

THROTTLE POSITION	SWITCHER		LIGHT		MEDIUM		HEAVY	
	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL
8	1	13.3	9	46.8	17	57.3	30	75.3
7	0.5	5.3	3	12.4	4	10.7	3	6.0
6	0.5	4.3	3	10.1	4	8.7	3	4.9
5	1	5.8	3	6.7	4	5.8	3	3.3
4	2	7.7	3	4.5	4	3.9	3	2.2
3	4	11.5	3	3.4	4	2.9	3	1.6
2	7	13.3	3	2.2	4	1.9	3	1.1
1	7	6.7	3	1.0	4	1.0	3	0.5
IDLE	77	32.1	66	10.7	46	4.9	41	3.2
DYNAMIC BRAKE	0	0	4	2.0	9	2.9	8	1.9

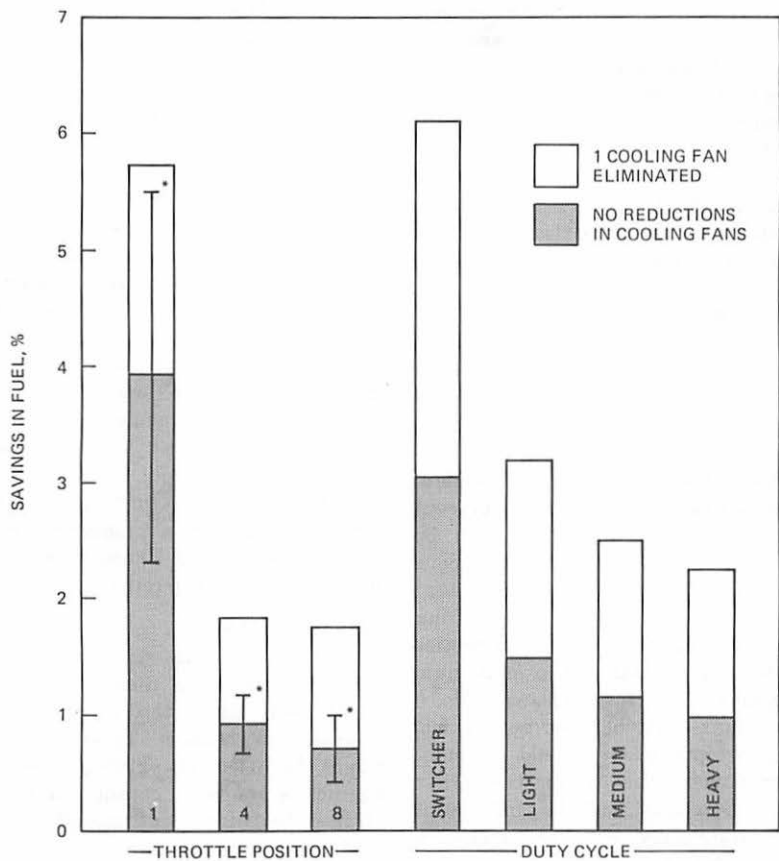
Fig. 5

FIGURE 6  
FUEL SAVINGS OF AN SAE 20W-40 COMPARED TO A  
MEDIUM VISCOSITY INDEX SAE 40



\* 95% CONFIDENCE INTERVAL

FIGURE 7  
TOTAL PREDICTED FUEL SAVINGS FOR A 13.9°C (25°F)  
INCREASE IN OPERATING TEMPERATURE



\* 95% CONFIDENCE INTERVAL

## II

## ALTERNATIVE FUELS UPDATE

In our 1980 and 1981 reports this committee discussed progress being made in the search for alternative fuels. It has been previously pointed out that there are two reasons to continue the search. These reasons are to increase supply and reduce cost. Over the past year work in this area has continued at Southwest Research Institute, individual railroads, oil companies and engine builders. This section of the report will provide some of the important insights gained in the past year.

## Viscosity

In last year's paper there was considerable discussion concerning one available less costly fuel possibility for the medium speed railroad diesel engine. This fuel consisted of a blend of No. 6 (residual containing) and No. 2 fuel (present type). Since No. 6 fuel can be as much as 280 times more viscous than No. 2 fuel, it is apparent that this will be one of the limiting physical-chemical blend properties that might define the maximum amount of the less expensive No. 6 fuel that could be used with existing equipment. It should be mentioned here that properties other than viscosity will be influenced simultaneously with the inclusion of significant quantities of the lesser quality No. 6 fuel. However, viscosity alone will play a role.

The most serious effect of increasing levels of viscosity is in

atomization and fuel-air mixing and thus combustion. Another significant concern is, of course, simply handling the product in cold weather. One of the investigations carried on by Southwest Research Institute in the 12-cylinder GE and 12-cylinder EMD engines was the viscosity effect. In order to factor out the effect of other properties which could influence burning characteristics, the Institute utilized lubricating oil stocks. Data presented in their progress report indicate that horsepower loss at low throttle positions (4) occurs at viscosities approximately three times that of present diesel fuel. However, full horsepower was obtained at much higher viscosities at higher loads. On the basis of combustion abnormalities the maximum viscosity tested would suggest the possibility of using fuels containing as much as 70% of the heaviest No. 6 fuel. It must be pointed out here that problems were encountered in pumping very high viscosity fuels. These problems included transfer pumps.

## Cetane Number

Another physical-chemical property of fuels for diesel engines which will limit the amount of unusual alternative fuels which might be used in existing diesel engines is known as cetane number. It must be pointed out immediately that fuel cetane number rarely changes independent of other properties. One of the investigations which has been carried out at Southwest Research Institute on the multi-cylinder GE and EMD

engines was cetane number limitation. There is usually a wide range of cetane number values over which diesel engines are insensitive. However, with a given design there will be a threshold limit (low) beyond which the engine simply will not operate or will not operate properly.

The diesel engine is an auto-ignition engine. That is, the initial fuel charge is ignited simply as a result of temperature achieved through compression. The amount of time between injection of the fuel and combustion (usually determined by an increased rate of pressure rise) is referred to as ignition delay. This ignition delay is inversely proportional to cetane number (Figure 8). If the cetane number is too low for a given engine's compression temperature, the engine will simply fail to start.

Many factors influence cetane number sensitivity. These include, but are not limited to, compression ratio, fuel droplet size and inlet air temperature. If the cetane number of a fuel is sufficiently high for ignition but too low for "proper" burning much more fuel is introduced into the cylinder before ignition occurs. This excessive fuel, once it ignites, can cause abnormally high rates of pressure rise which may be noticeable as "knock." Too long an ignition delay can also result in excessive levels of cylinder pressure being reached at the wrong time of the burning cycle. The abnormal pressure conditions which can result from improper cetane number have been

known to result in mechanical damage to engines.

The "cetane number" of a fuel is determined in a single cylinder laboratory engine which is equipped with a variable compression ratio combustion chamber which allows for control of ignition delay by either increasing or decreasing the compression ratio. The procedure for this test is covered by ASTM. Since many laboratories are not equipped with a single cylinder engine and because of the time consumed in the test, certain physical properties of the fuel are often used to estimate cetane number. The most common method used is the combination of gravity and 50% boiling point.

The latest Bureau of Mines survey of No. 2 diesel fuel used in transport trucks and locomotives shows that the cetane number averaged 45.7 with a range of 36 to 52.4. ASTM specification D975, to which most railroads purchase fuels, specifies a minimum cetane number of 40. The cetane number scale is determined by comparison with two pure chemicals. One of these is cetane having a rating of 100 and the other is heptamethylnonane having a rating of 15. Small, high-speed engines require relatively high cetane number fuels because of the short time interval available for start of combustion. Large, medium-speed engines are known to operate well on fuels having more moderate cetane number values. Last year we briefly discussed possible ways of obtaining a portion of the energy needs

by blending fuels having essentially zero cetane number.

### Southwest Cetane Work

The Southwest Research investigation was admittedly brief. Because of the ambient temperatures experienced at San Antonio the cold temperature starting tests were less successful than desired. However, those tests conducted on the 12-cylinder GE and EMD engines showed that they may be operated without "audible knock" at all throttle positions with fuels having a cetane number below 40. The actual limiting operating point with regard to cetane number is at lower throttle notches. Both engine builders list minimum cetane number requirements for their engines as they are currently designed. Since some of the alternative fuels often considered for use in railroad diesel engines have, of themselves, low cetane numbers this property can limit the amount of alternatives which might be used. Some of the fuels coming within this category are: the inclusion of No. 6, tar sands, alcohol (zero cetane number).

### Railroad Fuel Tests

At the time this report was developed (March 1982) three U. S. railroads had experimented with blends of No. 6 fuel and No. 2 fuel. One of these railroads experienced difficulty with compatibility of the particular No. 6 and No. 2 fuel which prevented the test from really getting off the ground. Another, Eastern railroad, conducted station-

ary fuel experiments with both General Electric and Electro-Motive locomotives. The third railroad operates in the West and has been conducting over-the-road tests in both builders' power in relatively cold climate since December 1981. While the testing at this time is admittedly rather preliminary, two very important points have emerged to date.

In the stationary tests, the fuel blend included approximately 10% of a known-to-be-compatible No. 6 fuel. The railroad noted that a significantly lower volume of fuel was required to generate rated horsepower. Assuming that the No. 6 fuel included in the blend will in fact burn properly, a lower volume of fuel should be used as a result of the higher energy content (BTU) per gallon of fuel.

The fuel used in the over-the-road test in mid-winter in the West exhibits a viscosity of 55 Saybolt seconds at 100° F. The viscosity of normal No. 2 diesel fuel is approximately 37 Saybolt seconds at 100. The calculated cetane value of the blended fuel is approximately 35 (compared to the minimum of 40) allowed by ASTM D975. No special provisions were made to handle this fuel. Both locomotives are equipped with the same fuel heating equipment that is standard for regular diesel fuel. This particular fuel blend consisted of 20% of heavy material.

It must be pointed out that many other properties of fuel are altered by the inclusion of residual material. Not least among these al-

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tered properties are sulfur content, vanadium content and carbon residue. All of these properties can effect the durability of the engines. Of course, many of the objectionable properties could be specified out of the blend. Thus, at this time, we are optimistic about being able to define less expensive alternative fuels for the railroad diesel engine.

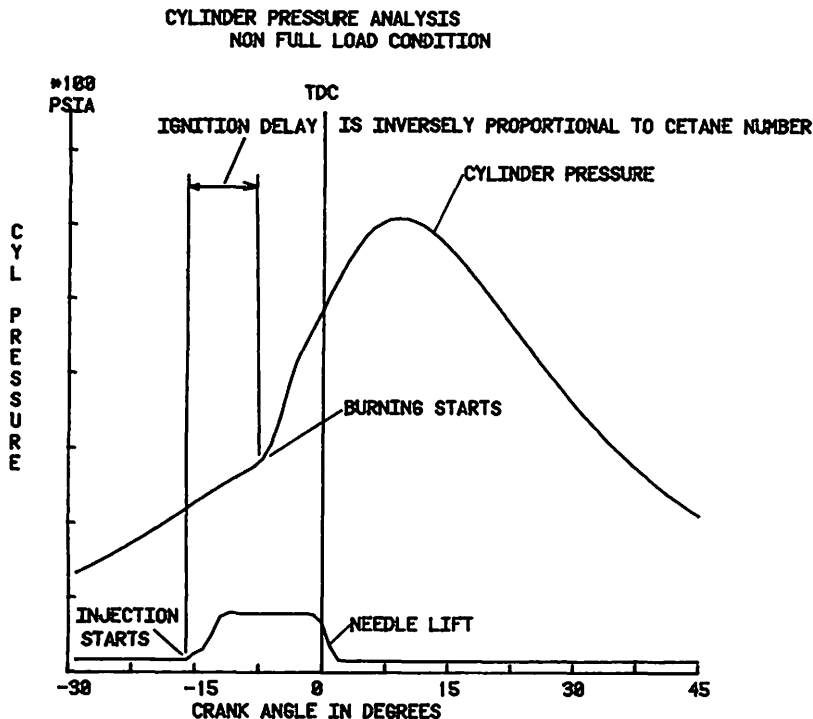
### No Free Lunch

The use of less restrictive fuel specifications, while being attractive from the viewpoint of fuel cost, could increase maintenance. At a minimum, close adherence to builders' recommended maintenance practices will be required. For example, increased sulfur content could cause increased power assembly wear. This possibility can be adequately dealt with by using Generation 4 lubricating oils and using care to maintain water jacket temperatures above critical points. Durability tests in one builder's laboratory over a duty cycle heavily weighted to full load, showed that the lubricating oil reserve alkalinity was consumed at a substantially more rapid rate with blended No. 6 and No. 2 fuels. However, this was the only oil deterioration property which accelerated under high load conditions. The No. 6 portion of the fuel blend, dependent upon the source of the crude oil, could contain significant quantities of the element vanadium. When this element is compounded with oxygen it can be severely corrosive to the metals used in valves and turbochargers at certain elevated temperatures. This poten-

tial problem can be alleviated by either specifying very low vanadium content or modification of the metallurgy in the valves and turbine buckets. Depending upon the refining methods used in developing fuels, materials known as "catalyst fines" may be present in the fuel. These materials, most commonly made up of silicon and aluminum, are normally extremely small in particle size and are known to cause abrasive wear in the fuel system and power assembly of engines. These materials have long been prohibited by the fuel specification of one of the engine builders. The No. 6 portion of the fuel blend is far more likely to contain water, wax and sludge compared to the normal No. 2 fuel. These materials can, of course, cause difficulties with filter plugging and/or fuel system component durability. While all of these items detract from the ease of using less expensive fuels, none present insurmountable problems. There are known methods for overcoming all of them. Engine builders are currently conducting tests to determine the best means of coping with these potential difficulties.

### Recommendations

1. Utilize the help of the petroleum industry to develop appropriate specifications for less costly blended fuels.
2. Purchase fuels to specification and already blended rather than purchase components for blending.
3. Seek advice of engine builders before using alternative fuels



### III AVAILABILITY OF MEDIUM AND HIGH VISCOSITY IXDEX RAILROAD OILS

Your committee reports that at the present time, the railroad industry is having no difficulty in securing sufficient quantities of medium VI diesel railroad engine oils to satisfy requirements.

This is because of the national and worldwide downturn in demand for all lubricants. The lower demand and development of alternate formulations released medium VI base stocks for use in railroad

oils. However, in the United States, several oil companies still believe the supply of medium VI oils will continue to diminish and will not meet demand when economic conditions return to normal.

In anticipation of the ultimate depletion of medium VI oil, field evaluations of both a 10 and 13 TBN high VI engine oil have been conducted. These tests indicate equal or better performance results compared with current medium VI lubricants. High VI oils were completely compatible with other system oils.

Field tests on high VI oils show them to give satisfactory service in both two and four cycle locomotive engines. Both engine builders have given their approval for use of these oils. At present, Canadian railroads have standardized on use of high VI oils in all locomotives.

#### IV

##### JOURNAL BOX OIL AND ANILINE POINT

When the revised Journal Box Oil M 963-79 specification for use in freight car journals was issued with changes in viscosity index and pour point, the lower pour point caused some suppliers to alter their formulation blends by using larger amounts of aromatic base oils to help meet the lower pour requirement. This affected aniline point of these oils.

Aniline point of an oil is the measure of the paraffinicity or aromaticity of an oil. It is the temperature at which equal volumes of lubricant and aniline become mutually soluble. High aniline point oils are paraffinic; low aniline point (temperature) products are aromatic. Low aniline point oils cause greater rubber swell than high aniline point oils.

The use of low aniline point oils in a freight car journal box has a positive affect on front and rear seals. It causes a small amount of swelling, giving better sealing ability and control of leakage.

A secondary use has developed for M 963-79 Journal Box Oil. This is with the EMD-Hyatt cylindrical roller bearing where a rubber

donut is used to cushion lateral loads. Low aniline point oils may cause the neoprene donuts to swell excessively and deteriorate prematurely. High aniline point oils do not cause excessive swelling of the donut.

EMD recommends that any railroad experiencing premature deterioration of the rubber donut due to swelling, consider using a journal box oil that has an aniline point of 200° F or higher.

#### V

##### TRACTION MOTOR GEAR LUBRICANT UPDATE— 1982

Activity in the traction motor gear lubricant area is at a high level. It now involves four groups: suppliers, engine builders, railroads, and associations. These groups have been brought together under the auspices of an AAR ad hoc committee to establish a traction motor gear lubricant specification.

The spur for this activity stems from the need to develop a pinion and gear lubricant and ultimately a specification that meets most, if not all, user requirements. In addition, test methods must be chosen which emphasize performance criteria of traction motor gear lubricants, and also include basic considerations of lubricant characteristics.

Because of the diversified approach to the development of a product, variations occur in both types and composition of the greases currently being offered. As

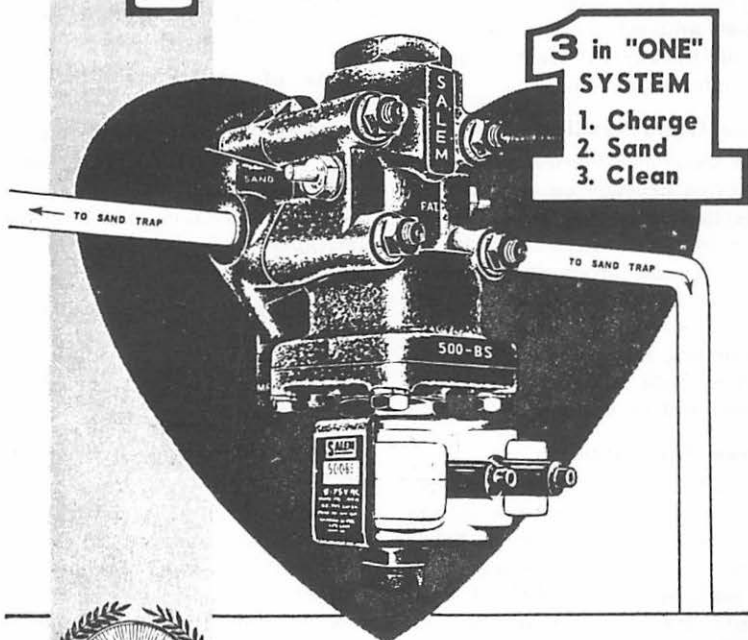


## SALEM ELECTRIC SANDING

REPORT  
NO. 500-BS

ISSUE OF  
JAN. 1, 1965

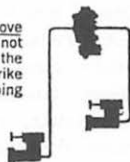
the Heart of the Salem System -



*in  
Sanding*

Salem #500-BS 3 in 1 Sander Control Valve is located above and away from the sand traps. Sand and sand dust will not enter the Control Valve and the Control Valve is out of the range of possible damage should maintenance forces strike the sand trap in an attempt to dislodge obstructions stopping the sand flow.

Only 4 Salem No. 500-BS 3 in 1 Sander Control Valves required per locomotive for the individual control of 8 sand traps.



**GRAHAM-WHITE  
SALES CORP.**

SALEM, VIRGINIA



a result of this diversity, there is only limited agreement among the groups involved about which tests should be included in a specification that will adequately define field performance. Test methods suggested by some groups are limited because only standard laboratory equipment is specified. Other groups suggest many types of equipment, even some unique types of test apparatus. The following updates the current traction motor gear lubricant status:

### Grease Characteristics

The value of a lubricating grease in service depends on its physical properties and characteristics. These, in turn, reflect choice of ingredients and processing. Before outlining the potential tests available for establishing performance parameters, some of the characteristics of both sodium and lithium greases will be outlined.

### Lithium Lubricants

An advantage exhibited by lithium soap lubricants and not sodium based ones is resistance to being washed off gear teeth by water.

A common characteristic of some lithium grease is shear back or loss of apparent viscosity with use. For greatest shear stability soap fibers should be long and narrow. When fibers break into shorter fragments, consistency decreases. Once sheared, lithium soap lubricants do not completely recover their original structure and apparent viscosity decreases.

Lithium based lubricants have apparently been providing satisfac-

tory performance in use on a large portion of the U. S. locomotive fleet for the last several years and are currently the lubricants of choice by EMD.

### Sodium Lubricants

Sodium based lubricants had for years provided satisfactory performance for the entire U. S. fleet and are still used by several major railroads and are still the lubricant of choice by GE.

Loss of apparent viscosity through shear is frequently small and the loss is largely temporary. Most apparent viscosity is recovered when shear stresses are removed from sodium soap thickened lubricants.

### Oxidation

Both sodium and lithium based lubricants can oxidize. Oxidation causes apparent viscosity increase, sometimes even to the point where hardening is so great that channeling occurs resulting in dry gears and tooth scoring.

Certain groups do not consider that oxidation and for that matter shear stability, are inherent functions of whether sodium or lithium soap is used. Rather they believe that the characteristics of the finished product are more determined by the oil, anti-oxidants (if any) and manufacturing process used in preparation of the product.

It should be realized that historically traction motor gear lubricants have not required a great degree of shear or oxidation stability. Leakage has been sufficiently high so that typical service

life has been short. As more tightly sealed cases are adopted, a need for lubricants with better shear and oxidation stability becomes apparent.

### Testing

Performance, as previously mentioned, should be the principal criterion for traction motor grease selection rather than composition.

Test areas under consideration:

- 1) Wear Protection
- 2) Shear Stability
- 3) Characteristics
- 4) Consistency
- 5) Water Content
- 6) Adhesiveness
- 7) Oxidation
- 8) Low Temperature Mobility
- 9) Compatibility with other lubricants.

Other considerations are:

- 1) Environmentally acceptable disposal procedures
- 2) Pouch Properties
  - a) Sealing techniques (seam leakage)
  - b) Pouch separation (tendency of bags to stick in storage)
  - c) Solubility during service
- d) Size and shape of the bag.

### Proposed Tests:

The AAR ad hoc committee has at the time of this writing submitted a proposed specification to the AAR locomotive committee. See Tables I & II.

In addition to the tests listed in Tables I & II others may also be considered. It is premature to speculate on which tests will ultimately

be adopted by AAR member railroads

### 1) Wear Protection

Both wear and EP properties of traction motor lubricants can be demonstrated in conventional laboratory equipment. Steel on steel wear tendencies are determined with the Four Ball EP Tester (Figure 9) and Timken OK Load procedure. Tables I & II give specifications for extreme pressure properties.

Extreme pressure properties can also be determined by using the Falex 6 Tester operated at high loads (237,000 PSI contact stress) for 15 hours. The test differentiates between the efficiency of EP additives and effective treat levels. (Figure 10).

A bench test is used by one supplier to simulate many of the operating parameters of traction motor lubricants. The tester contains two spur gears, one driven and the other loaded. The tester mechanically shears grease, checks coating adhesion, flow characteristics, compatibility, and wear (Figure 11).

### 2) Shear Stability

Shear stability in a Shell Roll Tester (Figure 12) at 180° F for a two-hour period indicates shear loss. Loss is determined with a Brookfield viscometer. Low readings relative to initial readings indicate high shear.

Alternately, the half hour roll sample is worked and penetration taken. Percent change is obtained by comparison with the original worked sample.

# Extreme Pressure

## BY PRECISION-SHELL FOUR BALL E.P. TESTER

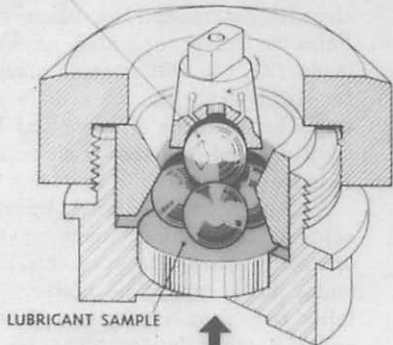
### WHAT IS THE FOUR BALL E.P. TEST?

The determination of the load carrying capacity of a lubricant in kilograms applied to a system of four steel balls in the form of a tetrahedron.

### WHY THE TEST?

To evaluate the E.P. characteristic of lubricants by a load scar curve and weld point.

TOP BALL ROTATES AT 1800 R.P.M.



LUBRICANT SAMPLE

LOAD FORCE

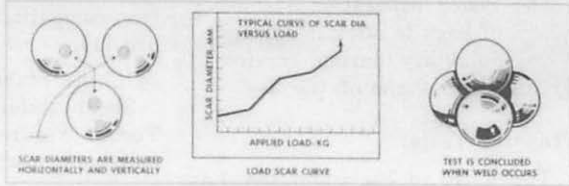
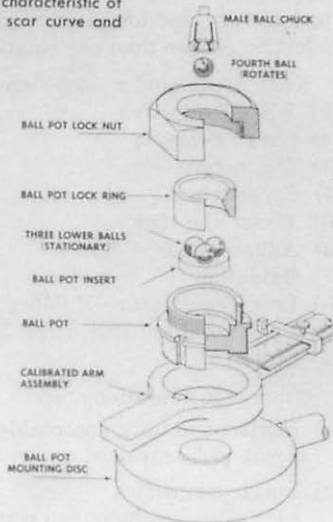


Fig. 9

### 3) Characteristics

Standard ASTM procedures D128 and D445 for determination of soap and mineral oil content respectively are proposed and specification given in Tables I & II.

### 4) Consistency

The Brookfield apparent viscosity and cone penetration (ASTM D217) are recommended procedure. The BAV is to be a standard method, based on EMD procedure No. 90.

### 5) Water Content

Standard ASTM D128 procedure is suggested and specifications given in Table I & II.

### 6) Adhesiveness

Retention of the grease film on a working surface can be checked using the U. S. Steel Retention Test (Figure 13). A film of grease is spread uniformly over the face of the Timken cup, a 10-lb. load applied and running time to failure without lubricant replacement is determined. One quarter hour has been proposed as the acceptable minimum operating time.

A test method employed by one supplier uses a 3 in. by 5 in. metal plate coated with about a one inch wide strip of product set at a 45° plane in a beaker. The test is made at 75, 150, and 200° F. The test determines the tendency of greases to slump and their retention or adhesion to the surface. One hundred percent coverage of the plate is the desired characteristics. The test objective is to relate coverage (film adhesion) to gear teeth surface during operation.

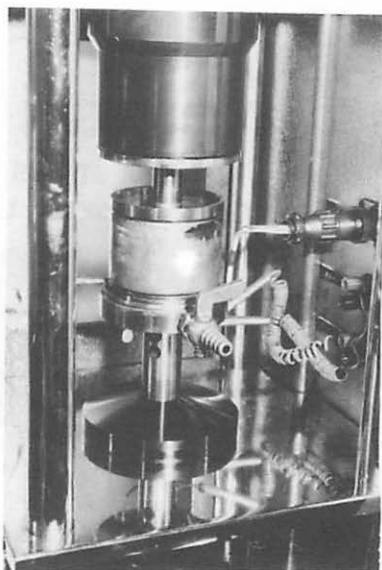


Fig. 10



Fig. 11

### 7) High Temperature Oxidation

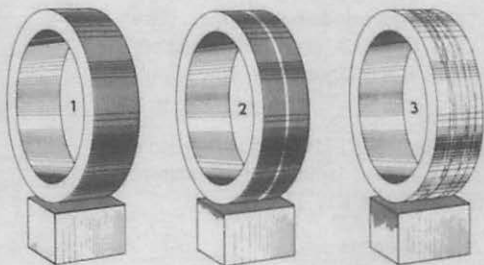
An accepted method for determining oxidation is yet to be established as are its limits. General Electric has a unique test that it uses in evaluating lubricant oxidation. It is called the General Electric Paddle Wheel Test and testing

# Retention Test

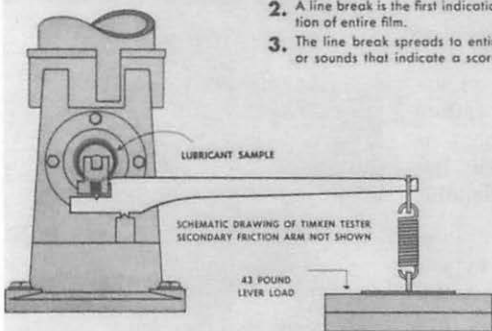
UNITED STATES STEEL METHOD  
BY THE TIMKEN LUBRICANT TESTER

## WHAT IS THE U.S. STEEL RETENTION TEST?

The Retention Test is a time evaluation to failure of a film lubricating for extended periods without lubricant replenishment.



1. Start of test—the block will not be scored as long as the film completely covers the entire face of the cup.
2. A line break is the first indication of failure 200-300 seconds prior to destruction of entire film.
3. The line break spreads to entire face of cup. Machine chatter, overheating, or sounds that indicate a scored block terminate the test.



## WHY THE TEST?

To simulate lubricating open gears operating for long periods without lubricant replenishment.

## TEST PROCEDURE

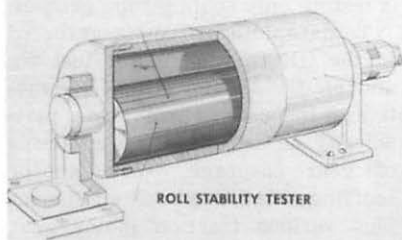
Four grams of lubricant are placed on the test cup and run under 43 lbs. lever arm load until failure occurs. Two runs of thirty minutes or the longest single run out of the three tests is the measure of the retention ability.



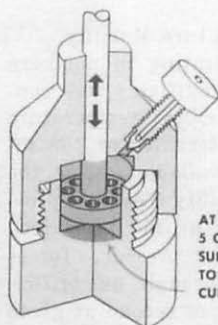
Fig. 12

# Roll Stability

## OF LUBRICATING GREASE

A.S.T.M.  
D-1831

ROLL STABILITY TESTER

1/4" SCALE  
GREASE WORKERAT LEAST  
5 GRAMS  
SUFFICIENT  
TO OVERFLOW  
CUP

### WHAT IS ROLL STABILITY?

The Roll Stability Test is a measure of the mechanical stability of a grease. It determines the changes in the consistency of greases when worked in the roll stability tester.

### WHY THE TEST?

The changes in worked penetration of a grease after rolling are believed to be a measure of its shear stability.

### TEST PROCEDURE

A sample of lubricating grease is worked for two hours in the roll stability tester at room temperature. Worked penetrations are taken before and after rolling in the roll stability tester. The percent change in consistency is calculated using the difference between the two penetrometer measurements.

#### PROCEDURE

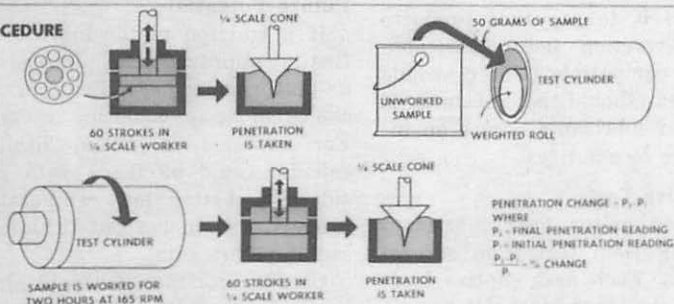


Fig. 13

is done at 250° F while the sample is stirred. Periodically samples are removed and a BAV measured. When apparent viscosity begins to increase rapidly, breakpoint time is recorded.

#### 8) Low Temperature Mobility

Railroads operating in northern climates can justifiably be concerned with the low temperature mobility characteristics of the lubricants. An available test is the U. S. Steel Mobility Test. A pressure viscometer at the prescribed temperature and pressure forces the lubricant through an orifice. Flow in grams per second at given conditions is recorded.

It might be pointed out that some groups feel that adhesiveness and EP characteristics are the most important properties on start-up in very cold climates since at low temperatures current traction motor lubricants are for all purposes immobile.

#### 9) Compatibility with other lubricants

Suffice it to say that products used as traction motor lubricants must be compatible. The desirable properties should be retained if mixing of lubricants occurs on interchange locomotives.

#### Locomotive Tests

Traction motor gear lubricants are being field tested on several railroads. Each uses captive locomotives so that inspection and maintenance can be made without the possibility of mixing which might occur with interchange engines.

The greases used in most tests are experimental heavy lithium (EMD 1027 type B specification) obtained from several suppliers. In most cases, these lubricants are being directly compared with sodium type greases. One railroad is testing only sodium type greases.

To date data are being gathered in the GE traction motor test rig and on GP-38 and GP-50 locomotives. Inspections are made periodically as are visual observations of gear coverage, wear, and/or scuffing using a mix of equipment plus various traction motor gear locations.

The primary test objective varies with each road, but ultimately the tests will allow selection of the best grease for the service pattern of the testing road. Most want information on performance using a variety of wheels, bearings, seals and gutter arrangements.

To date the tests are on-going so no final, conclusive report can be made.

#### Future Potential

If a traction motor lubricant is finally approved and defined by a performance specification, the choice of soap could be widened. For example, a mixed lithium-calcium could be made with considerably better low temperature properties than current lithium or sodium lubricants.

Calcium complex (acetate stabilized) has excellent EP and water resistance properties. Shear is low and texture fibrous, so better adhesion is possible than with straight lithium.

TABLE I

## PROPOSED AAR TRACTION MOTOR GEAR LUBRICANT SPECIFICATIONS

	TYPE B <u>Light</u>	TYPE C <u>Heavy</u>
Appearance	Tacky	Tacky
Thickener, % Max. D128	5	5
Consistency		
Brookfield Apparent Viscosity (---) <sup>a</sup>		
200°F, #3 Spindle, 4 rpm, cP	5,000 <sup>b</sup> - 10,000 <sup>b</sup>	15,000 <sup>b</sup> , 20,000 <sup>b</sup> , 25,000 <sup>b</sup> Max.
200°F #6 Spindle, 20 rpm		
77°F #7 Spindle, 4 rpm	150,000- 600,000	
Mineral Oil Viscosity (D445)		
cSt at 100°C	165 min.	165 min. <sup>c</sup>
SUS at 210°F (Approx.)	800 min.	800 min. <sup>c</sup> 1200-1400*
Wear Prevention		
Four Ball - (D2266)		
130°F, 1800 rpm, 60 min.		
20 kg; Scar Diam., mm	0.8 max.	0.8 max.
Extreme Pressure Properties		
Four Ball EP Test (D2596)		
Load Wear Index, Kg	40 min.	40 min.
Weld Point Kg	200 min.	200 min.
Timken Test (D2509)		
OK Load, lbs.	40 min.	40 min.
Shear Stability D1831 (Modified)		
180°F Shell Roll (---) <sup>d</sup>		
Brookfield Apparent Visc., 200°F, #3 Spindle, 4 rpm, cP	4000 min. <sup>e</sup>	14000 min. <sup>e</sup>
Water Content (D-128)		
% Water	0.10 max.	0.10 max.
Oxidation (---) <sup>f</sup>	(---) <sup>f</sup>	(---) <sup>f</sup>
Adhesiveness		
Timken Adhesiveness Test (---) <sup>g</sup>		
Time to Film Failure	15 min. <sup>h</sup>	15 min. <sup>h</sup>

a/ Standard method to be developed based on EMD Procedure No. 90.

b/ Corresponding limits could be set with the #6 spindle and 20 rpm, based on tests on the current products.

c/ Possibly a higher limit might eventually be needed in the heavy grade to satisfy GE requirements. A higher viscosity here might also be acceptable to EMD for heavy grade only. The light grade should remain at 800 SUS min. to attain optimum characteristics for cold weather service.

d, e, f, g, h, / Details tentative & subject to revision according to data developed on products satisfactory in field.

\* / Typical of present product in the field. Brookfield viscosity (BAV) can be controlling if lighter base oil (800 min.) is used.

TABLE II  
TEST PROCEDURES FOR TRACTION MOTOR GEAR LUBRICANTS

<u>Test Purpose &amp; Identity</u>	<u>Test Method</u>	<u>Type <sup>a</sup></u>
Appearance - Color & Texture Thickener - % Maximum	Visual ASTM D128	Dark/Tacky
Consistency		
a. Cone Penetration, Unworked @ 77°F	ASTM 217	320-350
b. Brookfield Apparent Viscosity @ 200°F #6 Spindle @ 20 RPM (Centipoises) *#3 Spindle @ 4 RPM (Centipoises)		--- ---
c. Brookfield Apparent Viscosity @ 77°F #7 Spindle @ 4 RPM * EMD Procedure No. 90		
Mineral Oil Content - Grease Composition		
a. Viscosity of the Lubricating Oil Minimum SUS @ 210°F	ASTM D445	1500 Min.
Wear Preventive Characteristics in Sliding Steel on Steel Applications		
a. Four Ball Wear Test (1) Scar Diameter, mm, 130°F 1800 RPM, 60 Min, 20 kg. Max.	ASTM D2266	0.8mm
Extreme Pressure (EP Properties)		
a. Four Ball EP Tester (1) Load Wear Index (LWI), kg. Min. (2) Weld Point, kg. Minimum	ASTM D2596 ASTM D2596	32 160
b. Timken, OK Load (Pounds Pass) -Minimum. (1) An optional addition to the above	ASTM D2509	---
Shear Stability - Change in Consistency		
a. Shell Roll Stability Test @ 180°F for 2 hours	ASTM D1831	Record <sup>e</sup> Results
Water Content, Max.	ASTM D128	0.10

d/ Method details to be established.

e/ Tentative. Subject to revision after precision of method established, and data developed on products satisfactory in field.

Finally, a challenge is made to builders to improve the gear cases so leakage is no longer a factor.

This leads us into our next section which updates last year's New Developments Committee report on traction motor gear case seals.

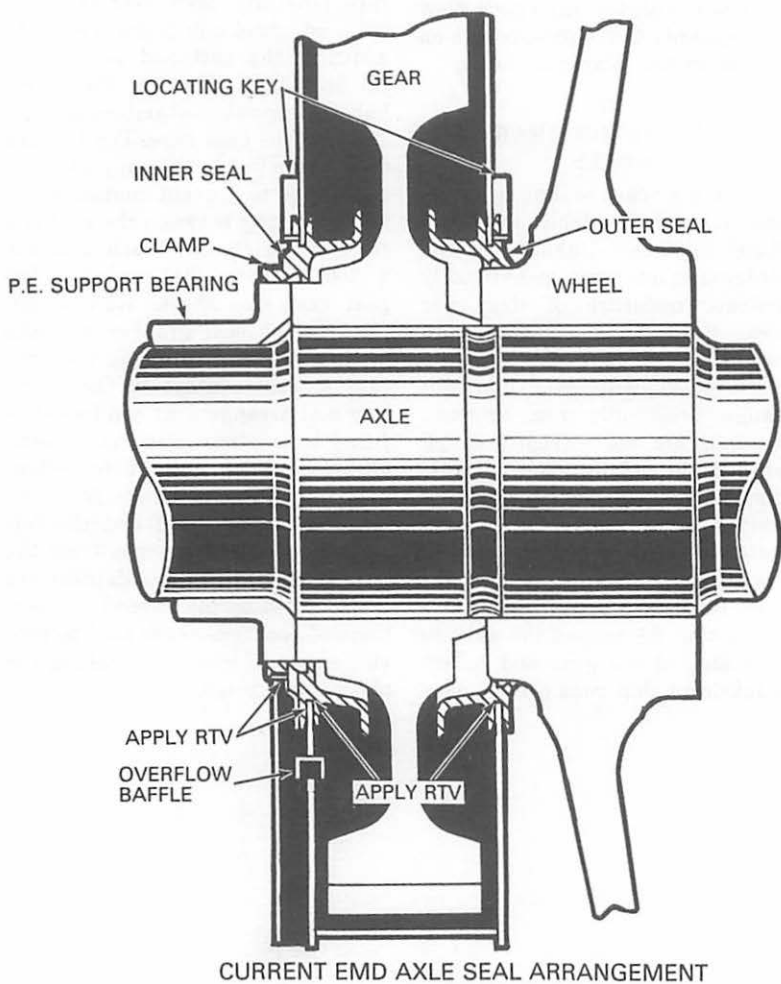
## VI TRACTION MOTOR GEAR CASE SEALS

A new gear case sealing arrangement is now available that will reduce lubricant leakage, extend maintenance intervals, and virtually eliminate incidence of dry gear cases. Gear cases equipped with new seals have operated up to 280,000 miles with gear lubricant leakage practically non-existent. The seals are made from a tough and durable polyurethane that is resistant to oils, solvents, and most caustics at less than elevated temperatures, and will easily last through the wheel life.

The seals, Figure 14, have 360° gutters that fit around the axle on either side of the gear and collect the lubricant that runs off the gear

and gear case sides. The principal sealing feature is the gutter, although both inboard and outboard seals include running clearance type labyrinth seals over the gear hub and wheel hub respectively. In addition, the outboard seal has a lip seal that rides on the wheel hub to prevent contaminants from entering the gear case. The inboard seal is clamped to the support bearing flange to prevent contaminants from entering between the seal and the bearing flange. Each seal has a 360° groove that engages the gear case side sheet. RTV is applied to the seal grooves to make a more positive seal along the gear case to seal contact surface. The new seal arrangement can be retrofitted to existing gear case assemblies by cutting out the felt channels and gutter retainers from the upper gear case half and the felt channels and gutter stops from the lower gear case half. Adapters are then welded to the burned out sections of each gear case half to provide new surfaces for engaging the plastic seal rings.

Fig. 14



**FUEL & LUBRICANTS****COMMITTEE****Six-Year Index**

1981

**Problems, Solutions and  
New Techniques In  
Fuel and Lubrication**

1. Effects of Using Alternate Fuels on Existing Diesel Engines
2. Update on Cold Weather Procedures for Fuels
3. New Techniques in Lube Oil Analyses
4. Traction Motor Gear Lubrication
5. Multi-Viscosity Oils as an Energy Conservation Technique

1980

**Fuel and Lubricants —  
New Decade**

1. High VI Diesel Engine Oil in the Railroad Industry
2. Assessment of Future Fuel Supply and Quality

1979

**Fuel and Lubricant Innovations**

1. Reclamation of Used Railroad Lube Oils
2. Reclamation of Chromate Water and Waste Oil
3. Effects of Engine Modifications on Fuel and Lube Oil
4. Air Compressor, Governor and the New AAR Journal Box Oils
5. New Spectroscopic Technique

1978

**Problem Prevention Through  
Lubrication**

1. New Energy Sources — The Race of Snails
2. Lube Oil Consumption Using Strontium 88 as a Tracer
3. Generation 4 Lubricating Oil — Performance Update
4. Locomotive Wheel Flange Lubricators
5. Discussion on the Use of Proper Lubricants

1977

**Better Performance Thru  
Lubrication**

1. Engine Lubricating Oil Developments
2. Progress in Spectrographic Analysis and Computer Data System
3. Other Lubrication — Air Compressor Oils, Synthetics and Traction Motor Greases
4. Fuel Additives
5. Methods of Measuring Lube and Fuel Oil Consumption

1976

**Projected Advances in Locomotive  
Fuels and Lubricants**

1. LMOA Diesel Engine Lubricating Oil Field Evaluation Procedure
2. Petroleum Industry Supply/Demand
3. Fuel Alternatives — The Gasification and Liquefaction of Coal
4. New Oils and Additives for the Future
5. Traction Motor Gear Lubricants
6. Locomotive Filters

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**J. S. MASTRANGELO**  
SECRETARY  
P. O. Box 1744  
Roanoke, VA 24008

# Wednesday, September 22, 1982

8:30 A.M.

## REPORT OF THE COMMITTEE ON DIESEL MATERIAL CONTROL

Pre-Convention  
Presentation:  
Southern and  
Southwestern  
Railway Club



April 15, 1982  
Holiday Inn  
"Gateway"  
Huntington, WV

**M. L. WALL, Chairman**  
Superintendent Motive Power  
Missouri Pacific Railroad  
St. Louis, MO

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### 1982 TOPIC:

**"MAINTAINING PRODUCT QUALITY THROUGH  
IMPROVED MATERIAL HANDLING"**

## PERSONAL HISTORY

### MICHAEL L. WALL

Michael L. Wall was born in East St. Louis, Illinois, on August 31, 1945. He graduated from the University of Missouri—Rolla in August, 1967, with a BS degree in Mechanical Engineering.

He was employed by Missouri Pacific Railroad in St. Louis on August 7, 1967, and has held mechanical officer positions at various locations on the MoPac system. He returned to St. Louis as Superintendent Motive Power in May, 1979.

He is Chairman—LMOA Diesel Material Control Committee, Director—TTD Implementation Officers Mechanical Equipment Group, Chairman—AAR Alternative Fuels Steering Committee, Member—AAR Locomotive and Electrical Equipment Committee, Vice-President—Southwestern Railway Club, and Member—American Society of Mechanical Engineers.

Mr. Wall is married to the former Judy Wright and they have one daughter named Rebecca.

## INTRODUCTION

The theme of the Diesel Material Control Committee's 1982 paper is, "Maintaining Product Quality Through Improved Material Handling." While quality control in the maintenance of locomotives is commonly viewed as a function of the methods, tooling, and caliber of labor, the ultimate in quality maintenance cannot be achieved without material of equal quality. The intent of the committee is to pro-

vide new ideas or expand on existing methods to ensure that material handling and control systems support efforts to achieve quality maintenance.

The paper is divided into four sections:

- I Use of kits in locomotive maintenance
- II Cost effective methods of shipping material from vendors
- III Union Pacific's Component Inventory Maintenance System (CIMS)
- IV Advantages of using shipping containers

The level of quality maintenance and cost effectiveness that can be attained is assessed in each of these sections; adoption of the concepts presented will enhance overall product quality.

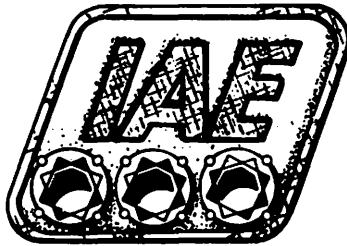
## I

### USE OF KITS IN LOCOMOTIVE MAINTENANCE

The use of maintenance kits for repair of locomotive components may not be a totally new concept, but the acceptance and expansion of kit usage appears to be gaining. Several railroads are pursuing kit development to solve complex material handling and control problems. Benefits can be derived from packaging material in kit form.

The basic question is, "When should kits be considered?"

The simple answer is that kits can be considered whenever more than one item is required to repair a component.



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While a variety of kits are available, two larger kits will be specifically assessed — engine rebuild kits and truck rebuild kits.

Many railroads that rebuild diesel engines are faced with developing the best method to bring the replacement parts to the locomotive. In most cases, few of the parts are qualified and reused. This requires obtaining new material from the shelf or the material warehouse. When you analyze what happens, it is evident that the mechanic builds his own kit — one piece at a time.

An engine rebuild kit, which is available from the locomotive manufacturer, eliminates the need for the mechanic to expend labor in gathering material. The kit consists of seventy-eight (78) separate items — not 78 pieces, but 78 distinct components of various quantity required to build a 16-cylinder diesel engine. These components consist of gaskets, seals, o-rings and bearings, which are 100% replacement items.

The locomotive truck rebuild kit probably has achieved the most rapid acceptance in the railroad industry. These kits are available from the locomotive manufacturer and material suppliers. Like the engine rebuild kit, the benefit of a truck rebuild kit is in reduced handling of numerous components required to rebuild a truck. One typical truck kit consists of 43 separate items, including pins, bushings, wear plates, seals and rubber mounts. Depending on the truck style, the number of components can be much greater.

Those familiar with truck repair are aware of the numerous types of trucks used in a railroad's locomotive fleet. Various brake rigging and lever arrangements require providing an extensive inventory of repair material.

The alternatives are clear: stock individual components in bins and on pallet racks, or inventory pre-packaged kits for the different trucks.

While only engine and truck rebuild kits are illustrated, kits are also available for injector rebuild, pump repair, and various other components. Several railroads use the kit principle for the distribution of air brake components at the two-year inspection and air brake changeout.

Some of the advantages of using maintenance kits may be evident, but following is a list of what the committee feels are primary benefits.

### 1. Purchasing and Invoicing

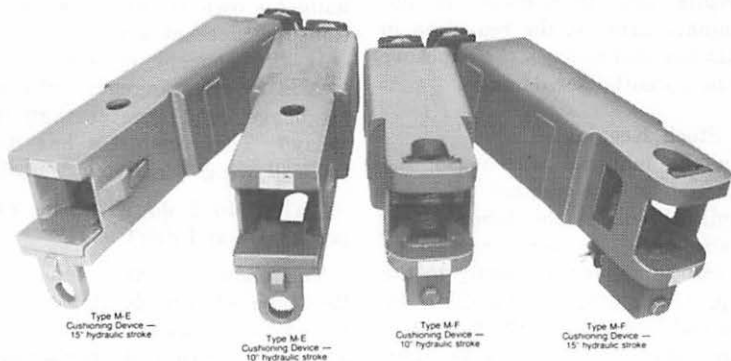
There is a distinct advantage to Purchasing and Material Departments and Mechanical Departments whenever a single order number can be used to order multiple items. The initiating department is not required to look up individual part numbers. Also, the Purchasing Department has a reduced cost of issuing purchase orders, handling payables and matching receipts.

### 2. Handling

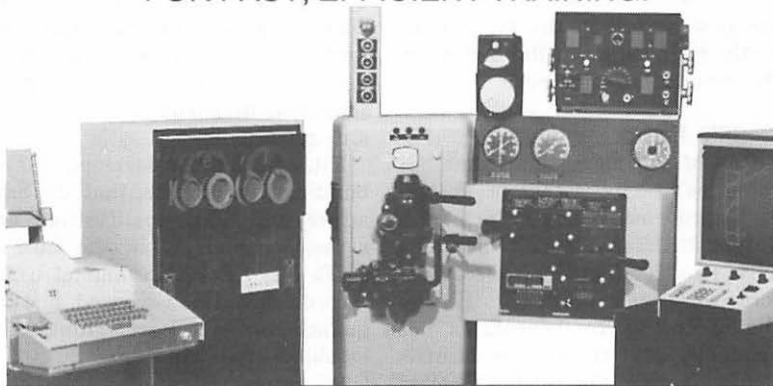
Obviously, handling expense is greatly reduced when only one box is involved compared to handling

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**FreightMaster Concepts for  
More Efficient Railroading**

**SUPER-EFFICIENT CUSHIONING FOR FREIGHT  
CAR AND CARGO PROTECTION.**



**THE TRAIN DYNAMICS ANALYZER SYSTEM  
FOR FAST, EFFICIENT TRAINING.**



**FreightMaster**

A Halliburton Company

P. O. Box 40555, Fort Worth, Texas 76140

78 boxes of engine parts or 43 boxes of truck parts.

### 3. Accumulations

100% of the material needed to accomplish each job function is accumulated at the vendor's warehouse instead of in the railroad shop.

### 4. Damage

While kits themselves do not eliminate damage, the reduction in boxes handled reduces the exposure to the potential for damage.

### 5. Stock Keeping

In the material warehouse, the reduction of the number of boxes required reduces the labor effort significantly. In some cases, the kit can be delivered directly to the shop, eliminating all handling by material personnel. While it had been customary to remove individual parts from boxes and segregate them in bins and on shelves at the work station, these items can now be left in the kit and directly removed from the box when the rebuild is performed.

### 6. Idle Labor

One of the more significant advantages of kits is that productivity improvements can be achieved. Output is affected when a mechanic must look for individual pieces before work can progress. If any one of the 78 components is not available, or if there is an insufficient quantity, the rebuild process stops, and manpower must be diverted to other duties with a resultant loss in efficiency.

### 7. Mechanics Trips to the Stock Room

Since all the material is contained in the kit, the mechanic does not have to leave his work station to order or obtain additional material when his shelf supply is depleted.

One fact must be kept in mind when considering the use of maintenance kits. The mechanic will build his own kit at the work station one piece at a time!

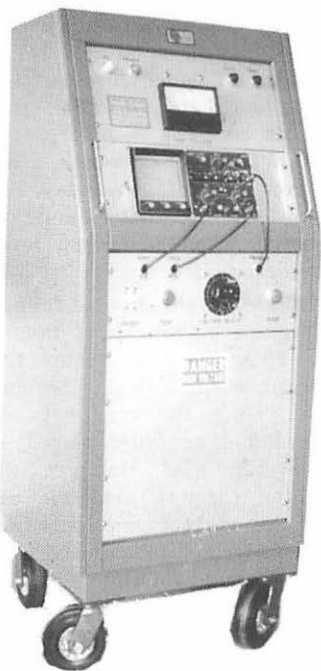
If the concept of maintenance kits is so advantageous, why isn't kit usage even greater than it is today? The committee has heard the following concerns about kits.

"What do I do with the extra material that I don't use?"

The answer to this depends on the type of kit developed. If a kit contains components that have a 100% required replacement, there will be no leftover components. In fact, kits can enhance quality of repair. Since the mechanic knows he has sufficient parts and that they must all be used, he is not as likely to make judgment decisions on qualification and reuse.

Kits also may be developed for rebuilding components that do have a percentage of qualification and reuse, particularly in the case of truck kits. For this, annual usage records should be reviewed, and the quantity of each part estimated to establish the kit contents. If a large number of parts are qualified, the excess kit material can be used to replenish floor inventory. If there is a shortage of material in

**TEST TURN-TO-TURN**  
**MOTOR/GEN COILS**  
**AC-DC TRACTION EQUIPMENT**



**TEST**  
**ARMATURES-STATORS-FIELDS**  
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**P-J SURGE TESTERS**

P-J SURGE COMPARISON TESTERS are being used world-wide for quality control of Motor/Generator coils and their installation. They are built to rigid industrial standards with strong steel cabinets and rack mounted high quality solid-state dual beam oscilloscopes. All console models are mounted on large rubber wheels for easy portability. Test voltages can easily be read on a large direct reading panel meter.

Models from 5KV to 40KV



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Phone: (412) 372-3700

the kit, floor inventory can be used to supplement the kit.

Manufacturers and suppliers will adjust kits based on feedback from the railroad until the optimum kit size is developed.

It is not intended that the kit will replace all stocking of individual components since less than a total rebuild may be required. But this inventory can be reduced to a minimum which also will minimize ordering, handling, and stock-out problems.

**"I can't use kits because my engines are built at three different work stations!"**

Some of the advantages of kits are lost if the parts must be separated and moved to different work stations. Generally, suppliers are agreeable to sub-packaging of kits to meet these requirements. A "kit within a kit" can be furnished and the sub-kits placed at the proper work stations.

In an era of productivity and quality improvement with reduced maintenance expense, the use of maintenance kits should be thoroughly investigated by the railroads. Unnecessary handling of material is non-productive, labor intensive, and an overhead expense. The committee strongly recommends that railroads investigate the kit alternative.

## II

### COST EFFECTIVE METHODS OF SHIPPING MATERIAL FROM VENDORS

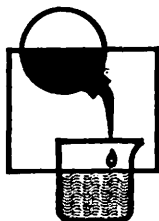
Today, more than ever, the cost of carrying an inventory of re-

placement parts for locomotive maintenance erodes profits. It is essential that inventory be managed and controlled to keep badly needed dollars available for other purposes.

Since most locomotive repair parts are not available at your local hardware store, some inventory must be maintained at repair shops to assure that the locomotive fleet continues to operate. None of us can afford to let an investment of some three-quarters of a million dollars sit idle. It is estimated that the cost of a locomotive held out-of-service is a loss of approximately \$500 per day. This cost or penalty factor must be considered when inventory levels are determined.

It is inevitable that some failures will require repair parts not on hand. Then the time required to procure needed material becomes critical. Once the vendor is determined and an order placed, an efficient Material Manager will know the carriers available and select the correct one based on specific criteria. The cost and transit time required for shipment from point of origin to destination must be weighed against the penalty or cost of holding the unit out-of-service.

The following charts are examples of the kind of information needed to make the most economic and expeditious choices. Note the wide range in transit time and shipping costs. These will vary from point to point, so no one chart can be used as a guide. These



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### ***OTHER RECYCLED LUBRICANTS:***

- PREMIUM CAR JOURNAL OILS
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DIESEL — GASOLINE
- GEAR LUBRICANTS
- METAL WORKING FLUIDS
- HYDRAULIC OILS

### ***PLUS:***

- CONTINUOUS QUALITY CONTROL
- LABORATORY ANALYSIS SERVICE

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MARSHALL V. JOHNSON

**MOTOR OILS REFINING CO.**

7601 W. 47th St. McCook, Ill. 60525

PHONES: Plant, 312-442-6166; Office, 312-788-9017

can be readily developed and used to make the right choice for shipments from regular suppliers.

The method of shipping material is often left to the discretion of the supplier. The instructions given by the purchaser in many cases are merely "Best Way." When needed locomotives are held out-of-service, carrier determination for expeditious shipment of required material should never be left to chance or to a supplier's shipping personnel. The proper choice of carrier should be made by the purchaser. A chart such as these provides the specific information necessary for correct carrier selection.

### III

#### UNION PACIFIC'S COMPONENT INVENTORY MAINTENANCE SYSTEM (CIMS)

In conjunction with establishment of a centralized component repair concept in the early 1970's and because locomotives operate over a thirteen state area, the Union Pacific found it necessary to establish a system to capture component changeout data for each locomotive in the fleet, maintain an adequate supply of repaired components at each Locomotive Repair Shop and produce a daily schedule of components to be repaired and shipped at the Component Repair Shop.

The basic data needed to control the supply of repaired components are:

1. The quantity of each component required to be kept on hand at each Locomotive Repair Shop.
2. The quantity of each repaired component on hand at each Locomotive Repair Shop.
3. The quantity of each component on hand for repair at the Component Repair Shop.

To capture the data needed with a minimum of manual effort, a preprinted, serialized, three-part repair and return tag is attached to each component furnished by the Component Repair Shop. (Exhibit A).

Functions of the three-part tag are:

**Tag Part 1**—For receipt of the bad order component at the Component Repair Shop; indicates whether disposition is for repair, scrapped, returned to the manufacturer for warranty, or sent to an outside concern for repair.

**Tag Part 2**—For changeout of a component on a locomotive at the Locomotive Repair Shop, ordering of a repaired component from the Component Repair Shop and establishment of a changeout record for a locomotive.

**Tag Part 3**—Indicates reason the component failed, which is determined during the component repair process.

There are two production schedules produced daily for each repair department to schedule the repair of components at the Component Repair Shop:



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Ogontz has been  
a leading supplier  
of railroad controls:**

- Thermal Drain Valves for positive freeze protection.
- Water Temperature Regulators
- On-Board Permanent and Portable Cab Signal Testing Units.
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- Windshield Defrosters.
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- Air Compressor Governor Control Switches.
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- For details, contact Joe Morris, Ogontz Controls Company, 141 Terwood Road, Willow Grove, PA 19090.

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**Ogontz**  
Controls Company

### Proposed Production Schedule (Exhibit B)

This schedule notifies the Component Repair Shop of the System requirements and is used to notify CIMS of tomorrow's planned production. It is produced by matching the quantity of each type component on hand to the pool size for each Locomotive Repair Shop. When the quantity on hand is less than the pool size, the following data are printed on the schedule:

1. CIMS component number.
2. Component description.
3. Location requiring component.
4. Quantity required for each location.
5. Percent of pool size on hand for each location.
6. Pool size for each location.
7. Quantity on hand for each location.

All of the data are printed on a single line for each location and component, each line being sequentially numbered.

To notify CIMS of tomorrow's planned production, the Department code, the Schedule date, the Schedule page number, the sequential line number and the quantity to be repaired for that location is reported. This will then also reduce the quantity of this component owed to this location on tomorrow's Proposed Production Schedule.

### Final Production Schedule (Exhibit C)

This Schedule notifies the Component Repair Shop of the serialized tag records assigned to the

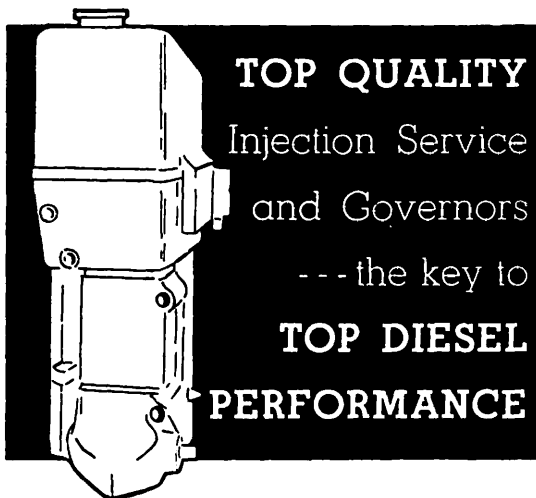
components in today's planned production and is used to notify CIMS of today's actual production and shipments. It is produced from the data contained in the line numbers selected from yesterday's Proposed Production Schedule and contains the serialized three-part tag numbers for each Locomotive Repair Shop that is to be attached to the repaired components.

To notify CIMS of this day's actual production, we report only the serialized tag numbers used. This reporting will add the quantity of each component tagged and shipped to the proper Locomotive Repair Shop on hand quantity.

The basic operating procedures for CIMS are:

#### LOCOMOTIVE REPAIR SHOPS

1. Remove the complete CIMS tag from the rebuilt component being installed in the locomotive.
2. Complete the CIMS three-part tag as follows:
  - A. CIMS tag Part 2 and Part 3 — Record the changeout date, the removal reason code, the locomotive owner's initials, the locomotive number, engine or truck position code and the component position code.
  - B. CIMS tag Part 1 — Record the removal reason.
3. Remove CIMS tag Part 2.
4. Attach CIMS tag Parts 1 and 3 to the bad order component removed from the locomotive.
5. Forward tag Part 2 for same day data entry.



## **SARDELLO'S** **five-way assurance** **of top performance**

1. Foremost "specialists" in diesel injector, governor, and pump remanufacturing.
2. Largest inventory of power packages—all make diesels.
3. Immediate delivery from consignment areas.
4. Best available techniques in remanufacturing and testing.
5. Low cost unit exchange policy.

The Sardello System takes all injectors and governors off your hands and gives you precision units in exchange. And the price is "right." So you can replace periodically for better, cleaner engine performance.

Through volume work and many specialized techniques — including testing — the Sardello System solves a tough maintenance problem for the railroads — large, medium, and small alike — CALL US.

## **SARDELLO, INC.**

2700 NEVILLE ROAD, NEVILLE ISLAND

PITTSBURGH, PA. 15225

PHONE (412) 771-2766/264-0829

**COMPONENT REPAIR SHOP**

1. Upon receipt of component, remove CIMS tag Part 1 and circle proper disposition code.
2. Forward tag Part 1 for same day data entry.

**COMPONENT REPAIR SHOP SCHEDULING AND COMPONENT REPAIR**

1. Receive Proposed and Final Production Schedules and also new CIMS tags.
2. Forward Final Production Schedule and new tags to proper Repair Department.
3. Remove CIMS tag Part 3 from failed component.
4. Determine failure reason and record on tag Part 3.
5. Forward tag Part 3 for same day data entry.
6. On Final Production Schedule, check tag number used for components repaired and attach proper tag to each component.
7. Forward Schedule for same day data entry.
8. Determine tomorrow's production plan.
9. Complete Proposed Production Schedule accordingly.
10. Forward Schedule for same day data entry.

From the data reported, the following basic historical reports are produced.

**Component Changeouts By Locomotive (Exhibit D)**

This is a report of all component changeouts reported for each locomotive for the current year. It is sorted by locomotive number, com-

ponent family type, date of changeout and contains the following data:

1. Locomotive owner's initials.
2. Locomotive number.
3. Component description.
4. Locomotive Repair Shop that performed the changeout.
5. Date of changeout.
6. CIMS component number.
7. Engine/truck position code, as applicable.
8. Component position code.
9. Changeout reason code.
10. Component Repair Shop initial failure code as determined at receipt. This is most generally the same as the changeout code.
11. Final Failure code that was determined during the component repair process.
12. The descriptive reason for the changeout.

**Component Usage (Exhibit E)**

This is a report of component usage (changeouts) for the last twelve months. It is sorted by component number and reporting month. It contains the following data:

1. CIMS component number.
2. Component description.
3. Locomotive Repair Shop.
4. Individual monthly usage for each location and system total.
5. Twelve month total for each location and system total.
6. Monthly average usage for each location and system total.

**Components Scrapped (Exhibit F)**

This is a report of the quantity of each type of component scrapped

# **MVI Caprinus<sup>®</sup> R Oil** **the hardworking oil** **for today's locomotives**

**You don't have to accept an HVI oil.**

MVI oils have been proven in almost half a century of operation in medium-speed diesels. Shell's MVI Caprinus\* R Oil maintains that reputation of MVI oil and uses a modern additive package to meet the latest engine service requirements.

Since Shell has doubled its MVI lube oil capacity, there is no need to switch to HVI oils that form harder, denser carbon deposits — deposits that can block port areas and crowd rings in their grooves.

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Chicago	312-887-5500
Cleveland	216-842-4000
Houston	713-526-4631
Los Angeles (Anaheim)	714-991-9200
San Francisco	
(San Ramon)	415-820-7000
St. Louis	314-291-5700
Seattle	206-453-3000
East Coast	201-325-5200

Come to   
**Shell for answers**

\*Caprinus is a trademark and is used as such in this writing

for a single month and is sorted by component number.

Other reports also are generated from those data such as, component service life, repetitive failures connected with an individual locomotive or component type and predominate failure reason for component groups.

CIMS also provides the important function of component warranty monitoring. When a component is received new or vendor repaired, CIMS monitors this component from receipt through changeout or warranty expiration. At the Component Repair Shop a daily listing of components changed out under warranty is printed (Exhibit G). This report contains the following data:

1. CIMS component number.

2. Component description.
3. Locomotive Repair Shop component was changed out at.
4. Serialized tag number.
5. Component serial number.
6. Date component was installed.
7. Mileage on component since installation.
8. Changeout date.
9. Locomotive number.
10. Engine or truck position code.
11. Component position code.
12. Reason component was changed out.

A suspected warranty component will stay on this report until it is received at the Component Repair Shop and disposition is reported on tag Part 1.

The data contained within CIMS has been extremely beneficial in supporting warranty claims with the various vendors.



## POWER BY Wagstaff

### TYPE 4RD-25

IN MOULDED RUBBER  
CONTAINERS  
FOR  
DIESEL LOCOMOTIVE  
CRANKING CONTROL  
AND OTHER APPLICATIONS  
4 CELLS - 8 VOLT



**Wagstaff** BATTERY MANUFACTURING COMPANY

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ERIE, PA. TO MINNEAPOLIS, MN.

	Transit Time (Days)	10#	50#	100#	200#	Over 200#
Parcel Post	4-5	4.22	9.18	-	-	-
Air Parcel Post	2-3	9.12	39.24	-	-	-
Fast Mail	1	16.85	50.30	-	-	-
UPS	3-4	2.97	10.36	-	-	-
UPS Air	2	11.11	49.95	-	-	-
Air Express	1	37.70	71.35	-	-	-
Air Freight	2-3	27.74	59.60	89.35	155.50	-
Bus Freight	3	11.65	28.30	49.70	-	-
Commercial Truck	7-10	33.77	33.77	33.77	33.77	19.57 Cwt. x Wt. + 3.1% Fuel Surcharge

LA GRANGE, IL. TO MINNEAPOLIS, MN.

	Transit Time (Days)	10#	50#	100#	200#	Over 200#
Parcel Post	4-5	2.87	5.64	-	-	-
Air Parcel Post	2-3	7.15	29.39	-	-	-
Fast Mail	1	14.80	40.05	-	-	-
UPS	2-3	2.59	8.47	-	-	-
UPS Air	2	11.11	49.95	-	-	-
Air Express	1	35.20	65.20	-	-	-
Air Freight	2-3	27.74	63.38	99.19	174.45	-
Bus Freight	2	9.35	17.55	24.55	-	-
Commercial Truck	3-5	28.10 Min. Chg.	28.10 Min. Chg.	28.10 Min. Chg.	28.10 Min. Chg.	14.94 Cwt. x Wt. + 3.1% Fuel Surcharge

FORM 2525  
FINAL FAILURE HISTORY  
UPPR CIMS  
REPAIRABLE MATERIAL



TAG  
NUMBER

19112531

TAG PART 3

SHIP TO: NOP  
UP COMP. NO. 61003596

RETURN TO: OMIA

MFG. NO. 126X1605

CHANGE OUT DATE     /    /     REMOVAL REASON                     

LOCOMOTIVE / CAR  
INITIAL-NUMBER

ENGINE / TRUCK  
NUMBER

POSITION

TAG NO. 19112531

FINAL FAILURE REASON                     

RECEIPT / REPAIR STATUS  
CIMS  
COMPONENT REPAIR SHOPS

TAG  
NUMBER

19112531

- CIRCLE ONE -

— REPAIR — WARRANTY — SCRAP — KNOCKDOWN — UNIT EXCH —

TAG PART 1

UP COMP. NO. 61003596

MFG. NO. 126X1605

DES. Turbocharger GE C30-7

INSP. FAILURE REASON                     

SHIPPED TO NOP

RETURN TO: OMIA

TAG NO. 19112531

CIMS  
LOCOMOTIVE / CAR  
CHANGE OUT HISTORY

TAG  
NUMBER

19112531

TAG PART 2

UP COMP NO. 61003596

MFG. NO. 126X1605

CHANGE OUT DATE     /    /     REMOVAL REASON                     

LOCOMOTIVE / CAR  
INITIAL NUMBER

ENGINE / TRUCK  
NUMBER

POSITION

TAG NO. 19112531

SHIP TO NOP

CONTINUOUS INTERFOLIO © MOORE BUSINESS FORMS, INC.

PROPOSED PRODUCTION SCHEDULE

For January 16, 1981

Department: 01 Oil Engines

Page 1

Exhibit B

<u>Line No.</u>	<u>CIMS Comp. Number</u>	<u>Description</u>	<u>Loc</u>	<u>Qty. To Build</u>	<u>% Pool On Hand</u>	<u>Pool Size</u>	<u>Qty. On Hand</u>
1	2005 7147	INJ 12 16 567A-B-BC	NMP	1	75	4	3
2	2005 7147	INJ 12 16 567A-B-BC	NOP	3	81	16	13
3	2005 9044	INJ 16 567C	NOP	10	69	32	22
4	2005 9044	INJ 16 567C	POC	1	92	12	11
5	2006 0224	INJ 16 567D2-D3-D3A	NOP	2	94	32	30
6	2006 0224	INJ 16 567D2-D3-D3A	SLC	16	71	56	40
7	2006 0810	INJ 16 20 645E3	NOP	23	52	48	25
8	2006 0810	INJ 16 20 645E3	SLC	18	63	48	30
9	2006 1115	INJ 16 645 E3A-E3B	NOP	4	92	48	44
10	2015 4795	Cover-Case 567B-BC	SLC	1	90	10	9
11	2060 5705	Cover-Case 567D 645	NOP	4	83	24	20
12	2107 3531	Nozzle-Fuel INJ U30C	NOP	20	83	120	100
13	6000 0437	Turbo 16 645E3	SLC	1	75	4	3
14	6000 0767	Cover-Cyl. Hd. 16 567 645	HKL	2	75	8	6
15	6000 8729	Drive Gear-Turbo 567	NOP	1	67	3	2
16	6100 2994	Gov.-GE C30-7 80	CHN	1	50	2	1
17	6100 2994	Gov.-GE C30-7 80	NOP	3	25	4	1
18	6100 3000	Gov.-GE U30C C30-7	NOP	2	50	4	2
19	6100 3034	Gov.-GE Overspeed Up&rd.	NOP	2	80	10	8
20	6100 3596	Turbo-GE C30-7 78	NOP	1	0	1	0
21	6101 1136	Blower-Equip. GE	NOP	2	0	2	0
22	6101 1151	Blower-Equip. GE	NOP	1	50	2	1

FINAL PRODUCTION SCHEDULE

For January 16, 1981

Department: 01 Oil Engines

Page 1

<u>CIMS Comp. Number</u>	<u>Description</u>	<u>Ship To Location</u>	<u>New Tag number</u>
2006 0810	INJ 12 16 567A-B-BC	No. Platte	1023 7790
			1023 7791
			1023 7792
			1023 7793
			1023 7794
			1023 7795
			1023 7796
			1023 7797
			1023 7798
			1023 7799
			1023 7800
			1023 7801
			1023 7802
			1023 7803
			1023 7804
			1023 7805
			1023 7806
			1023 7807
			1023 7808
1023 7809			
1023 7810			
1023 7811			
1023 7812			
1023 7813			
20060810	INJ 12 16 567A-B-BC	Salt Lake	1023 7814
			1023 7815
			1023 7816
			1023 7817

Exhibit C

Exhibit C

CIMS

COMPONENT CHANGEOUT BY LOCOMOTIVE

JANUARY, 1981, THRU SEPTEMBER, 1981

Locomotive Init. No.	Component Description	C/O Loc	C/O Date	CIMS Number	Position		C/O Code	CRS Code	Fail Code	Changeout	Reason	
					Eng Trk	Comp						
UP 1111	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	2	1	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	2	2	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	2	3	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	1	1	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	1	2	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	9-12-81	60000197	1	3	680	680	680	Thin Rim		
	TM D77B 11-5-43 62/15 GR	NOP	4-16-81	60000197	2	2	680	680	680	Thin Rim		
	Rad Bank SD40-2 RS	NOP	3-19-81	60012580			R	007	007	011	Leaking	
	Rad Bank SD40-2 LS	NOP	3-19-81	60017159			L	007	007	011	Leaking	
	Horn 3 or 5 Bell	SLC	7-10-81	60009164				095	095	095	Scheduled	Change
	Valve MAG-CCS	SLC	7-10-81	60001732				095	095	095	Scheduled	Change
	Valve Indep. Brake	SLC	7-10-81	60008000				095	095	095	Scheduled	Change
	Valve Service Portion	SLC	7-10-81	60008042				095	095	095	Scheduled	Change
	Valve Charging	SLC	7-10-81	60008125				095	095	095	Scheduled	Change
	Valve Vent No. 8	SLC	7-10-81	60008885				095	095	095	Scheduled	Change
	Valve Vent No. 8	SLC	7-10-81	60008885			1	095	095	095	Scheduled	Change
	Valve Salem 816 MAG	SLC	7-10-81	60009081			1	095	095	095	Scheduled	Change
	Valve Salem 816 MAG	SLC	7-10-81	60009081			2	095	095	095	Scheduled	Change
	Valve Application P2-A	SLC	7-10-81	60008083				095	095	095	Scheduled	Change
	Valve Auto Brake	SLC	7-10-81	60007960				095	095	095	Scheduled	Change
	Valve Quick Release	SLC	7-10-81	60009248				095	095	095	Scheduled	Change
	Valve Relay J1.6-16	SLC	7-10-81	60009586				095	095	095	Scheduled	Change
	Valve Relay Air 25#	SLC	7-10-81	60009529				095	095	095	Scheduled	Change
	Valve Auto Wtr Drain	SLC	7-10-81	60009743				095	095	095	Scheduled	Change
	Valve Indep. Brake	NOP	5-5-81	60008000				007	007	007	Leaking	
	Valve Service Portion	NOP	1-16-81	6000J842				007	007	007	Leaking	
	Refrig. 1/2 DR AC Volt	NOP	9-27-81	60007499				901	902	905	Will Not Cool	
	Amplifier Tran Type	SLC	4-15-81	60010824				053	053	053	Out fo Adjust.	
	Converter-Dual	ALB	8-3-81	60018876				084	084	084	Grounded	

Exhibit D

Committee on Diesel Material Control

## CIMS

## COMPONENT USAGE

OCTOBER, 1980, THRU SEPTEMBER, 1981

CIMS Number	Component Description	C/O	80	80	80	81	81	81	81	81	81	81	81	81	Total	Mth. Avg.
		Loc	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
60009800	Valve Service Portion	LOS	0	0	0	0	1	0	0	2	0	0	1	0	3	0
		NOP	1	1	0	1	3	0	1	1	0	1	1	0	10	0
		OMA	1	2	2	0	1	0	0	0	0	0	0	0	6	0
		POC	0	0	0	0	0	0	0	0	0	0	1	0	1	0
		SLC	1	2	2	1	0	0	1	3	0	0	2	4	16	1
		TOTAL	3	5	4	2	5	0	2	5	0	1	5	4	36	3
60009883	TM D87 11-5-43 62/15 GR	NOP	0	0	0	0	0	0	4	0	0	0	0	4	0	
		OMA	0	0	0	0	0	0	0	0	8	10	4	22	1	
		TOTAL	0	0	0	0	0	0	4	0	8	10	4	26	2	
60009909	Turbocharger EMD 645E3	NOP	0	0	0	0	0	0	0	2	3	0	0	5	0	
		SLC	0	0	0	0	0	0	0	2	5	3	0	13	1	
		TOTAL	0	0	0	0	0	0	0	2	7	6	0	18	1	
60009941	TM D77B 11-5-47 62/15 GR	ALB	0	0	0	1	0	1	0	0	0	2	1	5	0	
		ARG	0	0	0	0	0	0	0	1	0	0	0	1	0	
		LOS	0	0	1	0	1	0	0	0	1	0	2	0	5	0
		OMA	0	4	20	4	8	5	4	6	8	4	0	4	67	5
		SLC	0	0	0	0	0	0	0	3	0	1	1	0	5	0
TOTAL	0	4	21	5	9	6	4	10	9	5	5	5	83	6		
60010006	Turbocharger EMD 645E3	NOP	0	0	0	0	0	0	0	0	0	0	1	1	0	
		OMA	0	0	0	0	0	0	0	0	0	0	1	0	1	0
		TOTAL	0	0	0	0	0	0	0	0	0	0	1	1	2	0

Exhibit E

## CIMS

## COMPONENTS SCRAPPED

FOR MONTH OF DECEMBER, 1981

CIMS Number	Component Description	Qty.	Number	Component Description	Qty.
01961457	Head Comp LP WBO	6	01961655	Cyl Comp LP WBO	3
01976315	Cyl Comp HP WBO New Style	3	01976372	Head Comp HP WBO New Style	2
20045431	Motor Starting 32 Volt	2	20214763	Rod Assy Fork 567A-B-BC	4
20258836	Reverser EMD 1800 Cls	1	20310330	Head Cyl 567A-B-BC Eng	11
20386462	Grid Dyn EMD	1	20393443	Core Rad 6 In SGL	11
20548319	Liner 9 1/16 Chr 567D	1	20593059	Brushholder TM D77B	46
20594040	Grid Dyn Arrow	44	20597761	Cont Dyn Brk SD40 SD45	3
20615407	Piston 8 1/2 567D 3 3A	8	20628525	Liner 9 1/16 Cast 645 E	7
20641601	Core Rad 8 In SGL	1	20675245	Core Rad 6In DBL	1
20717898	Brushholder TM 752	14	20719563	Piston 9 1/16 645 E3A	26
20725602	Head Cyl 645 Eng	56	20725610	Head Cyl 567C Eng	19
20730842	Rod Assy Fork 645E3A	6	20731121	Piston 9 1/16 645E3	58
20914941	Mtr Cab Htr SD40 SD40-2	13	21013800	Grid Dvn GE	24
21039136	Brushholder TM X3B	3	39070800	Battery Loco Large	4
60000007	Piston 8 1/2 567A-B-BC	8	60000015	Rod Assy Blade 645E3A	6
60001278	Cyl Comp LP WBO	2	60001583	Cont Starting SD40-2	1
60003852	Battery Loco Small	2	60004330	Liner 9 1/16 Cast 645B3A	20
60015484	Air Comp WBO RM	1	60018157	Battery Loco Unitized	3
61006451	Switch Brk U30C	1	61011151	Blower Equip GE	1

Exhibit F

## ELECTRICAL COMPONENTS TO BE CHECKED FOR WARRANTY

<u>CIMS Number</u>	<u>Component Description</u>	<u>C/O Loc</u>	<u>Tag Number</u>	<u>Manufacturer Serial No.</u>	<u>Date Installed</u>	<u>Mileage (000)</u>
20731121	Piston 9 1/16 645E3	VGS	10200708	81-C-116	5-12-81	45
	Date Removed 12-6-81	Loco No. UP 2222	Eng	Pos 12		
	Removal Reason Cracked					
60004371	Liner 9 1/16 CHR 645E3	VGS	10225159	81-A-2779	5-12-81	45
	Date Removed 12-6-81	Loco No. UP 2222	Eng	Pos 12		
	Removal Reason Scored					
60004298	Head Cyl DIA 3	HKL	10234281	80-F-1133	4-16-81	53
	Date Removed 12-15-81	Loco No. UP 1111	Eng 1	Pos 8		
	Removal Reason Cracked					
21073531	Nozzle Fuel INJ	NOP	10234420	7809092	4-30-80	139
	Date Removed 12-22-81	Loco No. UP 1122	Eng	Pos L1		
	Removal Reason Leaking					
20061115	Injector Fuel 645E3B	SLC	10234619	A8434	10-18-81	24
	Date Removed 12-18-81	Loco No. UP 2211	Eng	Pos 2		
	Removal Reason Sticking					
61003661	Core Rad GE	SLC	17197043	439109	11-3-81	4
	Date Removed 12-18-81	Loco No. UP 3333	Eng	Pos L1		
	Removal Reason Leaking					
61003661	Core Rad GE	SLC	17197062	442159	11-5-81	14
	Date Removed 12-18-81	Loco No. UP 3344	Eng	Pos R1		
	Removal Reason Leaking					
60000437	Turbocharger EMD 645E3	SLC	17240179	81-F3-A80	7-24-81	36
	Date Removed 12-18-81	Loco No. UP 4444	Eng	Pos		
	Removal Reason Bearings					
20630182	Pump Water 645E3	LOS	19059580	79-F-5	4-16-80	130
	Date Removed 12-2-81	Loco No. UP 5555	Eng	Pos L		
	Removal Reason Leaking					

Exhibit G

# MAINTENANCE EQUIPMENT FOR LOCOMOTIVES

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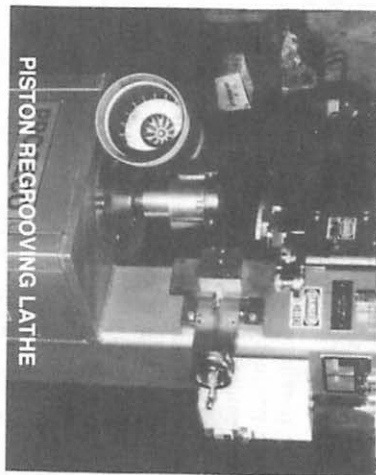
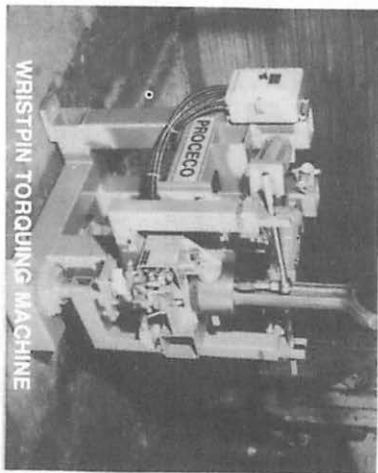
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## IV

## ADVANTAGES OF USING SHIPPING CONTAINERS

The purchase of almost any consumer product makes you familiar — and sometimes frustrated — with the protective packaging that must be removed before the product can be used. While it complicates unwrapping, the purpose of protective packaging is met, i.e., to maintain the quality of the product to the end user.

While the transportation of railroad maintenance material is not the same as shipping a consumer product, the consequence of damage in transit can have a far more devastating result, such as preventing a \$750,000 investment from operating.

We now discuss the various types of shipping containers in use in the railroad industry. Emphasis is on shipping containers used for transporting material between maintenance facilities rather than containers for storing repair material within the shop.

While locomotive maintenance material formerly was repaired at the location where the component was removed and no sophisticated containers were required, now many railroads centralize component repair or rebuild at one facility. That requires that bad order material to be shipped to the centralized point, and the repaired material returned to numerous maintenance facilities.

Before there is agreement that shipping containers are needed, the

cost of building or buying them must be justified. For many years wood pallets have been the way to ship material. Items of all shapes and sizes have been nailed, banded, or tied to wood pallets. Often the item is just placed on the pallet, and the Law of Gravity employed to keep it in place.

Another law of physics states that for every action there is a reaction, one that can best be seen by opening the door of a material car that has traveled hundreds of miles and has been humped several times. The time and effort to unload such a car with material strewn about, plus the cost of damage to the material demands a better way.

The use of shipping containers satisfies several of the following requirements for transportation of material:

- Safety
- Damage Prevention
- Reduced Securement
- Storage
- Reduced Expense

While the safety aspect is sometimes taken for granted, the use of containers that positively secure the material being shipped can prevent injuries that may occur when material falls off pallets or shifts in the car. The exposure to hazards while nailing or banding material to wood pallet can be eliminated.

Prevention of damage to repaired material is one of the most beneficial aspects of shipping containers

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to a mechanical officer. Nothing is more wasteful or discouraging than to receive from a repair shop material that was damaged in transit. The complete cycle must be repeated, often while a locomotive is held out of service. Sometimes the material appears undamaged and is not found until it is applied or until a premature failure results.

Reduced securement and blocking of material is a key advantage of the use of shipping containers over previous methods. Containers can be designed to hold the component in position without securement.

While the shipping container's primary purpose is for transportation, it can also be used for storage of material at the maintenance facility or at the centralized repair facility. Stackable containers can be designed to reduce the storage space required. Also, containers can hold numerous smaller components in less space.

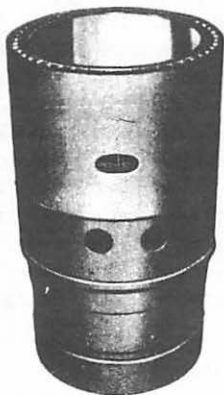
The reduced expense is the key ingredient in determining the cost effectiveness of shipping containers. Most of the shipping containers discussed here cost several hundred dollars to construct. They can be used many times with little or no maintenance. A wood pallet, on the other hand, about \$7.00 and has a limited number of uses before it must be discarded. When exposed to the weather, deterioration accelerates rapidly, shortening its life. Shipping containers can be used for shipping both the material requiring repair as well as the repaired material.

An example of the cost effectiveness of a shipping container is shown:

	Shipping Con- tainer	Wood Pal- let
Initial Cost	\$300	\$7
Expected Life	5 Yrs.	1 Yr.
Trips Per Month Per Trip	4	4
Blocking Cost	—	\$20
Blocking Removal Cost (Labor)	—	\$10
Five Year Cost	\$300	\$7,235
Annual Cost	\$60	\$1,447

Most of the shipping containers in use evolved from a specific railroad's need for a better system of transporting material. The design generally incorporated the ideas of those who were familiar with the shipping and handling requirements. The benefits from shipping containers are sufficient to justify a strong engineering effort for a simple, rugged, and practical construction. Standardization should be designed into the containers for ease of handling. In fact, most containers are equipped with pockets for lift truck forks and brackets for lifting with an overhead crane. Designing containers that stack will save storage space for both loaded and empty shipping containers. Color coding and stenciling can be employed to identify material in the shipping container, especially when enclosed containers are used.

The use of shipping containers between railroad shops is most common, but they also may be practical for use with unit exchange and



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repair and return shipments to vendors.

Following are several types of shipping containers in use:

#### **Diesel Engines — Photo 1**

A rail car can be considered a shipping container to transport diesel engines between shops. A converted flat car may be used to transport 8, 12, or 16-cylinder EMD and GE diesel engines. I-Beam framing is used for support and strength and the engine is secured by the base bolts. Also incorporated in the design are locations for shipping main generators, air compressors, and complete trucks on the same flat car. The flat car can easily be spotted beneath an overhead crane for loading or unloading. Plastic or canvas is used to protect the material in transit.

#### **Locomotive Trucks — Photo 2**

A special flat car may be equipped with rails on the deck and end stops for transporting locomotive trucks complete with wheels and traction motors. Adjustable slide plates act as pockets for the wheels, and the trucks are secured with turn buckles for tie down which can easily be applied. Some cars are designed to carry a truck and engine or two complete trucks.

#### **Traction Motor/Wheelsets — Photo 3**

Both modified flat cars and gondolas are used to transport traction motor/wheelsets to points of use. Wheels are set in pockets with a

radius to match the wheel, while structural members support the traction motors. One original design used individual covers over the traction motor/wheelset assembly. This was later refined by modifying covered gondolas to provide protection from the weather and reduce the time to load and unload the car.

To provide flexibility, some cars are designed with the capability of transporting main generators and alternators, or any combination of generators/alternators and traction motor wheelsets.

#### **Wheels/Axles — Photo 4**

Wheel cars for transporting wheelsets, less traction motors, have been utilized for many years. Generally, a flat car is converted with rails or channels used to support the weight. Wheelsets are staggered to allow maximum carrying capacity while preventing damage to the journals of the axles. One railroad uses steel pockets that eliminate the need to tie down any of the wheelsets. Gears and bearing surfaces are coated prior to loading to protect their surface. Most designs allow transporting 12-15 wheelsets per car, depending on length.

#### **Main Generators — Photo 5**

Several railroads use a shipping container for transporting main generators. An I-Beam supports the generator base, and an upright at one end is used for the shaft and bearing support. Mounting holes are used to secure the generator or alternator to the skid.



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### Traction Motors — Photo 6

One railroad has converted surplus auto parts racks to ship traction motors to various maintenance facilities. The modification of existing racks and containers reduces initial cost of building the shipping container. Any traction motor can be placed in the container which has three verticle corner legs. The fourth leg is removed to ease loading and unloading. A hinged top bar allows securement of the traction motor in the container after it is loaded. No securement of the traction motor to the container is required with this design.

### Auxiliary Generators — Photo 7

Containers also are used for auxiliary generators with and without blowers. One style is a flat metal skid with raised pedestal to accommodate the various mounting arrangements. Another design utilizes structural members for the generator and blower securement.

### Turbochargers — Photo 8

The high value of turbochargers is a primary reason for providing shipping containers. A metal skid with raised sections is used to mount the turbo in its running position. Either a metal or plastic cover can be used to protect the turbocharger from the weather.

### EMD Power Assemblies — Photo 9

There are several variations of containers used for transporting EMD power assemblies. One railroad uses an angle iron frame with tubes to hold eight complete assemblies. Both fork lift pockets and

lifting eyes are used for moving the container. The power assemblies are wrapped in plastic for protection.

Several other railroads use the same principle without the tubes. An angle iron frame holds eight power assemblies in position, generally four fork rod and four blade rod assemblies.

Where required, sectional box-type containers can be used for individual power assembly components, such as heads, liners, pistons, and rods.

### GE Power Assemblies — Photo 10

Several railroads have shipping containers for GE power assemblies. One uses a container for four assemblies, which is a low profile design. The liner sits in a recessed hole at each of the four corners and a center upright with a lifting eye is used to lift the container, as well as pockets for fork lift movement.

Another railroad uses a similar principle but only holds two GE power assemblies. Fork lift pockets are used for movement of the container.

GE assemblies also can be shipped lying flat using a pedestal to support the rod. Box-type shipping containers are also used to transport GE power assembly components.

### Engine Governors — Photo 11

Several railroads use governor shipping containers due to the need to protect this component. The general design is an enclosed container with the governor fastened



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to a removable base plate. One railroad uses a clamshell door on the top to remove the governor vertically, while another railroad has a side entry door with the governor and base plate on slide rails for loading and unloading.

#### **Governor Power Pack — Photo 12**

One railroad uses a metal box for shipping governor power packs. The top half of the metal container lifts off for easy access. Two power packs can be carried in the container at one time; it is equipped with steel pegs to secure them in position.

#### **Radiators — Photo 13**

One design of a shipping container for radiator cores is a box with four cores placed vertically in pockets that are sectioned off. The tight clearances prevent the cores from moving in the pockets to eliminate the possibility of damage. The box containers are stackable to reduce storage space requirements.

Assembled radiator banks can also be transported using a longer version of the metal shipping container. The enclosed container prevents damage to the fins.

Lube oil coolers can be shipped vertically, two per container, by bolting to the flat metal skid.

#### **Air Compressors — Photo 14**

Several variations of air compressor containers are available. One railroad converted four-sided metal skids and provided securement bolts to hold the air compressors in position. Another railroad

has used flat metal containers with various bolt hole patterns to allow shipping any type of air compressor. Fork lift pockets are provided to transport the compressor to the work area.

In conjunction with the air compressors, metal four-sided skids have been converted for shipping air compressor heads, six to a skid. Clamshell doors were provided, wrapping the heads in plastic prevent weather deterioration.

#### **Cooling Fans — Photo 15**

One style shipping container also was constructed by modifying a surplus auto parts shipping rack. Two 36" or 48" cooling fans and motors can be transported, one above the other, in the open container, which has four vertical legs and cross pieces to support the lip of the fan. Dowel pins hold the cooling fans in position. Another version is used for shipping one cooling fan in a similar type of container.

#### **Locomotive Batteries — Photo 16**

While unnecessary for unitized batteries, a metal shipping container is used by one railroad to transport monoblock batteries. Each container which holds four batteries, has fork lift pockets located in the base. Sides on the container prevent the batteries from shifting or falling off.

#### **Hyatt Journal Bearing Boxes — Photo 17**

One railroad has a novel shipping container for transporting Hyatt

journal bearing boxes. Each container holds four boxes. The bottom of the container has rollers and the container is injected in the production line conveyor system so that the box is loaded as the last step. Boxes being returned for repair also are placed in the conveyor line and rolled out of the container onto the inbound conveyor.

This design illustrates how containers can become an integral part of a component rebuild production line.

#### Water and Lube Oil Pumps

Smaller components such as water pumps and lube oil pumps can easily be transported in sectional shipping containers. By sectioning the container, the components do not strike each other in transit while having the advantage of multiple shipment.

#### EMD Modules — Photo 18

At least one railroad uses enclosed boxes for shipping six EMD modules to a central repair point. A hinged lid is used for access, and the modules are placed in slots positioned face up. Another module container is color coded for shipment of bad order modules due to the difficulty of differentiating between good and defective modules visually. However, this does result in a one-way empty movement of the container. The containers can be padded to protect the modules from shock or impact in transit.

#### Dynamic Brake Grids

Box-type shipping containers also are used by some railroads to transport dynamic brake grids. Provisions may be made for forklift or crane handling.

The shipping containers discussed are but some of those currently used by many railroads. Sizes range from as small as a tool box to as large as a modified freight car. Regardless of size, all of them fulfill the primary objective of protecting the component being transported. Although initial expense of fabricating or purchasing containers may appear high, the long term reduction in shipping cost makes the containers an economically viable alternative.

In the committee's investigation of the use of shipping containers, it was found that many railroads have containers for transporting power assemblies, air compressors, and generators. A lesser number use shipping containers for components, such as modules, radiators, batteries, etc. Other containers may be in use or definitely can be developed for transporting numerous other components, such as engine blowers, speed recorders, power contactors, and others. There is no limit to the variety of shipping containers that can be utilized effectively and economically.

This committee recommends that each railroad evaluate its shipping methods and determine the benefits to be attained from using shipping containers.

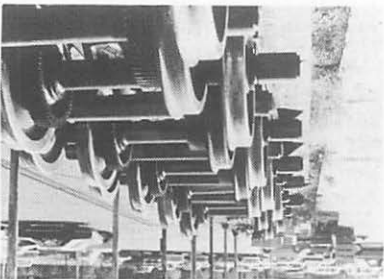


Photo 4

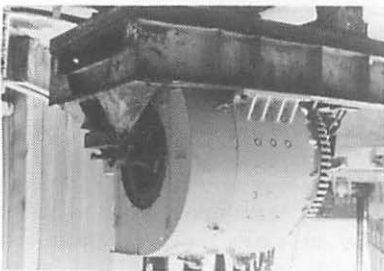


Photo 5

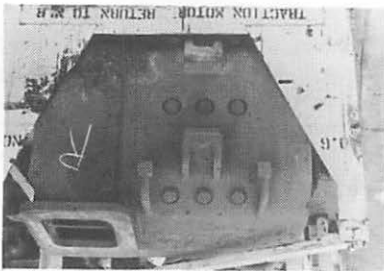


Photo 6

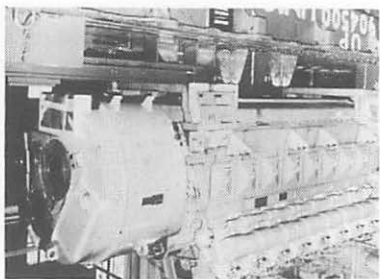


Photo 1

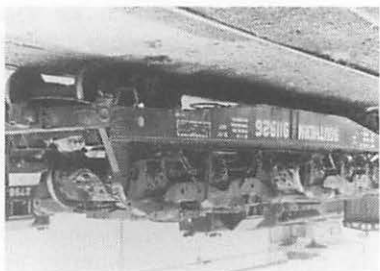


Photo 2

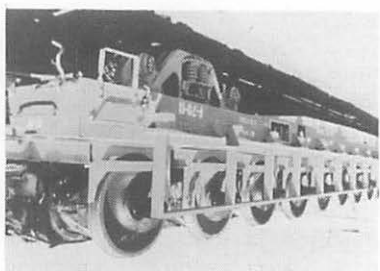


Photo 3

Photo 9

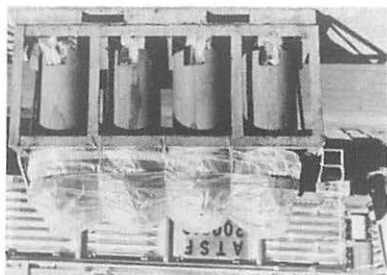


Photo 12

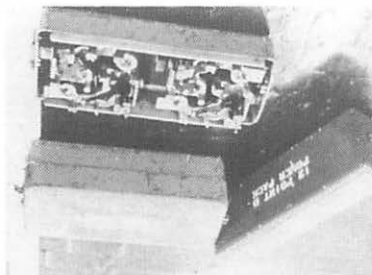


Photo 8



Photo 11

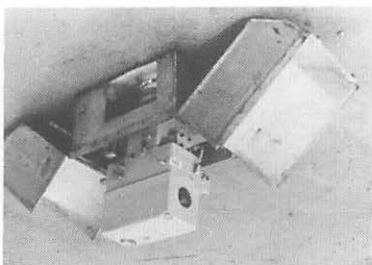


Photo 7

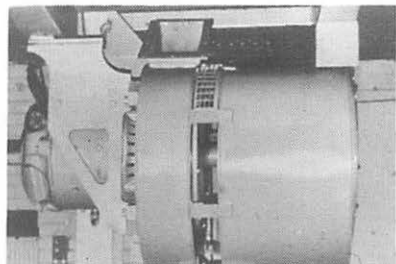
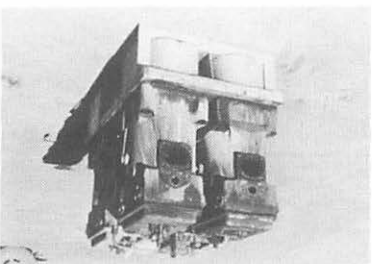


Photo 10



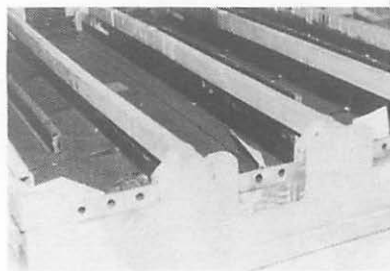


Photo 13

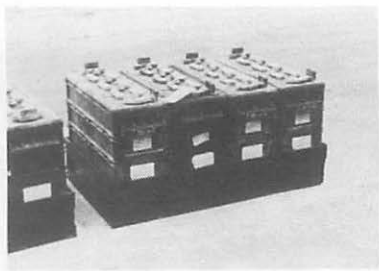


Photo 16

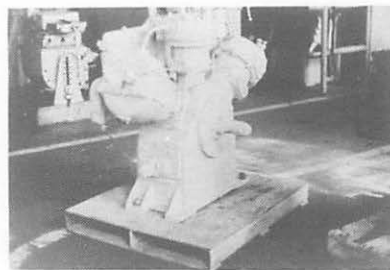


Photo 14

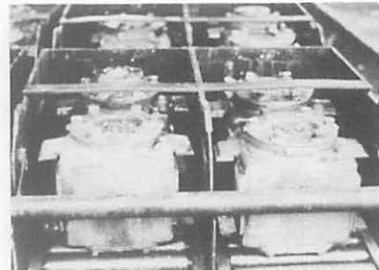


Photo 17

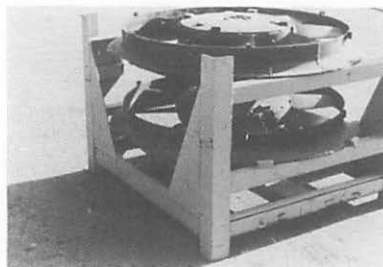


Photo 15

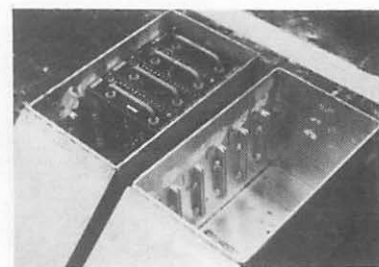


Photo 18

**DIESEL MATERIAL CONTROL  
COMMITTEE**

**Five-Year Index**

1981

**Diesel Material Control:  
Innovations In Material Handling  
and Control**

1. Disposal of Unserviceable Component Parts: What is the Most Profitable Method?
2. Innovations in Stores Material Handling, Via Computer Technology
3. Locomotives Held for Material: An Update for the 80's
4. The Best Approach to Procuring Material; New, UTEX, Repair and Return or Shop Repair

1980

**Locomotive Material Management: What Lies Ahead  
in the 80's?**

1. Robbing Material — Its Consequences to the Railroad
2. Cyclical and Seasonal Demand for Material — Some Counteractive Methods
3. Improved Mechanical Department and Material Department Communications — One Step to More Efficient Locomotive Maintenance
4. Uses and Service Life of Reclaimed Power Assembly Components

1979

**Material Management:  
Dollars Saved  
Through Efficiency**

1. Investment and Cost of Carrying Inventory — 1979 (A Comparison with the Committee's 1973 Study)
2. Dollars Saved Through Advanced Inventory Control Systems, Via Increased Availability

1978

**Problem Solving Through  
Analysis and Projection**

1. Warranty Labels and Their Use
2. Economics of Rebuilt Components
3. What Have We Learned From the 1975 Material Crisis?
4. Locomotives Held for Material
5. Computerized Information Systems

1977

**Production Stops —  
Causes and Cures**

1. Units Held for Material
  - a. Causes: Mechanical? Stores? Etc.?
  - b. Methods for Correction: Scheduling? Computer? Etc.?
2. Changing Warranty Procedures
3. Progress Made in Using Pressure Sensitive Labels





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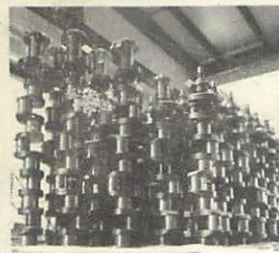
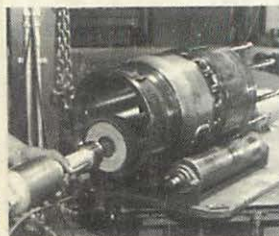
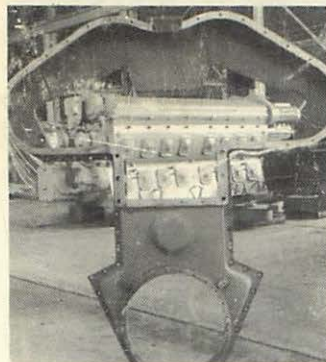
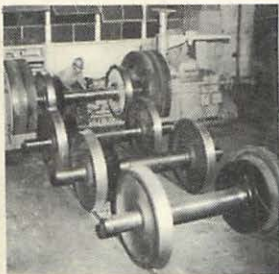
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